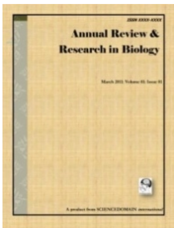

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Birth Weight Correlation with Conception Interval and Other Factors in Bangladesh New Born

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Authors' contributions

This research was carried out in collaboration between all authors. Authors MSR, MSH, MFH and MIK designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors MSR, MSH and MIH managed the analyses of the study. Authors MSR and KSI managed the literature searches. All authors read and approved the final manuscript.

Research Article

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ABSTRACT

Aims: Low birth weight (LBW) is a major health problem and a significant contributor to neonatal death in both industrialised and developing countries. To examine the birth-weight status of newborns and to identity the relationship between birth-weight and other anthropometric parameters of newborns.
Study Design: Three districts of Khulna division from South-west region of Bangladesh were our primary study area. Pregnant women attending the selected hospitals and clinics for delivery purpose and their newborn babies during the study period were regarded as the study subjects. A multistage sampling procedure was adopted in selecting the ultimate sampling unit for the present study.
Place and Duration of Study: This cross sectional study was carried out among the mothers and their newborn babies at the South-west region of Bangladesh, during the

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time period January 2008 to December 2008.
Methodology: Data of socio-demographic factors, obstetric history, lemal morbidities, anthropometrics parameters of mother, hematological ors, and anthropometric parameters of the newborn baby subsections were collected in a questionnaire form. Anthropometric parameters of the newborns were recorded by the investigator within 18 hours of birth by standard techniques described byJelliffe and Jelliffe in 1989. All the newborns were weighed naked on a spring electronic balance with a maximum paucity of 15kg and a minimum of 125g and 5g subdivisions. The weighing machine was checked daily by known standard weight before weighing. Crown heel length (CHL) was measured to the nearest of 0.1cm on a manometer. Head circumference (HC) was measured between glabella anteriorly and along the most prominent point posteriorly within the 24 hours of delivery. Chest circumference (CC) was measured at the level of nipple at the end phase of expiration. Mid-upper arm circumference (MUAC) was measured at the midpoint between the tip of acromion process and olecranon process of the left upper arm.
Data were analyzed using standard statistical methods, which include correlation-coefficient, analysis of variance, simple and multiple regressions, and sensitivity and specificity analyses for different cut-offs of the newborns (CHL, HC, CC, MUAC).
Results: The mean birth-weight was 2754.81±465.57g and 28.6% were low-birth-weight (<2,500 g) babies. All key anthropometric parameters of the newborns significantly correlated with infant birth-weight (P<0.05). Mid upper arm circumference and chest circumference were identified as the optimal surrogate indicators of LBW babies.
Conclusion: In the community where weighing of newborns is difficult, these measurements can be used to identify the LBW babies.

Keywords: Anthropometric surrogates; newborn; low birth weight; cross sectional study.

1. INTRODUCTION

In recent years, there has been a considerable interest in using simple anthropometric measures as a proxy for birth-weight. Of the approximately four million global neonatal deaths that occur annually, 98% occur in developing countries, where most newborns die at home while they are being cared by mothers, relatives, and traditional birth attendants (TBA) [1]. About 38% of total under-five mortality occurs during the first 28 days of life and nearly three quarters of these deaths occur during the first week of life [2]. Globally, about one-sixth of all newborns are low birth weight (LBW, <2500 grams), which is single most important underlying risk factor for neonatal deaths [3,4]. Only about half of the newborns are weighed at birth and for a smaller proportion of them gestational age is known [5]. An estimated 18 million babies are born with Low Birth Weight (LBW) and half of them are born in south Asia [6]. Although these LBW babies account for 14% of the children born, they account for 60–80% of neonatal deaths [7]. Moreover, LBW babies who survive the critical neonatal period may suffer impaired physical and mental growth. Therefore, an early identification and prompt referral of LBW newborns is vital in preventing neonatal deaths. Available evidence from resource-poor settings shows that extra essential newborn care for LBW babies can reduce the number of neonatal deaths by 20–40% [8]. Research has also shown that this extra essential newborn care may be delivered by health workers or family members if they are suitably trained. In resource-poor settings, a large proportion of deliveries take place at home and birth-weight is most often not recorded. Therefore, there is a need to develop simple, inexpensive and practical methods to identify LBW newborns soon after birth [9]. One such method may be the use of anthropometric surrogates to identify LBW babies.

