

## “Measurement of Neonatal Foot Length to Identify Low Birth Weight Babies: a cross-sectional hospital based study”

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### Abstract:-

**Objective:** To determine the utility of using foot length as a screening tool to identify Low Birth weight babies in need of extra care.

**Study design:** Cross Sectional Observational Study.

**Setting:** Neonatal wards of Department of Pediatrics, SMS Medical College, Jaipur from May 2014 to April 2015.

**Methods:** In the present study, 250 new born, preterm (AGA) as well as full term SGA babies (birth weight 2-2.5 kg) irrespective of gestational age were included. Right Foot length of each newborn recorded to nearest 0.5mm, by using indigenous design wooden ruler.

**Findings:** 89.2% babies were preterm (AGA) and 10.8% babies were full-term (SGA). For identification of low birth weight babies (<2500) a foot length less than 7.27 cm has 100% sensitivity and 68.6% specificity.

**Conclusion:** Foot length may be used an efficient screening tool to identify low birth weight babies.

**Keywords:** Neonatal Mortality, Preterm, Low birth Weight, Foot length.

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### I. INTRODUCTION

Globally, about 18 million infants are born with a birth weight of <2500 grams every year<sup>(1)</sup>. Though these low birth weight (LBW) infants constitute only about 14% of the total live births, they account for 60%-80% of total neonatal deaths<sup>(2)</sup>.

Most of these deaths can be prevented with early identification, extra attention to Warmth, prevention of infection and optimal feeding.

Today, when there are encouraging signs, India's IMR remains high at 53/1000 live births. UNICEF estimated the IMR of India at 2020 as 35/1000 live births. IAP has proposed mission 20/20 to accelerate the reduction in IMR with a target to achieve an IMR of 20 by the year 2020<sup>(3)</sup>.

The most challenging part of infant mortality is large proportion of new born deaths, contributing to an estimated 64% of all infant deaths, mostly in the first week of life<sup>(4)</sup>.

Major causes of neonatal mortality are diseases associated with low birth weight babies (LBW). Thus birth weight is an important indicator of survival, future growth and overall development of the child. It is associated with socio-economic, clinical, racial, hereditary, personal and geographical factors<sup>(5)</sup>.

Low birth weight is associated with high neonatal morbidity and mortality due to susceptibility to adverse environmental influences, predilection to infections and difficulties in maintaining adequate nutrition.

Low birth weight is also associated with post-neonatal mortality and with infant and childhood morbidity. Low birth weight accounts for about 70% of all perinatal and 50% of all infant deaths in India<sup>(6,7)</sup>.

Birth weight and gestational age have been traditionally used as strong indicators for the risk of neonatal death. For any given weight, shorter the gestational duration, higher will be neonatal mortality.

For any given duration of gestation, lower the birth weight, higher will be neonatal mortality.

All these factors thus underlines the importance of early identification of low birth weight in rural setup where no medical care facilities are available and hence early referral to higher centres. But the situation is worse due to non-availability of resources in the form of trained or expert health care staff and lack of basic facilities such as weighing machine<sup>(8)</sup>.

This tells the need for an alternative measurement which can predict birth weight. A number of studies have been done in this regard for finding suitable substitute measurements for birth weight estimation.

The technique used for measuring such a parameter should be simple so that even an untrained health care staff can do the measurement reliably. Foot length is one such parameter which can be measured easily in preterm and sick neonates without disturbing the baby.

A large number of babies in India are born at home and majority of communities have no access to scales or other means by which to identify a baby as low birth weight (LBW) in need of extra care, hence we need a simpler criteria.

In India, where health care services are poorly accessed, a home based device to identify small babies could support community efforts to save New-born.

## II. Material and Methods

A cross-sectional study was conducted from May 2014 to April 2015 in the maternity ward and neonatal units attached to SMS Medical College Jaipur, Rajasthan, India. 250 babies were included in the study. All inborn babies preterm (AGA) and full term (SGA) (birth weight 2-2.5 kg) during the study period were included, excluding those with Congenital anomaly, birth asphyxia, meconium aspiration syndrome, extremely LBW babies and large for date babies.

