

ORIGINAL RESEARCH

Assessment of gestational age by new ballard's score and its correlation with foot length

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ABSTRACT

Background: Foot length has been studied by various authors as proxy measurement which can be measured easily in sick and preterm newborns. This study was done to find the correlation of foot length with gestational age and birth weight. **Methods:** Study sample of 206 newborns was selected by simple random sampling technique. Born at CMCH, Bhopal from June 2021 to November 2022. Babies with limb deformities were excluded from the study group. Babies were grouped into term, preterm and gestational age was assessed by New Ballard score. Correlation of foot length with gestational age and birth weight was statistically analysed by correlation and regression analysis. **Results:** In the study, male newborns were 51% and female were 49%. Of the 206 newborns, preterms were 20.9%, terms were 79.1%. Mean birth weight was 2.657 kg with a standard deviation of 0.534. The mean foot length was 8.2 cm with a standard deviation of 0.7. Foot length correlated significantly ($p < 0.05$) with birth weight, gestational age in the neonates. Correlation was observed with birth weight ($r = 0.794$) which indicates strong positive association between them. **Conclusions:** Foot length is a easy and reliable anthropometric measurement to assess birth weight and gestational age in neonates, especially who are ill. Foot length can be reliably measured by peripheral health care workers and could be used effectively for identifying and referring highrisk newborns.

Keywords: Neonates, Foot length, Birth weight, Crown heel length, Head circumference.

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INTRODUCTION

Anthropometric measurements of the new-born population is an important scientific research tool to study the determinants and consequences of impaired or excessive fetal growth.

It is a non-invasive and cheap universal technique to assess the body size, proportions, and composition.

Value of anthropometric measurement is the basic gold standard technique to describe growth at individual and population level.

Babies with abnormal fetal growth need to be identified and observed closely as they have a higher neonatal mortality and morbidity, as compared to normally grown babies of identical gestation.

These babies with abnormal fetal growth are more prone for metabolic complications like hypoglycemia and polycythemia during neonatal period.

Therefore it is very essential to recognize neonates with abnormal fetal growth at birth, so that it forewarns the pediatrician for subsequent management

of complications on priority basis.

To identify these babies at risk, we have to quantitate normal fetal growth in utero and to classify newborn baby into small for gestational age, appropriate for gestational age and large for gestational age.

Birth weight has been universally used as a measure of intrauterine growth largely because of relative ease of its measurement in hospital setting and its correlation with gestation. However birth weight by itself is not infallible.

Infants of identical race, sex, gestational age and length have been known to differ in their body weight by up to 40%.

Also birth weight is the sum of fat and lean body tissue. Weight gain represents the sum of increments of different body components including muscle, skeleton, adipose tissue and water. So it is rather a nonspecific measure of growth.

Hence alternative simple anthropometric measurements could be useful for assessing fetal

growth.

Others studies also have established the strong correlation of mid arm circumference as well as thigh circumference with gestational age and early neonatal mortality.

Birth length and head circumference may provide an important diagnostic and prognostic information beyond that provided by birth weight alone.

Because of technical difficulties in measuring birth weight in developing countries, several studies have shown that different anthropometric measurements can predict birth weight and can be used as valid indicators of low birth weight.

This provides base line data for indigenous population and can be gainfully employed for further studies to know whether simple anthropometric measurements other than birth weight will be useful to quantitate fetal growth and to identify, at risk babies at the community level.

Prematurity is a significant contributor to neonatal mortality in India. Important determinant of birth weight and prematurity is maternal hemoglobin.

Conventionally, assessment of gestational age of newborns is based on New Ballard Technique, for which a pediatric specialist is needed. Anthropometry of the newborn, especially birthweight, has been used in the past to predict the gestational age of the neonate in peripheral health facilities, where a trained pediatrician is often not available. We aimed to determine if neonatal anthropometric parameters, can reliably predict the gestational age

AIMS AND OBJECTIVES

1. To study the correlation of foot length and gestational age among the neonates.
2. To study the correlation between foot length and birth weight.
3. To study if foot length can be used as a proxy measurement to gestational age and birth weight assessment

MATERIAL AND METHODS

MATERIALS

A. Source of Data: A study sample of 206 live newborn at CMCH, Bhopal was selected by Simple Random sampling technique.

RESULTS

In this study, total 206 newborns delivered and admitted in CMCH, Bhopal. The gestational ages ranged from 30 to 42 weeks.