Infant's sex difference, birth to conception interval, gestational age, apgar score are associated with infant birth weight. Boys grow faster than girls from an early stage of gestation, even from before implantation [10]. It was found that, birth to conception interval of six months or less were associated with an increased risk of intrauterine growth restriction [11]. Mcaleod and Kiely [12] also reported a strong association between birth weight and duration of pregnancy. Apgar score is a simple and repeatable method to quickly and summarily assess the health of newborn children immediately after birth [13,14]. The five minute Apgar score is positively correlated with birth-weight and is higher in small for gestational age infants compared with their appropriately grown counterparts [15].

In Bangladesh most delivery cases take place in home and performed by senior experienced relatives or by the TBA locally known as *Dias.* Though many TBA are trained they have no weighing scale in their delivery-kits. Moreover in most health complexes, babies are not weighed routinely due to lack of a suitable weighing scale at the centre. However, for this reason a number of alternative anthropometric measurements have been proposed as surrogate for birth-weight [16,17]. These include the circumferences of the newborn's head, chest, and mid arm, and crown-heel length.

Several researchers have attempted to identify suitable anthropometric surrogates which are simple and reliable to identify LBW babies. Recent hospital-based studies from India, Bangladesh and other developing countries have suggested different anthropometric surrogates to identify LBW babies and have also recommended various cut-off values for identification of LBW babies [18-27]. Available evidence suggests that there is a lack of consensus about most reliable anthropometric surrogate and a fixed cut-off point.

The aim of this study was to assess the potential relationship between birth weight and infant parameters, such as sex, conception interval, gestational age, and apgar score, in order to identify low birth weight newborns from South-West region of Bangladesh.

2. METHODS AND MATERIALS

This cross sectional study was carried out among the mothers and their newborn babies at the South-west region of Bangladesh, during the time period January 2008 to December 2008. Almost everywhere in Bangladesh, incidence of low birth weight is unacceptably high. Due to the limitations of time and resources it is not possible to conduct the study covering the whole country. Therefore, specific areas are chosen by a multistage sampling procedure. Three districts of Khulna division from South-west region of Bangladesh our primary study area. Pregnant women attending the selected hospitals and clinics for delivery purpose and their newborn babies during the study period were regarded as the study subjects. A multistage sampling procedure was adopted in selecting the ultimate sampling unit for the present study. In the first stage, three districts of Khulna division: Jessore, Kushtia and Jhenaidah were randomly selected as primary sampling units. In the second stage, twelve subdistricts called upazillas out of twenty of the aforesaid districts were randomly selected as secondary sampling units. In the third stage, thirty eight Hospitals and clinics were randomly selected taking at least three from each of the upazillas. In this stage nine mothers and their newborns from each hospitals and clinics were targeted to collect data. However in case of JessoreSadar Hospital ten mothers and their newborns were targeted. To have a representative sample of population of the study districts, it was decided to collect data from five upazillas from Jessore, four upazillas from Kushtia and three upazillas from Jhenaidah district. Women with normal vaginal delivery and live singleton birth were included in this study. Women with multiple pregnancies, caesarian section and still birth were excluded from study. The subjects were informed about the nature of the study and verbal consent was taken from them before data collection. Data were collected by the researchers themselves. Data of socio-demographic factors, obstetrical history, lemal morbidities, anthropometrics parameters of mother, hematological tumors, anthropometrics parameters of the newborn baby subsections were collected in a questionnaire form. Anthropometric parameters of the newborns were recorded by the investigator within 18 hours of birth by standard techniques [28]. All the newborns were weighed naked on a spring electronic balance with a maximum paucity of 15kg and a minimum of 125g and 5g subdivisions. The weighing machine was checked daily by known standard weight before weighing. Crown heel length (CHL) was measured to the nearest of O.1cm on a manometer. Head circumference (HC) was measured between glabella anteriorly and along the most prominent point posteriorly within the 24 hours of delivery. Chest circumference (CC) was measured at the level of nipple at the end phase of expiration. Mid-upper arm circumference (MUAC) was measured at the midpoint between the tip of acromion process and olecranon process of the left upper arm.

Data were analyzed using standard statistical methods, which include correlation-coefficient, analysis of variance, simple and multiple regressions, and sensitivity and specificity analyses for different cut-offs of the newborns (CHL, HC, CC, MUAC).

