Original Research Article

Study of correlation between mid-arm and chest circumference values and weight, to detect low birth weight babies

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Abstract

Background: Low birth weight(LBW) has been defined by World Health Organization (WHO) as weight at birth of less than 2500 grams (5.5 pounds), irrespective of its gestational age. Chest circumference and mid arm circumference are an easier, cheaper and reliable method for predicting birth weight of newborns. Present study was aimed to study correlation between midarm and chest circumference values and weight, to detect low birth weight babies. **Material and Methods:** Present study was prospective, observational study, conducted in live, term babies (37 - 42 weeks gestational age), delivered at our hospital. **Results: A**mong 809 full term newborns, incidence of low birth weight was 15.2%. 440 (54.4%) were males and 369(45.6%) were female babies. Mid arm circumference of study population ranged from 8 - 13 cm with mean of 10.5 ± 1.11 cm. By regression analysis, MAC was found to be highly correlated with birth weight. MAC of 8.5 cm had 96.4% sensitivity and 99.4% specificity to detect low birth weight. Its PPV and NPV values were 97.5% and 98.9% respectively with an accuracy of 98.6%. The Pearson correlation coefficient between birth weight and MAC was found to be highly significant. Chest circumference of study population ranged from 28-34 cm with mean 31.2 ± 1.1 cm. MAC of 29.5 cm had 96.7% sensitivity and 92.9% specificity to detect low birth weight. Its PPV and NPV values were 98 % and 94.8% respectively with an accuracy of 94.8%. It was statistically highly significant. **Conclusion:** The cut off value of MAC to predict LBW was less than 8.5cm. The cut off value of chest circumference to predict LBW was less than 29.5cm.
Keywords: low birth weight, Mid arm circumference, chest circumference, correlation

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INTRODUCTION

Birth weight is the first weight of the live and still born baby which should preferably be taken within the first hour of life and certainly during the first day of life before any significant postnatal weight loss has occurred. Low birth weight(LBW) has been defined by World Health Organization (WHO) as weight at birth of less than 2500 grams (5.5 pounds), irrespective of its gestational age.[1,2] Appropriate and timely care of a new born especially if born with low birth weight is important but this is difficult in developing countries since most of the deliveries are conducted at home where adequate facilities to weigh a newborn does not exist.[1] Birth Weight of babies born at rural health facility remains undetermined due to unavailability of weighing machine which may be due to lack of planning, lack of hand over and lack of replacement of damaged machine.[3,4] Various surrogates have been proposed and assessed for appropriateness for prediction of LBW newborns and these are anthropometric indices such as chest circumference,[5,6] mid arm circumference[5,6] head circumference, thigh circumference[4], foot length[7], crown heel length[8,9] Chest circumference and mid arm circumference are an easier, cheaper and reliable method for predicting birth weight of newborns. Present study was aimed to study correlation between midarm and chest circumference values and weight, to detect low birth weight babies.

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MATERIAL AND METHODS

Present study was prospective, observational study, conducted in department of paediatrics, Nepalgunj Medical College, Nepal. Study duration was of 1 years (November 2009 to November 2010). Study was approved by institutional ethical committee.

Inclusion criteria: All, live, term babies (37 - 42 weeks gestational age), delivered at our hospital

Exclusion criteria: Post term (>42 weeks of gestation) and preterm babies (< 37 weeks of gestation). Newborn babies whose gestational age is not certain. Very sick newborn baby and with gross congenital anomalies. Those babies whose parents were not willing to be included in the present study.

A brief introduction of interviewer was given to the care taker or parent of baby and also informed consent was taken from them by considering their willingness. Detailed clinical, obstetric history was obtained from mother and delivery details, any resuscutaion required was noted from case records. Gestational age was calculated from first day of last normal menstruation period. The New Ballard Scoring was used to assess the gestational age of the newborns. Birth weight was measured at birth on a caliberated electrical weighing machine. Mid arm circumference (MAC) – was measured using a flexible, non-stret hable tape (Cow Head B/rand), at birth at the mid-point between Acromion and Olecranon process of the left upper arm and recorded in centimeters. Chest Circumference was measured to the nearest of 0.1 cm at the level of the nipples perpendicular to the horizontal plane at the end of expiration during quiet respiration by a flexible, non stretchable measuring tape(Cow Head Brand). Measurement was taken thrice and average of them was recorded. Data was collected and compiled using Microsoft Excel, analysed using SPSS 23.0 version. The frequency tables, diagrams, curve estimation and linear regression were used to interpret the data.