Table 1: Gestational age by New Ballard Score

Gestational age by NBS	Count	%
28-30 WEEKS	4	1.94%
30-32 WEEKS	5	2.43%
32-34 WEEKS	11	5.34%
34-36 WEEKS	22	10.68%
36-38 WEEKS	1	0.49%
38-40 WEEKS	17	8.25%
38-40 WEEKS	80	38.83%
40-42 WEEKS	66	32.04%

INCLUSION CRITERIA

Live newborns of different gestational ages within 72 hours of birth.

EXCLUSION CRITERIA

babies with skeletal deformities of the foot.

B. INSTRUMENTS

1. Sliding Vernier calipers for measuring foot length.
2. Electronic weighing scale for measuring weight.
3. Flexible, non-stretchable measuring tape for head circumference.
4. Infantometer for measuring crown heel length.

METHOD OF COLLECTION OF DATA

Standard proforma which met the objectives of the study was used for collecting data.

- a) **Gestational Age assessment** was done using New Ballard's score
- b) **Foot Length** was measured using sliding vernier calipers. After the ventral surface of foot was straightened by using gentle pressure, foot length was measured from posterior most prominence of the foot to the tip of great toe of right foot. The length of the foot was documented in centimeters.
- c) **Weight of the baby** was measured using electronic weighing scale. All the dress of baby was removed before weighing.
- d) **Head Circumference** was measured using flexible and non- stretchable measuring tape. The measurement was taken by encircling the tape around the occipital prominence posteriorly, just above the supra orbital ridge anteriorly and just above the ear lobes laterally. Head circumference was documented in centimeters.
- e) **Crown Heel Length** was measured using infantometer. An assistant's help was sought to do the length measurement. Baby's lower limbs were straightened out before doing the measurement. Measurement was documented in centimeters.

STATISTICAL ANALYSIS

Gestational age was assessed by New Ballard score and babies were grouped into term and preterm. Correlation of foot length with gestational age and birth weight was statistically analyzed by correlation and regression analysis.

TOTAL	206	100.00%
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Table 2: Distribution of study participants according to sex

SEX	Count	Column N %
FEMALE	101	49.00%
MALE	105	51.00%
Total	206	100.00%

Table 3: Distribution of study participants according to term / preterm

TERM/PRETERM	Count	Column N %
PRETERM	43	20.90%
TERM	163	79.10%
Total	206	100.00%

Table 4: Correlation between gestational age and anthropometric variables of neonates

Variables	Maturity	r- VALUE	Mean	Std. Deviation	P-VALUE
Birth weight	Preterm (43)	.622**	1.99012	0.555795	<0.001
	Term (163)		2.83291	0.363061	
H.C.	Preterm (43)	.655**	30.867	1.8414	<0.001
	Term (163)		33.738	1.0307	
CHL	Preterm (43)	.570**	44.891	4.0012	<0.001
	Term (163)		48.696	1.455	
FL	Preterm (43)	.553**	7.367	0.7891	<0.001
	Term (163)		8.387	0.4905	

Table 5: Variation of foot length with gestational age

Gestational age (weeks)	FOOT LENGTH (cm)			
	Minimum	Maximum	Mean	Standard deviation
30	6.5	7	6.8	0.3
31	5.5	6.5	6	0.7
32	5.6	7	6.8	0.6
33	7.3	8	7.8	0.4
34	6	8.4	7.5	0.9
35	8	8.5	8.2	0.3
36	6.8	9	7.9	0.6
37	7	9	8	0.6
38	7.3	9.2	8.4	0.5
39	7.6	9.2	8.5	0.4
40	7	9	8.5	0.5
41	5.5	9	8.1	0.9

Table showing the foot length increased steadily with increasing gestation age from 34.7±1.3 cm at 28 weeks to 49.9±2.5 cm at 41 weeks. The r-value was 0.553