3. RESULTS AND DISCUSSION

3.1 Relationship between Birth Weight and Sex of Newborns

Table-1.1 and Figs. (2.1 and 2.2) shows the percentage of distribution of birth weight by sex. It was found that LBW was 34.9% in female infant and 21.0% in male infant, respectively. Inadequate birth weight (2500 to 2999g) was found to be 41.4% in female babies and 38.9% in male babies. Adequate birth weight (3000g or more) was 23.7% in female babies and 40.1% in male babies. And it was statistically significant(X^{2} = 13.321, *P*<0.05).Variance analysis also shows that the mean difference of birth weight between male and female newborns was 193.74g but the difference was statistically insignificant (F = 15.363, *P*<0.05).

Table 1.1. Relationship between Birth Weight and sex of newborns

	Birth weight (g)										
Variable	<2500		2500 - 2999		3000 +		X2 (0.5)	Mean	SD	F (0.5)	Total no. of cases
	n	%	n	%	n	%					
Sex of newborn											
Male	33	21.0	61	38.9	63	40.1		2859.87	476.480		186
Female	65	34.9	77	41.4	44	23.7	13.321	2666.13	438.157	15.363	157
Both	98	28.6	138	40.2	107	31.2	(0.5)	2754.81	465.568	(0.5)	343