RESULTS

In present study, among 809 full term newborns, birth weight was ranging from 1490 - 4300 grams with an average of 2850 grams. The incidence of low birth weight (birth weight < 2500 gm) among full term newborns babies was 15.2%. Majority of babies 494 (61.1%) had birth weight between 2.5-3 kg.

Table 1: Birth weight

Birth weight (kgs)	Number	Percent
<2.5	123	15.2
2.5-3.0	494	61.0
3.- 3.5	113	14.0
>3.5	79	9.8

440 (54.4%) were males and 369(45.6%) were female babies. Low birth weight babies were more in female group 17.1% as compared to male babies 13.6%. Maximum number of babies 31.7% were delivered as low birth weight in 37-38 weeks of gestational age followed by 25.2 % during 38.39 weeks, 16.2% during 39-40 weeks. Maximum number of babies 17.9% weighing less than 2.5kg were born to mothers less than 19 years followed by 15.4% low birth weight babies in the age group of 20-24 years. High percentage 86(69.9%) of LBW babies were born to primiparous mothers

Table 2: Distribution in relation to birth weight and other characteristics

Characteristic	Birth weight (kgs)		Total
	<2.5 Number(%)	>=2.5 Number(%)	
Gender			
Male	60(13.6%)	380(86.4)	440(100.0%)
Female	63(17.1%)	306(82.9%)	369(100.0%)
Gestational age (weeks)			
37-38	39 (4.82 %)	185 (22.87%)	224 (27.69%)
38-39	31 (3.83%)	180 (22.25%)	211 (26.08%)
39-40	36 (4.33%)	220 (27.19%)	255 (31.52%)
40-41	16 (1.98%)	84 (10.38%)	100 (12.36%)
41-42	2 (0.25%)	17 (2.1%)	19 (2.23%)
Maternal age (years)			
<=19	29 (17.9%)	133 (82.1%)	162 (100.0%)
20-24	63 (15.4%)	374 (84.6%)	410 (100.0%)
25-29	26 (14.2%)	157 (85.8%)	183 (100.0%)
30-34	5 (11.1%)	40 (88.9%)	45 (100.0%)
≥ 35	0(0%)	9 (100.0%)	9 (100.0%)

maternal Parity			
1	86 (69.9%)	380 (44.8%)	809 (100.0%)
2	25 (20.3%)	212 (30.9%)	
3	9 (7.3%)	61 (8.9%)	
≥ 4	3 (2.4%)	33 (4.08%)	

Mid arm circumference of study population ranged from 8 - 13 cm with mean of 10.5 ± 1.11 cm. By regression analysis, MAC was found to be highly correlated with birth weight. The above figure clearly shows that as the weight of baby (kg) increased, the MAC (in cm) also increased linearly.

Table 3: Mid arm circumference in relation to birth weight

Birth weight (kg)	Number	Minimum MAC in cm	Maximum MAC in cm	Mean ± Std. Deviation	P
<2.5	123	8	9.5	9.12 ± 0.23	<0.001
2.5-3	494	9.3	12	10.25 ± 0.81	<0.001
3.1-3.4	113	10	12	11.73 ± 0.31	<0.001
>=3.5	79	11.8	13	12.16 ± 0.26	<0.001

The cut off value of MAC to identify 2,500 grams birth weight from regression analysis was 8.5 cm. A new born whose mid arm circumference is less than 8.5 cm is likely to be low birth weight. MAC of 8.5 cm had 96.4% sensitivity and 99.4% specificity to detect low birth weight. Its PPV and NPV values were 97.5% and 98.9% respectively with an accuracy of 98.6%. It was statistically highly significant (p = 0.0001).