Examination of the each new born were done within 12 to 24 hours of birth, 1-2 hours after feeding (if given), after stripping them off completely at the temperature of 29-33 degree centigrade, with good diffuse light in the special care nursery units of the hospitals. Only singleton babies with no evidence of any congenital anomaly or serious illness were included. Examination of each new born were included measurements of gestational age and anthropometric measurements.

Gestational age of each newborn was calculated using new Ballard score. Right foot length was measured from the heel to the tip of great toe by using an indigenous design wooden ruler. At the time of measuring, ventral surface of foot was straight out using gentle pressure. The length of foot was documented in centimetres.

All measurements and also gestational age assessment was repeated by 4 observers and inter-observer reliability compared. The observers were all doctors who were trained for 1 week prior to the start of data collection.

All measurements were done from 12 to 24 hours of birth after taking informed consent from the mother or attendant. Birth weight were measured using digital Salter-Scale. Babies were grouped as preterm (AGA) and Full-term (SGA), Birth weight between 2 to 2.5 kg.

Quantitative data was expressed as mean  $\pm$  SD. Difference in mean was calculated by student-t test. Sensitivity and specificity of each foot length was calculated using receiver operating curve (ROC). Foot lengths having good sensitivity and also good specificity were considered as cut-offs for identification of ‘at risk’ babies. Ethical approval was taken from the institutional ethics committee.

## III. Findings

Of 250 new born included 223 (89.2%) were preterm (AGA) and 27 (10.8%) were full-term (SGA). 136 (54.4%) New born were female and 114 (45.6%) new-born were male. Females predominant over males in all age group.

There was no statistical difference between male and female foot lengths ( $P > 0.05$ ). Mean gestational age was 34.58 ( $\pm 3.4$ ) weeks, mean birth weight 2.35 ( $\pm 0.15$ ) kg and mean foot length was 7.44 ( $\pm 1.06$ ) cm. The objective was to find out a foot length having a very good sensitivity so as to assess the utility of using this anthropometric surrogate as a screening tool in identification of Low birth weight babies. This screening method may help in providing live saving home care or referral decisions to higher centers for babies in need of extra care. It may be particularly useful at the community level in low resource settings where most births occur at home, almost out of reach for clinical evaluation by a trained physician.

For identification of low birth weight babies ( $< 2500$ ) a foot length less than 7.27 cm has 100% sensitivity and 68.6% specificity. Correlations were calculated, positive correlation was observed between foot length and gestational age of pre-term (AGA) babies (P value  $< 0.001$ ). No significant correlation was observed between foot length and gestational age of term (SGA) babies (P value 0.523).

Positive correlation was observed between foot length and birth weight of pre-term (AGA) babies (P value  $< 0.001$ ). No significant correlation was observed between foot length and birth weight of term (SGA) babies (P value 0.935).

**Table no-1 Correlation between foot length and gestational Age for preterm (AGA)**

	Mean	SD	N				
preterm-gest.age wks	34.32	1.267	223	R	R Square	Equation	Sig. F Change
preterm-foot length Cm.	7.41	.395	223	.328 <sup>a</sup>	.108	y = 1.053x + 26.51	<.001S

**Table no-2 Correlation between foot length and gestational agefor term (SGA)**

	Mean	Std. Deviation	N				
term-gest.agewks	36.69	.612	27	R	R Square	Equation	Sig. F Change
term-foot length Cm.	7.75	.333	27				

This table is showing that there is no significant correlation was observed between foot length and gestational age for term (SGA) babies.

**Table no-3 Correlation between foot length and birth weight in kg for preterm (AGA)**

	Mean	Std. Deviation	N				
preterm-birth wt. in kg.	2.34	.180	223	R	R Square	Equation	Sig. F Change
preterm-foot length Cm.	7.41	.395	223				

This table is showing that foot length has a positive correlation with birth weight of preterm (AGA) babies. foot length increases with increase in birth weight.