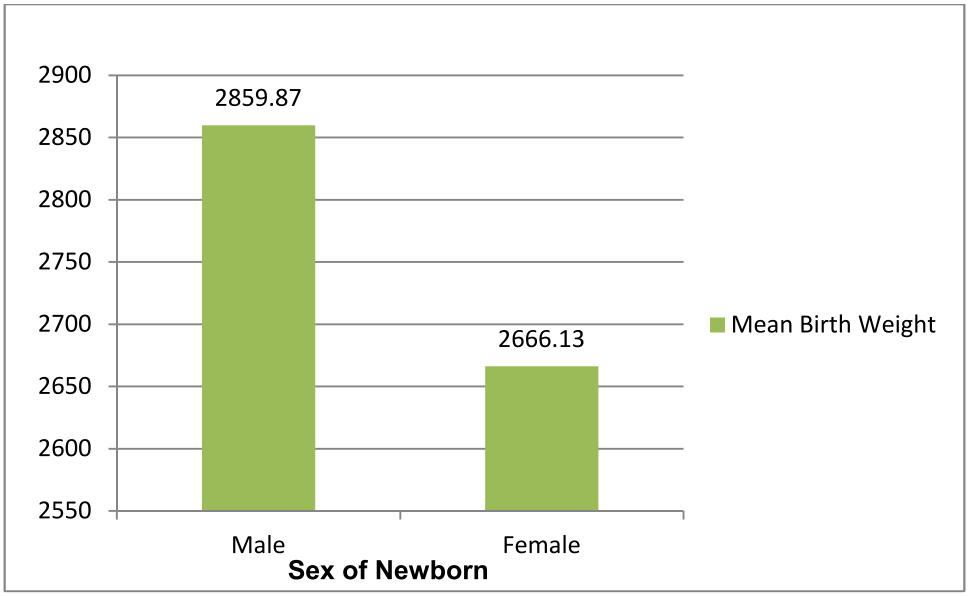

Fig. 2.1. Mean birth weight by sex

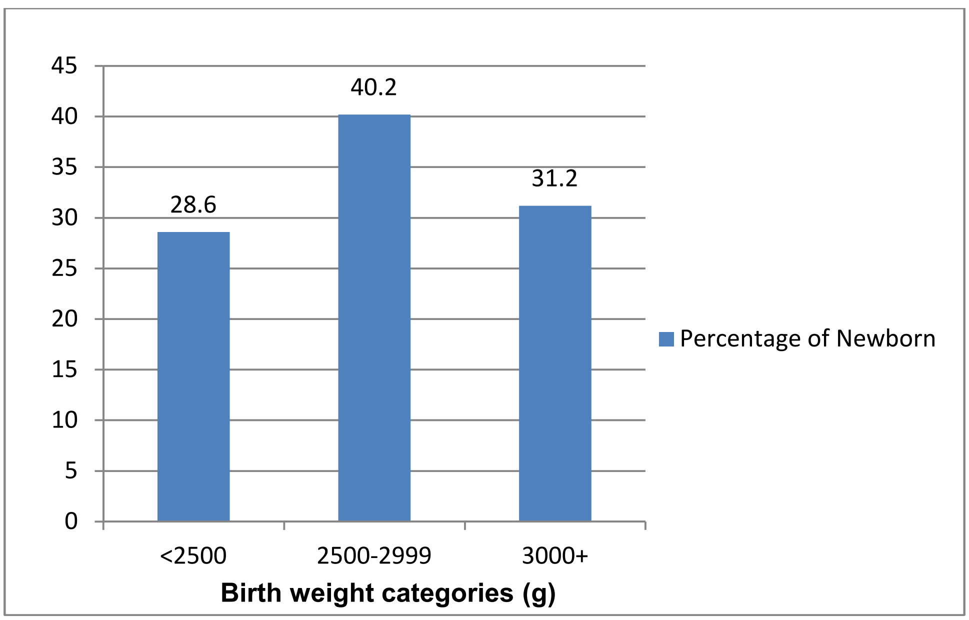

Fig. 2.2. Distribution of newborns by birth weight category

3.2 Relationship between Birth Weight and Birth to Conception Interval

Effects of conception interval on birth weight are presented in Table 1.2. The highest percentage of LBW was found to be 37.5% when the interval was 60 or more months. Second (32.5%) and third (30.8%) highest percentage of LBW was found in 37-48 and 12 months group, respectively. Incidence of LBW was about 20% when the birth to conception interval was between 49–59 months. Incidence of adequate birth weight was observed 37.5% and 35.0% for interval of 60 or more months and 49–59 months, respectively. For first born this incidence was found to be 30.3%. The result is statistically insignificant (X^2 = 2.244, $P<0.05$). There were no significant differences in mean birth weights among different birth to conception interval groups (F = 0.440, $P<0.05$).

Table 1.2. Relationship between Birth Weight and birth to conception interval

Variable	Birth Weight (g)									
	<2500		2500-2999		3000+		X2 (P)	Mean	SD	F (P)
	n	%	n	%	n	%				
Birth to conception interval (month)										
No prior	40	28.2	59	41.5	43	30.3		2705.00	461.354	
Up to 12	4	30.8	5	38.5	4	30.8		2754.93	454.013	
13 – 24	15	27.8	22	40.7	17	31.5		2724.07	414.790	
25 – 36	19	28.8	25	37.9	22	33.3		2777.27	514.944	
37 – 48	13	32.5	16	40.0	11	27.5		2707.69	504.086	
49 – 59	4	20.0	9	45.0	7	35.0	2.244 (0.05)	2890.00	515.956	0.440 (0.05)
60 +	3	37.5	2	25.0	3	37.5		2762.50	385.218	
Total	98	28.6	138	40.2	107	31.2		2754.81	465.568	

3.3 Relationship between Birth Weight and Gestational Age

The effect of gestational age on birth weight is shown in Table 1.3 and Fig. 2.3. Mean birth weight gradually increased as gestational age increased. The highest mean birth weight was observed 3120.00g in 39–40 weeks of gestational age subgroup. The result was highly significant (F = 2.625, $P<0.05$). Fig. 2.3 shows the increased trend mean birth weight from 31 weeks onwards. But at 37 weeks birth weight drooped slowly and then after 38 weeks weight increase sharply.

Table 1.3. Relationship between birth weight and gestational age

Variable	Birth Weight(g)									
	<2500		2500-2999		3000+		X2 (P)	Mean	SD	F (P)
	n	%	n	%	n	%				
Gestational age (weeks)										
31-32	9	42.9	9	42.9	3	14.3	14.795	2561.9	390.482	2.625
33-34	12	27.3	21	47.7	11	25	(0.05)	2718.18	407.644	(0.05)
35-36	37	34.6	40	37.4	30	28		2723.36	479.894	
37-38	22	19.8	47	42.3	42	37.8		2848.65	474.986	
39-40	18	32.7	19	34.5	18	32.7		3120	456.624	
40+	0	0	2	40	3	60		2696.36	408.656	
Total	98	28.6	138	40.2	107	31.2		2754.81	465.568	