Table 4: Sensitivity and specificity of different cut off values of MAC

MAC (cm)	Sensitivity	Specificity	PPV**	NPV*	Accuracy
8.5	95.60%	99.40%	97.50%	98.90%	98.60%
8.7	99.40%	84.80%	60.90%	99.80%	87.10%
9	100%	61.10%	39.20%	100%	68.90%
9.5	100%	26.50%	25.40%	100%	41.50%

**PPV-Positive Predictive Value *NPV-Negative Predictive Value

The Pearson correlation coefficient between birth weight and MAC was found to be highly significant. The cubic model was used to estimate the birth weight by CC = 1247.77, p<0.001, R^2 = 82.3%). The significance level below 0.05 for both the models showed that the variation explained by the models were not due to chance.

Birth weight =-.896 +.355 MAC

Table 5: Correlation of birth weight with mid arm circumference

B.W	Pearson Correlation(r)	0.928	0.606
	P	<0.001	<0.001
M.A.C	Pearson Correlation(r)		0.641
	P		<0.001

Chest circumference of study population ranged from 28-34 cm with mean 31.2 ± 1.1 cm. By regression analysis, Chest circumference was found to be highly correlated with birth weight. The cut off value of CC to identify 2,500 grams birth weight from regression analysis was 29.5 cm. MAC of 29.5 cm had 96.7% sensitivity and 92.9% specificity to detect low birth weight. Its PPV and NPV values were 98 % and 94.8% respectively with an accuracy of 94.8%. It was statistically highly significant (p = 0.0001).

Table 6: Sensitivity and specificity of different cut off values of chest circumference.

Chest circumference (cm)	Sensitivity	Specificity	PPV**	NPV*	Accuracy	P value
≥28.5	95.7%	92.8%	70.5%	99.2%	93.2%	<0.0001
≥29.0	95.7%	92.6%	70.1%	99.2%	93.2%	<0.0001
≥ 29.5	96.7%	92.9%	80.1%	98.0%	94.8%	<0.0001
≥ 30.0	97.8%	92.6%	39.8%	100%	76.8%	<0.0001

Then Linear regression was applied to predict birth weight using two independent variables MAC and CC (R2 = 86.2%). The ANOVA table shows that F test was highly significant (F = 2511.313, p<0.001) showing that variation explained by the model was not due to chance.

Birth weight = -1.010 +0.350 MAC +0.005 CC

Table 7: Correlation of birth weight with chest circumference

Correlations			
		Birth Weight	Chest Circumference
Birth Weight	Pearson Correlation	1	.926**
	N	809	809
Chest Circumference	Pearson Correlation	.926**	1
	N	809	809