Table 6: Correlation between FL and anthropometric variables of babies

Variable	Anthropometric variables	Pearson correlation (r)	P-value
Foot length	HC	0.786	0.001
	BIRTH WEIGHT	0.794	0.001
	CHL	0.743	0.001

Table 7: Anthropometric variables of study participants

	Mean	Standard Deviation	Minimum	Maximum
Birth weight	2.657	0.534	0.955	3.9
H.C.	33.1	1.7	26.5	36.5
CHL	47.9	2.7	34.5	52.5
FL	8.2	0.7	5.5	9.2

DISCUSSION

To reduce mortality, the important pre-requisite of any

initiative is early identification of low birth weight babies. The routine anthropometric measurements

done at birth are birth weight, head circumference, crown heel length, etc. In the developing countries like India, basic equipments required to measure these are not available. Flexed posture of term baby also lead to difficulty in measurement of length. In sick babies or babies in incubators, minimum handling should yield maximum information about the baby's growth. In these cases, foot length is an easy measurement which can be used.

The present study was conducted to find correlation between foot length, gestational age and other anthropometric measurements in neonates, so that foot length can be used as a proxy measurement for estimation of gestational age and birth weight. Assessment of the gestational age by Ballard's scoring is time consuming and requires handling of the sick babies.

The study was done during the period from June 2021 to November 2022 (1.5 year). Two hundred six (206) neonates were examined within 72 hours of birth.

Of the 206 neonates studied, male neonates were more than female neonates in number consisting 51% and 49% respectively. This is comparable to the study done by Kulkarni et al.⁶ which showed 56% males and 44% females. In the study done by Shambhu Sharan Shah et al.⁷ it shows 52.4% males and 47.6% females. However, James et al.⁸ study showed 48% males and 52% females out of 123 neonates studied.

The birth weight of 206 neonates studied ranged from 0.955-3.9 kg with a mean of 2.657 kg. In the study done by Shambu Sharan Shah et al.⁷ where 1000 newborns were studied, showed a birth weight range of 0.85-4.3 kg which is comparable to present study, but had a mean birth weight of 2.931±0.464 kg.

In a study done by Huque Fazhul et al.² in 217 newborns, 2.679 kg was the mean birth weight which is comparable to present study. The study done by Hossain MM et al.⁹ in 148 newborns, the mean birth weight was 3.5 kg.

In present study, the head circumference of preterm neonates the mean head circumference of 30.867 cm

and term neonates a mean head circumference of 33.738 cm. This is comparable to Gohil JR et al.¹¹ study which showed mean head circumference of preterm neonates as 29.1 ± 1.64cm and that of term neonates as 33 ± 1.05 cm. James et al.⁸

Study showed mean head circumference for term neonates as 34.03 ± 2.88 cm which is comparable to present study. The present study shows that as the gestational age increases, head circumference also increases.

The mean crown heel length of the preterm neonates in the present study was 44.89 cm with a mean crown heel length of 48.69 cm for term neonates. This is not comparable to Gohil JR et al.¹¹ study which showed a mean crown heel length of 42.7 ± 2.08 cm for preterm babies. The crown heel length of term neonates ranged from 40 cm to 53 cm with a mean of 48.58 cm for term neonates. This is comparable to Gohil JR et al.¹¹ study which showed mean crown heel length of term neonates as 48.36 ± 3.13 cm. James et al.⁸ study also showed similar results with mean crown heel length in term neonates as 51.08 ± 2.05 cm.

Foot length is an easy anthropometric measurement which can be measured in sick and preterm neonates receiving intensive care which can act as a proxy measurement. The foot length of neonates ranged from 5.5 to 9.2 cm with the mean foot length of 8.2 cm.

This shows that foot length increases as the gestational age increases. It is comparable to Kulkarni et al.⁶ which showed foot length of preterm neonates ranged from 4.6 cm to 6.89 cm and that of term neonates ranged from 6.99 cm to 7.58 cm. It is also comparable to Gohil JR et al.¹¹ showed the mean foot length of preterm and term neonates as 6.56 ± 0.43 cm and 7.6 ± 0.33 cm respectively. Shambhu Sharan Shah et al.⁷ study showed the mean foot length in preterms as 7.18 ± 0.57 cm and terms as 8.0 ± 0.28 cm which are slightly higher than ours.