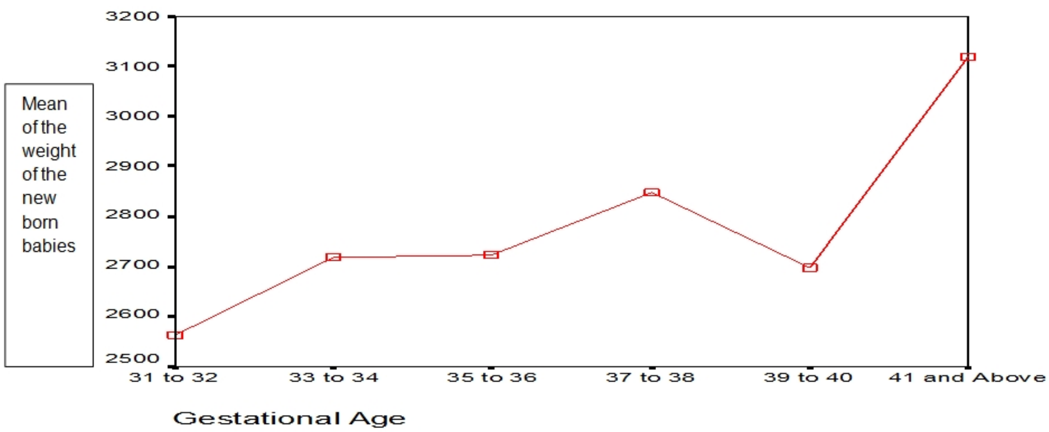

Fig. 2.3a. Relationship between mean birth weight and gestational age

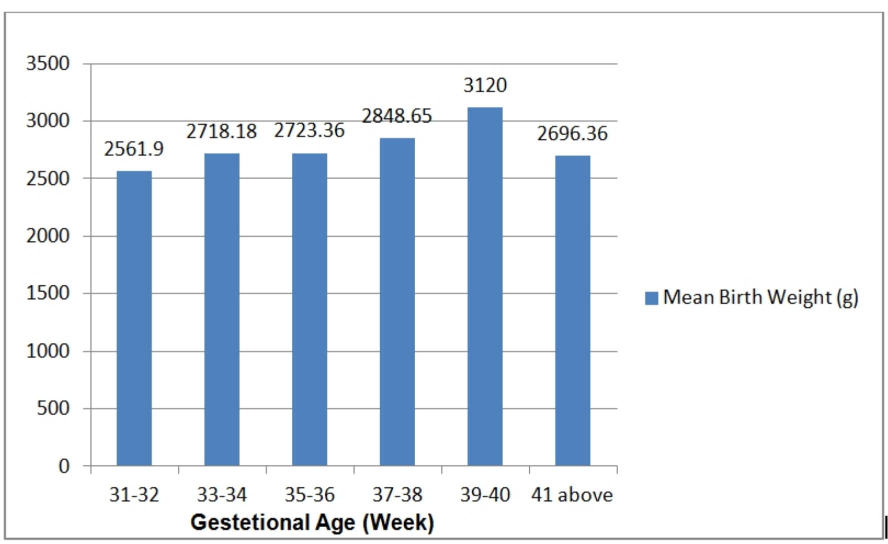

Fig. 2.3b. Mean birth weight in relation to gestational age

3.4 Relationship between Birth Weight and Apgar Score

Apgar score was recorded at birth and according to the scoring birth weight was categorized. Table-1.4 shows that incidence of LBW was 28.1% for Apgar score up to 7 and 25.0% for Apgar score 8 or more than 8. Incidence of adequate birth weight was highest (50.0%) for Apgar score 8 or more than 8. 33.3% for 7 and only 30.7% for up to 6. Mean birth weight difference between from highest to lowest Apgar score was found to be 197.39g (F = 0.354, *P*<0.05) which is statistically significant. The Fig. 2.4 shows the relationship between Apgar score and mean of the weight of the newborn babies which was found to be increased sharply from Apgar score 7 to 8 and above but a steady result for 6 to 7.

Table 1.4. Relationship between Birth Weight and Apgar Score

Variable	Birth Weight (g)									
	<2500		2500-2999		3000+		X2 (P)	Mean	SD	F (P)
	n	%	n	%	n	%				
Apgar score										
Up to 6	86	28.1	126	41.2	44	30.7	1.516 (0.5)	2752.61	463.567	0.354 (0.5)
7	11	33.3	11	33.3	11	33.3		2751.52	486.776	
8+	1	25.0	1	25.0	2	50.0		2950.00	532.291	
Total	98	28.6	138	40.2	107	31.2		2754.81	465.568	

