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Original Article

Maternal and fetal factors affecting birth length of healthy newborn babies: An observational study

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Abstract

Background: Length is an important neonatal measurement at birth. Many studies in the past have analyzed the birth weight and factors affecting it but studies that investigated the relationship between maternal factors and birth length are scarce and inconsistent. **Purpose:** This study was conducted with the aim to estimate the effect of maternal and fetal factors on birth length in singleton pregnancy. **Methods:** The present cross-sectional observational study was conducted in a tertiary care center in central India during February 2012. Of 450 deliveries, 191 newborns were included on the basis of inclusion criteria. The weight of the baby was taken by electronic weighing scale, and length was taken with infantometer. Babies were divided into two groups based on Fenton's chart, and Group A had babies with birth length <3rd centile and Group B had babies with birth length >3rd centile. The effects of factors such as maternal age, weight during last trimester of pregnancy, education, maternal and paternal height, parity, socioeconomic status, occupation, and residence were assessed. Fetal factors such as birth weight, sex, and birth order were assessed. **Results:** On analysis of data, it was found that maternal weight ($p<0.001$), maternal height ($p<0.001$), and occupation ($p=0.04$) was significantly associated with the length of the babies. The incidence of low birth length was lesser (53.37%) among housewives as compared to working mothers (72.09%) with $p<0.05$. Socioeconomic status, paternal height, and parity had no significant relationship with birth length. On analysis of fetal factors, birth weight ($p<0.001$) and head circumference (<0.001) were significantly associated with birth length. **Conclusions:** It may be concluded that length at birth may be influenced by factors such as maternal weight and occupation, which indirectly show the nutritional status of the mother.

Key words: *Birth length, Maternal weight, Birth weight*

Length is an important neonatal measurement at birth, but factors affecting the length of a baby at birth are less known. Many studies in the past have analyzed determinants of birth weight and factors affecting it [1-4]. Studies that investigated the relationship between maternal factors and birth length are scarce, and those available are inconsistent. The length of a fetus is an important factor for assessment of antenatal wellbeing, besides length at birth may also have an effect on the future height of a baby. Length can be an essential indicator for monitoring and evaluating maternal and child health programs [5].

This study was conducted with the aim to estimate the effect of parental and fetal factors on crown heel length at birth in singleton pregnancy in a tertiary care center of the central India.

METHODS

The present cross-sectional observational study was conducted in the Department of paediatrics of a tertiary care hospital during February 2012. The study protocol was approved by Ethics Committee of the Institute. Consecutive sampling was done for over a period of time, and all babies who fulfilled inclusion criteria during that period were included in the study.

In the month of February 2012, 450 deliveries were there in the labor room of the hospital. Of these deliveries, 191 newborns were included on the basis of following inclusion criteria: Single pregnancy with gestational age more than 37 completed weeks, normal vaginal delivery, and birth weight ≥2.5 kg. Informed consent from all the parents participating in the study was taken. Babies born with assisted/lower segment caesarian section (LSCS) delivery, having no antenatal visits, with any congenital malformation and parents not willing to participate in the study were excluded. Babies born with LSCS were excluded from the study to simplify the identification of normal newborns because some babies may have some problem antenatally for which LSCS was performed. The healthy newborn was defined as a baby having no antenatal and postnatal morbidity in first 24 h.

These newborns were analyzed in postnatal wards. The weight of baby as taken within first 24 h by electronic weighing scale with precision of 0.001 kg, length was taken with infantometer with precision of 1 mm, and head circumference was taken by non-stretchable tape, and babies were divided into two groups. Length was plotted in Fenton's fetal-infant growth chart (WHO growth standard version) after 40 completed weeks. Separate growth charts were used for boys and girls, and babies were divided into two groups Group A and Group B. Those babies falling below 3rd centile in gender appropriate growth curves were defined as small length at birth [6] and were put in Group A while those with above third centile were considered to have normal length and were put in Group B.