The present study was done to assess the correlation of foot length with gestational age.

Table 8: Correlation of foot length with gestational age in various studies

Studies	Foot length to gestational age correlation (r-value)
James et al. ⁸ (123 babies)	0.89
Gohil JR et al. ¹¹ (353 babies)	0.95
Shambu Sharan Shah et al. ⁷ (1000 babies)	0.86
Present study (206 babies)	0.553

There is a positive linear relationship between foot length and birth weight with different correlation coefficient (r-value) in different studies.

Table 9: Correlation of foot length and birth weight in various studies

Studies	Foot length to birth weight correlation (r-value)
James et al. ⁸ (123 babies)	0.95
Gohil JR et al. ¹¹ (353 babies)	0.92
Shambu Sharan Shah et al. ⁷ (1000 babies)	0.92
Present study (206 babies)	0.794

There is a positive linear relationship between foot length and birth weight with different correlation coefficient (r-value) in different studies.

Table 10: Correlation of foot length and crown heel length in various studies

Studies	Foot length to crown heel length correlation (r-value)
James et al. ⁸ (123 babies)	0.96
Gohil JR et al. ¹¹ (353 babies)	0.92
Shambu Sharan Shah et al. ⁷ (1000 babies)	0.89
Present study (206 babies)	0.743

There is a positive linear relationship between foot length and crown heel length with different correlation coefficient (r-value) in different studies.

Table 11: Correlation of foot length and head circumference in various studies

Studies	Foot length to head circumference correlation (r-value)
Gohil JR et al. ¹¹ (353 babies)	0.84
Shambu Sharan Shah et al. ⁷ (1000 babies)	0.85
Present study (206 babies)	0.786

There is a positive linear relationship between foot length and head circumference with different correlation coefficient (r-value) in different studies.

SUMMARY

This study was done to know the relationship between foot length and gestational age among the neonates. Also, to find out the correlation between foot length and other variables (birth weight, head circumference and crown heel length)

Two hundred six (206) newborns were studied. The foot length was correlated with gestational age and other anthropometric measurements such as birth weight, head circumference and crown heel length in neonates.

THE FOLLOWING IS THE SUMMARY OF OBSERVATIONS

1. Males predominated over females (51% and 49%).
2. 79.1% were term, 20.9% were preterm.
3. Mean birth weight was 2.657 kg with a standard deviation of 0.534.
4. The mean head circumference was 33.1 cm with a standard deviation of 1.7.
5. The mean crown heel length was 47.9 cm with a standard deviation of 2.7.
6. The mean foot length was 8.2 cm with a standard deviation of 0.7.
7. Foot length correlated significantly ($p < 0.05$) with gestational age, birth weight, crown heel length and head circumference in the neonates. The highest correlation (r value) of foot length was with birth weight ($r = 0.794$) followed by head circumference ($r = 0.786$).

CONCLUSION

Significant correlation was seen between foot length and gestational age in newborns. Foot length correlated significantly with other parameters like birth weight, head circumference and crown heel length.

The highest correlation (r value) was observed with birth weight ($r = 0.794$) which indicates strong positive association between them, followed by head circumference ($r = 0.786$), crown heel length ($r = 0.773$) and gestational age ($r = 0.553$).

Foot length is an easy, quick and reliable anthropometric measurement that can be used as a proxy measurement for gestational age assessment and

birth weight assessment, especially in sick and pre-term neonates receiving intensive care. It can be easily measured by medical practitioners and traditional birth attendants in the community.

LIMITATIONS

1. In our study, the participants were relatively small in number. Thus, the result of this study cannot be generalized for a larger population. Therefore, complementary studies with larger sample size and with diverse socio demographic profile should be conducted.
2. In this study, other anthropometric parameters like chest circumference, mid arm circumference, thigh circumference, calf circumference and proportionality indices like Ponderal Index, HC/length and CC/length and other measurements like skin fold thickness have not been measured and correlated.

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Nil

CONFLICTS OF INTEREST

There are no conflicts of interest

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