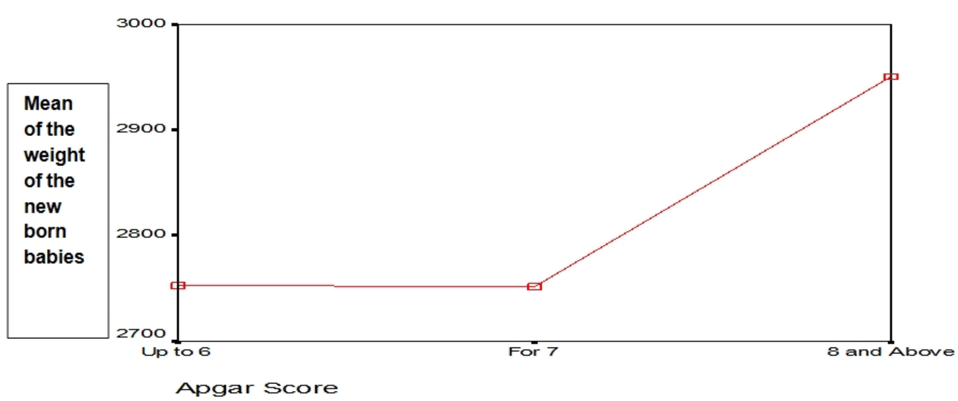

Fig. 2.4. Relationship between mean birth weight and apgar score

3.5Birth Weight and Surrogate Markers

<u>3.5.1 Midupper arm circumference (MUAC) of newborns</u>

Table-1.5 represents the mean birth weight of newborns in relation to categories of MUAC. The mean birth weight was found to be progressively higher with increasing MUAC (Fig. 2.5). The difference in mean birth weight from the highest (12 cm or more) to the lowest (7.0 – 9.9 cm) MUAC was found to be 524.67 g (F = 37.141, *P*<0.05).

Table 1.5. Birth weight and newborn's MUAC

Variable	Mean	SD	F (P)	Total no. of cases
MUAC (cm)				
7.0 – 9.9	2430.14	355.389		73
10.0 –10.9	2672.88	324.744	37.141	59
11.0 – 11.9	2928.86	447.172	(0.5)	201
12.0 +	2954.81	448.568		333

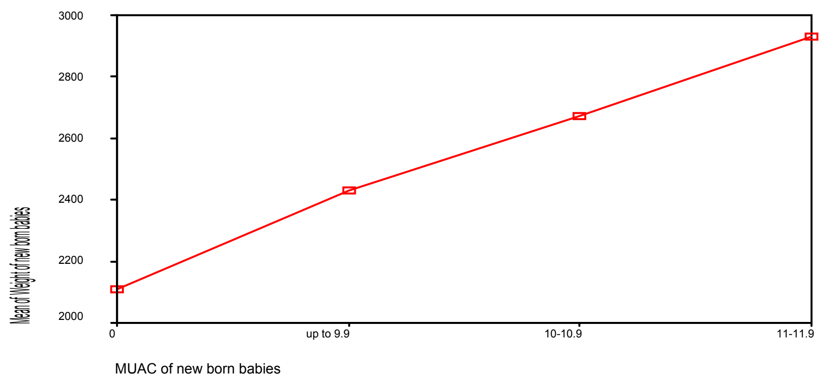

Fig. 2.5. Relationship between mean birth weight and newborn's MUAC

3.5.2 Chest circumference (CC) of newborns

Table-1.6 shows the distribution of mean birth weight of newborns in relation to different categories of CC. Result shows that the mean birth weight was increased with the increasing of CC (Fig. 2.6). The highest mean birth weight was found to be 3141.46g when CC was between 32 to 33.9 cm and lowest mean birth weight was 2619.44g for the lowest range (up to 29.9 cm) of CC. The difference of mean birth weight was found 522.02g between the highest and lowest CC group of newborns (F = 37.281, P<0.05).

Table 1.6. Birth weight and chest circumference

Variable	Mean	SD	F (P)	Total no. of cases
Chest Circumference (cm)				
Up to 29.9	2619.44	392.969		180
30.0 – 31.9	2964.21	424.494	37.281	95
32.0 – 33.9	3141.46	404.95446	(0.5)	41