Birth weight = 3.623 +0.203* CC -0.026* CC squared + 0.001* CC cubed

DISCUSSION

In Nepal, The LBW prevalence is relatively high, ranging from 14 to 32 %, as documented from various hospital and community-based studies. When LBW incidence is less than 10%, preterm infants represents the major component of LBW; however, if the rate is more than 10%, it is mostly due to intra-uterine growth retardation (IUGR), while prematurity remains almost unchanged at 5 to 7%.[2,4] Appropriate and timely care of a new born especially if born with low birth weight is important but this is difficult in developing countries since most of the deliveries are conducted at home where adequate facilities to weigh a newborn does not exist.[4] Present study was conducted to evaluate the usefulness and reliability of mid arm and chest circumference as an alternative method to predict low birth weight newborns when weighing scale is not available. In present study, among 809 full term live neonates, there were 440 (54.4%) male and 369 (45.6%) female newborns with ratio of 1.2:1. Similar findings were noted by Singh R *et al.*,[10] and Manandhar K[11] with male and female ratio of 1.1:1. In present study mean birth weight was 2895 grams, similar findings were noted by Joshi HS *et al.*,[12] (2600+400 grams) and by MIRA[13] study (2830 grams). The incidence of low birth weight among full term newborns in the present study is 15.2%. Nearly similar incidence of LBW has been reported by Singh SD *et al.*,[14] (11.1%), Adhikari N *et al.*,[15] (12%), Ojha N *et al.*,[16] (12.7%), and Singh R *et al.*,[10] (14.3%) from Dharan. Higher incidence compared to present study were reported by Manandhar DS et a1.,[11] (32.0%) from Kathmandu and reported by MIRA[13] from four different regions of Nepal (34.7% at Biratnagar, 22.3% at Pokhara, 20.4% at Kathmandu and 26% at Nepalgunj). The comparatively low incidence of LBW(15.2%) in present study as compared to above study could be because of the fact that preterm babies were not included and only the full term babies were included in the study. This also could be because of improvement in maternal nutrition and over all awareness in pregnant mothers and their families. In this study term babies who were delivered during 37 -38 weeks of gestation had the highest incidence (21.0%) of LBW. Similar finding were noted by Manandhar DS[11] and Mondal B[17]. The percentage of LBW babies was highest among primigravida mothers in present study (69.9%, p=0.011). Mondal B[17] from his study at Shillong reported that 31 Nepali primi mothers were 2.7 times more likely to have LBW newborns. Mid arm circumference(MAC) in present study was ranged from 8 – 13 cm with an mean of 10.5 ± 1.1 cm. Similar findings were noted by Dhar B *et al.*,[5] and WHO collaborative study[1]. We noted that, MAC at birth was found to be highly correlated with birth weight. The Pearson correlation coefficient (r) between birth weight and MAC was found to be 0.9. Similar correlation coefficient was shown by Sharma JN *et al.*,[18] (r=0.9), Ramaiya C *et al.*,[19] (r=0.9), WHO collaborative study[1] (r=0.60 to 0.95) and Huque F *et al.*,[6] (r=0.8). Lower correlation coefficient of MAC with birth weight were reported by Bhargav SK *et al.*,[20] (r=0.8) and Sood *et al.*,[21] (r=0.7). In the present study, MAC at the above mentioned cut off value had sensitivity of 97.6% (95% CI 90.8-98.1), specificity of 99.4% (95% CI98.30-99.80), Positive predictive value of 97.5% (95% CI 93.20-99.20), and negative predictive value of 98.9% (95% CI 97.70-99.50) with an accuracy of 98.6%. Chest Circumference of all newborns ranged from 28-34 cm with a mean of 31.2 ± 1.1 cm. Similar findings were noted by Dhar B *et al.*,[5] (31.9 cm). Slightly higher mean CC compared to present study was reported by WHO collaborative study undertaken in 22 centers throughout world[1]. In the present study chest circumference was highly correlated with birth weight. The pearson correlation coefficient between chest circumference and birth weight of newborn was (r=0.9). Similar high degree of correlation for LBW newborns were shown by Bhargava SK *et al.*,[20] (r=0.8), Huque F *et al.*,[6] (r=0.8), Arisoy AE *et al.*,[22] (r=-0.8), Dhar B *et al.*,[5] (r=0.8) and WHO collaborative study[1] (r=0.74 to 0.9). In the present study, chest circumference at the cut off value of 29.5 cm had sensitivity of 96.7%, specificity of 92.9%, positive predictive value of 80.9% and negative predictive value of 98.0% with an accuracy of 94.8% and p value <0.001. Nearly similar values of sensitivity and specificity of CC were observed by Naik DB.,[23] (94.2% and 87.5%) and LL Mullany *et al.*,[24] (90.6% and 83.0%). On the other hand lower values than present study were reported by Huque F *et al.*,[6] WHO collaborative study[1] and Kapoor SK *et al.*,[25] (79.6% and 87.0%). With a high degree of sensitivity and specificity of mid arm and chest circumference at the cut off value of 8.5 cm and 29.5 cm respectively as shown in this study, measurement of mid arm and chest circumference at birth can be used as an

alternative method to predict LBW in low resource developing country like ours when an infant weighing scale is not available. Trained birth attendants, health and family planning workers residing at the community can easily be provided with measuring tape.

CONCLUSION

The cut off value of MAC to predict LBW was less than 8.5cm. High degree of positive correlation was observed between birth weight and mid arm circumference. Chest circumference of full term newborn ranged from 28.0cm to 34.0cm with mean of 31.2 cm (SD 1.1). The cut off value of chest circumference to predict LBW was less than 29.5cm. High degree of positive correlation was observed between birth weight and chest circumference of newborns. Mid arm and chest circumference were found equally significant for prediction of low birth weight.

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