Maternal factors such as maternal age, education, parity, socioeconomic status, occupation, and residence were taken from antenatal records of the mother. Maternal weight during the last trimester was taken from an electronic weighing scale with a precision of 0.01 kg, and height was taken from stadiometer with the precision of 1 mm. Paternal height, educational status, and occupation were also noted down. Maternal education was noted and categorized from illiterate to intermediate and above; while according to parity, they were categorized as primiparous and multiparous. Socioeconomic status was assessed using Kuppuswami index and divided into upper, middle, and lower class; and residence was categorized as rural and urban. Fetal factors such as weight, sex of the baby, birth order, and head circumference were assessed from above mentioned methods.

Statistical Analysis

Demographic factors and clinical characteristics were summarized as counts (percentages for categorical variables such as maternal occupation, education, and parity, etc., and as mean for normally distributed continuous variable such as maternal weight, and height, etc.,). Both groups were compared using the Chi-square test for categorical variables and Student's *t*-test was done for continuous variables. The multivariate regression analysis stepwise method was done to assess the correlation between different variables affecting the birth length. Statistical analysis was done by SPSS software version 22.

RESULTS

Of the total 191 babies included in the study, 110 (57.5%) babies were in Group A and 81 (42.5%) babies were in Group B. Table 1 summarizes the characteristics of both the groups. Mothers who had normal length babies had significantly higher mean weight in the last trimester than mothers who had stunted babies ($p<0.001$). Similarly, mean maternal height in Group A was 153.5 cm (standard error - 0.54) was significantly higher than in Group B (151.1±0.54 cm) ($p<0.001$). There was no significant relation birth length with maternal age and paternal height. Mean birth weight was higher in Group B 3.1 kg (SE - 0.04) than in Group A with mean weight of 2.7 kg (SE - 0.02) and mean head circumference was also higher in Group B than Group A. Both these parameters were significantly associated with birth length.

We analyzed categorical variables with the Chi-square test (Table 2). Residence of mother, socioeconomic status, maternal education, maternal occupation, birth order, and gender of the baby were assessed. We could not find any significant relation among these factors and stunting at birth except maternal occupation (Table 2). Working mothers had smaller babies as compared to non-working mothers in our study with 72.1% stunting in working

Table 1: Baseline characteristics of both the groups studied

Characteristics	Mean±SE		p-value
	Group A (<3rd percentile)	Group B (>3rd percentile)	
Maternal age (years)	23.4±0.34	23.7±0.35	0.395
Maternal weight (kg)	50.6±0.74	57.5±1.07	<0.001
Maternal height (cm)	151.1±0.49	153.5±0.54	0.001
Paternal height (cm)	166.5±0.67	166.3±0.75	0.857
Birth weight (kg)	2.7±0.02	3.1±0.04	<0.001
Head circumference (cm)	33.6±0.09	34.1±0.10	<0.001

Table 2: Categorical variables studied in relation to birth length of babies

Parameter	Group A (<3rd percentile)	Group B (>3rd percentile)	Total	p-value
Residence				
Urban	24 (64.9)	13 (35.1)	37	0.41
Rural	86 (55.8)	68 (44.2)	154	
Socioeconomic status (Kuppuswamy index)				
Middle	23 (58.9)	16 (41.1)	39	1
Lower	87 (57.6)	64 (42.4)	151	
Maternal education				
Illiterate+Primary	31 (52.5)	28 (47.5)	59	0.20
High school+Matric	59 (64.1)	33 (35.9)	92	
Inter and above	20 (50)	20 (50)	40	
Maternal occupation (%)				
Housewife	79 (53.3)	69 (46.7)	148	0.04
Working	31 (72.1)	12 (27.9)	43	
Parity				
Primi	66 (58.4)	47 (41.5)	113	0.887
Multi	44 (56.4)	34 (43.5)	78	
Sex of baby				
Male	56 (52.3)	51 (47.7)	107	0.13
Female	54 (64.2)	30 (35.8)	84	

mothers as compared to 53.3% in housewives, which was statistically significant (p=0.04). Most of the working mothers in our study were laborers with 27.2% in Group A while 13.5% in Group B (Fig. 1).

Table 3 shows the correlation coefficients of various factors studied. Of all factors, maternal weight, and height, birth weight, and head circumference were significantly correlated with birth length. Table 4 shows the results of stepwise regression analysis on birth length with associated factors as independent variables. The contribution of birth weight was the strongest with birth length. Maternal weight significantly affected the birth length and head circumference was also significantly associated. Maternal age, socioeconomic status, parity, maternal height, paternal height, and gender did not meet the 0.05 significance level for entry into the model.