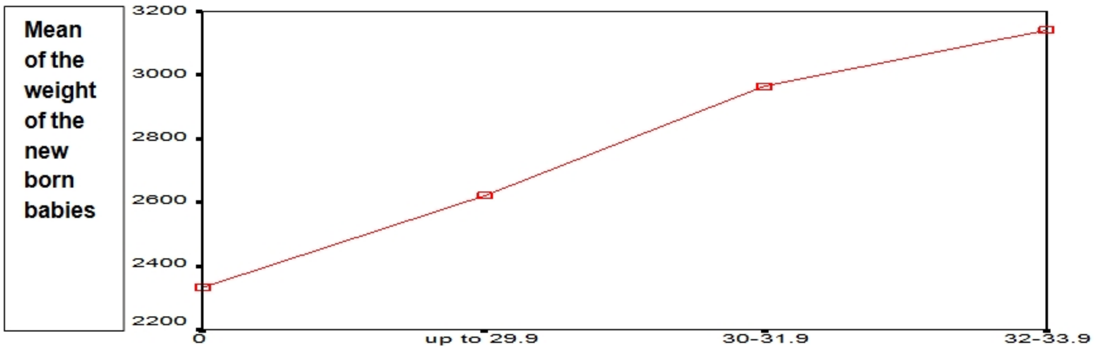

Fig. 2.6. Relationship between mean birth weight and chest circumference

3.5.3 Head circumference (HC) of newborns

Table-1.7 shows the distribution of mean birth weight of newborns in relation to different categories of HC. The birth weight was found to be progressively higher with increasing head circumference (Fig. 2.7). Mean birth weight was 2365.85g for HC ranging from 27.0 to 29.9 cm and 3366.67g for HC 36 cm or more. The difference was 1000.82g (F = 52.382, P<0.05).

Table 1.7. Birth weight and Newborn's HC

Variable	Mean	SD	F(P)	Total no. of cases
Head Circumference (cm)				
27.0 - 29.9	2365.85	304.785		82
30.0 – 32.9	2792.27	434.034	52.382	194
33.0 – 35.9	3116.07	318.392	(0.5)	56
36.0 +	3366.67	278.388		9

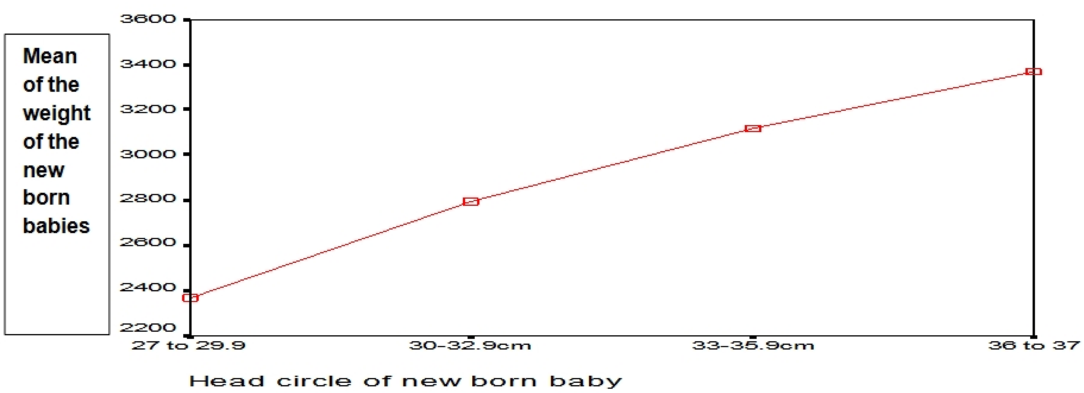

Fig. 2.7. Relationship between mean birth weight and newborn's HC

3.5.4 Crown heel length (CHL) of newborns

Table-1.8 depicts the relation between mean birth weight of newborns and different categories of CHL. The result shows that mean birth weight was increased with the increasing of newborn's CHL (Fig. 2.8). For crown heel length, mean birth weight was found to be 2359.26g when it ranges from 40.0 to 44.9 cm and 3282.61g when CHL was 51.0 cm or more. The difference in mean birth weight between the highest and lowest CHL group of newborns was 923.35g.

Table 1.8. Birth weight and newborn's CHL

Variable	Mean	SD	F(P)	Total no. of cases
Crown Heel Length (cm)				
Up to 44.9	2359.26	418.226		54
45.0 – 47.9	2588.89	355.793	65.285	144
48.0 – 50.9	3015.65	366.489	(0.5)	115
51.0 +	3282.61	332.555		23