**Table no-4 Correlation between foot length and Birth weightfor term (SGA)**

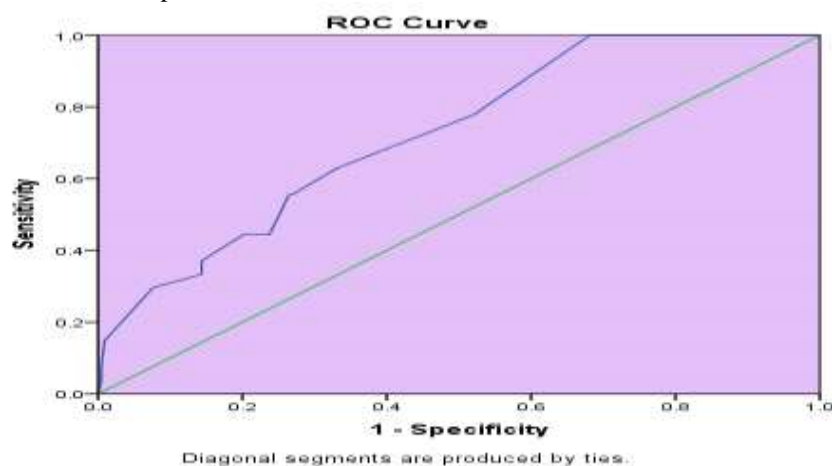
	Mean	Std. Deviation	N				
term-birth wt. in kg.	2.48	.070	27	R	R Square	Equation	Sig. F Change
term-foot length Cm.	7.75	.333	27				

This table is showing that there is no significant correlation was observed between foot length and birth weight of term (SGA) babies.

**Table no-5 Diagnostic performance of Foot lengthfor the differential diagnosis for identification of low birth weight neonates at the optimal cut-off points of the ROC analysis curves.**

Area Under the Curve				
Test Result Variable(s)				
Area	Std. Error <sup>a</sup>	Asymptotic Sig. <sup>b</sup>	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.724	.047	.000	.633	.815

The optimal Cut off of Foot length less than 7.275 cm has 100% sensitivity and 68.6% specificity with youdon index 0.318 for identification of preterm neonates. The Area under curve was 0.724.



#### IV. Discussion

Early identification of low birth weight babies is an important prerequisite of any initiative to reduce mortality. There are various measurements in newborn to identify low birth weight babies. Some of the routine measurements done at birth are birth weight, head circumference, chest circumference and crown heel length.

In many developing countries including India, either equipment’s required for these measurements are not available or the babies are sick or handling is needed to get the maximum information about the maturity of the baby. Flexed posture of baby also lead to difficulty in measurement of length.

In such cases foot length is an easy tool which can be measured even in sick neonate, requires less handling and less disturbance of the neonate.

Off 250 neonates studied, 223 (89.2%) were preterm (AGA) and 27 (10.8%) were full term (SGA). Female neonates were more than male neonates in number consisting 136(54.4%) and 114(45.6%) respectively. This is comparable to the study done by, **James et al**<sup>(9)</sup> study showed females 52% and males 48%. However **ShambhuSharan Shah et al**<sup>(10)</sup> which showed females 47.6% and males 52.4%.

We observed a minimum foot length of 7.3 cm and maximum 8.5 cm for full term (SGA) (n=27) with mean value of 7.75±0.66. For preterm (AGA) (n=223) minimum foot length was 6.2 cm and maximum 8.5 cm with mean value 7.41±0.78. **Kulkarni et al**<sup>(11)</sup> which showed mean foot length of preterm neonates ranged from 4.6 cm to 6.89 cm and the mean foot length of term neonates ranged from 6.99 cm to 7.58 cm.

**Gohil JR et al**<sup>(12)</sup> study showed the mean foot length of preterm as 6.56 ± 0.43 cm, term SGA as 7.13 ± 0.26 cm and of term AGA as 7.6 ± 0.33 cm which is comparable with present study.

**ShambhuSharan Shah et al**<sup>(13)</sup> study showed the mean foot length in preterm as 7.18 ± 0.57 cm and terms as 8.0 ± 0.28 cm.

Our data showed higher mean values of foot length as compared to the above studies because these studies included all preterm (AGA,SGA) & full-term (SGA,AGA) however we included only preterm (AGA) & full-term (SGA) within weight range of 2 to 2.5 kg.

off 250 subjects we observed mean gestational age 34.58±2.83 weeks and mean foot length 7.44±0.8 cm among all our subjects with coefficient of correlation 0.39 with p value <0.001 which is statistically significant.