DISCUSSION

Maternal weight and occupational status of the mother have an important effect on the birth length of their offspring as we have demonstrated in our study [7]. Birth weight and head circumference were significantly associated fetal factor. Other factors studied such as educational status, parity, socioeconomic status, residence, and sex of baby had no effect in birth length. Mean maternal age was found to be similar in both groups in our study. Elshibly and Schmalisch, in their study in Sudan showed that young adolescent women tend to deliver smaller babies [8]. Similar findings have been reported by other authors also [9,10].

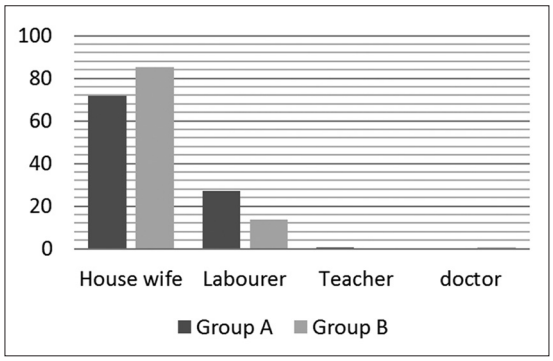

Figure 1: Distribution of occupation of mother in both groups

Table 3: Correlation coefficient of various factors studied on birth length

Factor	Coefficient	p-value
Maternal age	0.11	0.06
Socioeconomic status	−0.03	0.34
Gravida	−0.02	0.41
Maternal weight	0.45	<0.001
Maternal height	0.19	0.004
Paternal height	−0.02	0.40
Birth weight	0.64	<0.001
Gender	0.15	0.41
Head circumference	0.52	<0.001

Maternal weight during the last trimester was the most important maternal factor affecting the birth length in our study. A study in Vienna, Austria showed that obese mothers tend to have babies heavier and longer than normal weight mothers [11]. Elshibly and Schmalisch [8] and Kumar et al. [9] found that the maternal pregnancy weight was significantly associated with birth length of the babies. It may be attributed to better nutrition and antenatal care to these mothers which increase the birth length [12].

In our study, occupation was a variable which was found to be significantly associated with the birth length, which may show the importance of rest during pregnancy and also the lack of the proper nutrition in working mothers due to work pressure. However, period of the rest and nutrition during pregnancy were not assessed on this study, which is an important limitation of our study. Most of the working mothers were laborers in this study (Fig. 1), which showed that these mothers may have less time for rest during the pregnancy. Similar finding were shown in a study held in Europe which showed that the working mothers tend to have smaller babies [13].

The effect of maternal height on the crown heel length of the newborn has been found to be statistically insignificant which is in consonance with findings of another study [14]. The length of the babies is distributed almost equally in either primipara or multipara mother and rural or urban mothers. Birth weight was the major fetal factor affecting the birth length. Although, we could not found any relation with gender and birth length but in studies conducted in Japan and Turkey, gender was significantly correlated with birth length [15,16].

The major strength of this study was that all healthy neonates born in labor room were taken into account. The limitation of the present study may be that the sample size was small. Further research is required with sufficient sample size and adequately power study (>80%) to support these results.

Table 4: Results of multiple regression analysis of factors associated with birth length (stepwise method)

Dependent variable	Independent variable	Beta	p-value	Multiple *R*	Adjusted R^2
Birth length	Birth weight	0.443	<0.001	0.698	0.479
	Maternal weight	0.223	<0.001		
	Head circumference	0.199	<0.001		

CONCLUSION

From this study, it may be concluded that length at birth may be influenced by factors such as maternal weight and occupation, which indirectly show the nutritional status of the mother. Long-term implications of assessing the birth length may require further longitudinal follow-up studies. Although, the genetic factors have always been known to affect the length of a person, but environmental factors may also be an important determinant of length.

AUTHORS CONTRIBUTIONS

AV: Collected the data and conducted the study; DD: Helped AV in conducting a study and writing the first draft of the manuscript conceived and supervised the study. Finalized the manuscript and will be the guarantors.

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