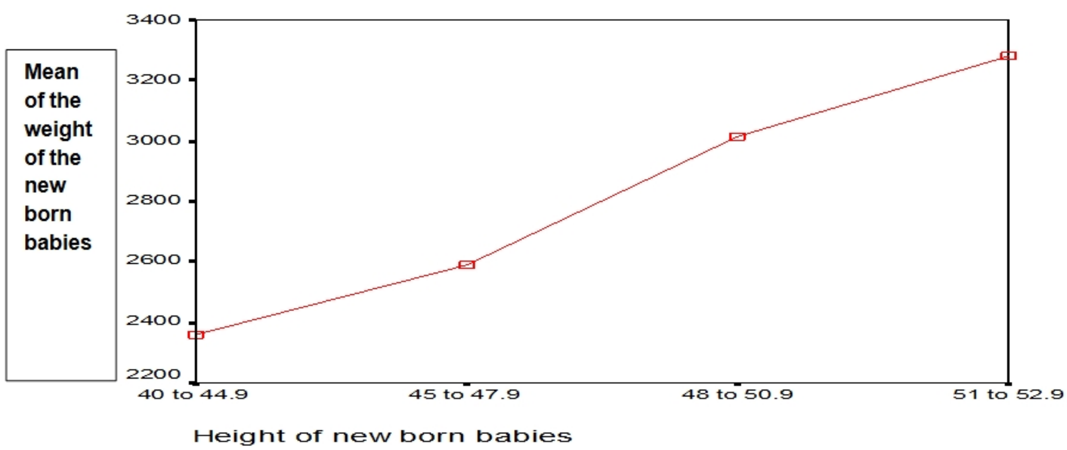

Fig. 2.8. Relationship between mean birth weight and newborn's CHL

In our study there were no significant differences in birth weight and anthropometric measurements between male and female newborns. Therefore we analyzed the combined data for both sexes. The sex of newborn is probably the easiest of the factors to evaluate16. In the present study LBW was found to be 21.0% and 34.9% respectively for male and female babies. Mean birth weight was found to be 2859.87g and 2666.13g respectively for male and female babies (Table-1.1). The finding is consistent with many other studies [29].

The present study reveals the fact that birth to conception interval <12 months or> 60 months leads to high incidence of LBW (Table-1.2). The highest and lowest mean birth weight was found to be 2890.00g and 2705.00g respectively for 49-59 and less than 12months groups of mothers. The possible explanation for higher incidence of LBW with

<12months interval is that women with closely spaced births have insufficient time to restore their nutritional reserves prior to conception and therefore have poor nutritional status. However, one study showed no increased risk of LBW for short pregnancy intervals after adequate multivariate control for confounding [30]. The higher incidence of LBW associated with the longest birth interval may be the result of maternal reproductive problems.

Relationship between mean birth weight and gestational age was shown in the present study. The study showed that birth weight increased as gestational age increased (Table-1.3). Highest mean birth weight (3120.00g) was observed in 41 or more weeks of gestation. This result is in consistence with other studies [31].

Apgar score of the newborn is an independent observer after immediate delivery of newborn. The five minute Apgar score is positively correlated with birth weight and is higher in small for gestational age infants compared with their appropriately grown counterparts [32]. In the present study, relationship between birth weight of newborn and their Apgar score was examined. There is significant difference in the mean birth weight (l97.39g) was found among the highest Apgar score (8+) and the lowest Apgar score (up to 6) group of infants.

Many researchers have attempted to identify a suitable anthropometric surrogate to identify LBW babies which is reliable, simple, and logistically feasible in field conditions. Some studies have recommended that CC, MUAC and HC may be used as anthropometric surrogates to identify LBW babies [33,34]. Therefore we considered MUAC, CC, HC, CHL as surrogate anthropometric measurements.

In the present study we assess the relationship between birth weight and anthropometric surrogates (MUAC, CC, HC, CHL) of newborns. Such indices are important tools in the identification of LBW babies in areas where scales are not widely available. Table- 1.4, 1.5, 1.6, and 1.7 shows that the mean birth weight increased progressively with increasing MUAC, CC, HC and CHL of the newborns. This finding is similar to the findings of other studies [35] found and proposed CC significantly related to infant birth weight and alone can be used as surrogate marker. But in our study we found that both MUAC and CC significantly related to infant birth weight and we suggest that measurement of both.

4. CONCLUSION

It is estimated that, in Bangladesh, about 80-90% of deliveries take place either at home or in the community till today. The results of the present study showed that MUAC, CC, HC and CHL can be used for identifying low-birth-weight babies at the community level, where weighing scales are not easily available. Since low birth-weight is highly predictive of neonatal mortality, and MUAC, CC, HC and CHL can identify infants with low birth-weight with a fair degree of accuracy, it would be logical to assume that these substitute measurements would be useful in predicting neonatal outcome. Furthermore, in the community, where taboos exist regarding weighing of newborns, these measurements can be used without any obstruction from the community to identify low birth-weight babies. However, further studies with larger populations are needed in the field to cross-validate our results.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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