223 preterm(AGA)subjects with mean gestational age 34.32±2.52 weeks and mean foot length 7.41±0.78 cm with coefficient of correlation 0.32 with p value<0.001 which is statistically significant.

27 full-term(SGA) subjects with mean gestational age 36.69±1.24 and mean foot length 7.75±0.66 cm with coefficient of correlation 0.13 with p value<0.523 which is statistically not significant.

A positive correlation between foot length and gestation age was found (r =0.396, 0.328 and 0.128). This shows that foot length increases as the gestational age increases.

223 preterm (AGA) we observed mean birth weight 2.34±0.36 kg and mean foot length 7.41±0.78 cm with coefficient of correlation 0.42 with p value<0.001 which is statistically significant.

27 full term (SGA) we observed mean birth weight 2.48±0.14 kg and mean foot length 7.75±0.66 cm with coefficient of correlation -0.016 with p value<0.935 which is statistically not significant.

Correlation of foot length with birth weight in various studies (r-value) with our study in tabulated form

Studies	Foot length to birth weight correlation (r-value)	
	Preterm (AGA&SGA)	Full-term ( SGA &AGA)
James et al(123 babies)	0.95	0.91
Gohil JR et al(353 babies)	0.92	0.69
Shambu saran shah et al(1000 babies)	0.92	0.64
In our study (250 babies)	0.42(preterm AGA)	-0.016(full-term SGA)

**In our study** foot length <7.28 cm has 100% sensitivity and 68.6% specificity for identification of LBW babies. Similarly **Mathur et al (1984)**<sup>(14)</sup> - in **Udaipur, India** found a foot length less than 7.2 cm to identify LBW babies (<2500 gm).

**Merchant et al (2010)**<sup>(15)</sup> - showed an 80% cut-off for both sensitivity and specificity to be desirable, is achieved for VLBW (<1500 g) at foot lengths <7.2 cm and <7.5 cm respectively, for LBW (<2500 g) at foot lengths <7.9 cm and <7.6 cm, and for prematurity (<37 weeks) at foot lengths <7.7 cm and <7.5 cm.

**Satarupa Mukherjee et alin (2013)**<sup>(16)</sup>-study done in a hospital of Kolkata India. She had found in her study,For identification of LBW babies (<2500 gm) a foot length less than 7.85cm has 100% sensitivity and 95.3% specificity.

Our study had certain limitations. It was a hospital based study with a small sample size without any community follow-up and hence it may not be representative at the population level. Moreover, the foot lengths were all measured on 12 to 24 hours of life. Whether any change occurred on subsequent measurements were not documented. This method of measurement foot length may be useful in specific areas where most of the

deliveries are occurring at home. For neonates born at the hospital, direct measurement of weight and close observation are better ways for detecting low birth weight babies.

Foot length being a physical parameter correlated with the other physical parameter. The study shows that foot length is influenced with the general growth pattern of the baby. Variation in reading has also been explained by the method of measuring the foot length and selection of babies. We measured foot length by indigenous design wooden ruler and correlates with various study.

## V. Conclusion

Significant correlation was observed between foot length and birth weight in different groups of new born (preterm AGA and term SGA). Foot length also correlated with other parameters like gestational age, head circumference and crown heel length significantly.

The correlation (r-value) of foot length with birth weight and other parameters was higher in preterm (AGA) neonates ( $r = 0.410$ ) than in term (SGA) ( $r = 0.016$ ) neonates. The foot length is an efficient screening tool in identifying low birth weight babies.

The highest correlation (r value) of foot length with gestational age in preterm (AGA) babies ( $r = 0.328$ ) than term (SGA) ( $r = 0.128$ ) babies.

Foot length is a simple, quick and reliable anthropometric measurement which can be used as a proxy measurement to birth weight assessment in neonates to identify low birth weight babies, who needs of extra care. It can be easily measured by medical practitioners and traditional birth attendants in the community.

It is particularly useful in resource constraint countries with a high burden of neonatal mortality and where facility-based services for new born are poorly accessed. Foot length may be used as a screening tool to identify low birth babies for live saving, home care or referral to higher centres for better management.

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