The Relation between Gestational Age and Anthropometric Measurements among Newborns

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Abstract

Background: Growth monitoring and assessing its parameters have an important role because accurate gestational age and growth measurements are important which reflects standard growth and morbidity, and mortality in newborns is directly, linked with gestational age and anthropometric measurements. **This study aimed** to investigate the relationship between gestational age and anthropometric measurements among newborns. **Design:** A cross-sectional study was conducted in the Obstetrics and Gynecology ward at Sohag University Hospital, from Dar El – Salam Abed- Allah Maternal and Child Health Center at Sohag City and Maternal and Child Health Center at Talkha City belonging to Dakhahlia Governorate within six months, including 280 newborns. **Tools:** A structured questionnaire, anthropometric measurement, and percentile charts from the 10th, 50th, and 90th percentiles were utilized for collecting the data. A positive correlation was found between gestational age and anthropometric variables. **Conclusion:** A positive correlation between gestational age and anthropometric measurements among newborns, and anthropometric variables can be used as simple tools for predicting gestational age.

Keywords: relation, gestational age, anthropometric measurements, newborns.

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Introduction:

Newborn anthropometric measurements are considered an important indicator for growth and are considered a major risk factor for neonatal mortality, worldwide. Growth monitoring and assessing its parameters have an important role in antenatal care management because accurate gestational age and growth measurements are important and reflect standard growth **(World Health Organization, 2018).**

From anthropometric measurements, birth weight was the most commonly used anthropometric indicator of birth size, it not only indicates the baby's growth, and development, but also is an important indicator of maternal

health, nutrition, genetics, socioeconomic status, environmental factors, and quality of antenatal care **(Soni, and Kapoor, 2017)**. Birth length has also been linked with cognitive development **(Lee et al., 2018)**, and LBW and restricted growth have been associated with other long term outcomes, such as attained height, achieved schooling/education, and later income of life **(Victora et al., 2008).**

Foot length as well as arm, head, and chest circumference have been correlated with gestational age as well as birth weight and length which can be measured with simple and easily available equipment as measuring tape and does not require any special training for use **(Deia et al., 2018).**

The anthropometric measurements in newborns suggest a variation in the ability of different anthropometric indices that help in identifying newborns with abnormal growth **(Ezenwa et al., 2016).** Growth is assessed by putting accurate values on growth charts and comparing them with previous measurements. Any deviations in growth patterns are considered indicators of serious medical disorders **(Nair et al., 2016)**

Gestational age is also an important factor of growth, and development for newborns, because morbidity and mortality in newborns are directly associated with gestational age and anthropometric measurements such as length, birth weight, head, arm, and chest circumferences **(OOluwafemi et al., 2013).**

Despite training in external Ballard examinations to assess gestational age, experienced health workers showed poor skill development **(Taylor et al., 2013)**. In contrast, anthropometric measurements collected by health workers have been shown to be more reliable than clinical examination **(Ngirabega et al., 2010).** Additionally, the long-term decrease in the knowledge and skills of primary health personnel in managing sick children has been low **(Venkatachalam et al., 2011).**

Assessment of the gestational age of newborns by using the New Ballard Score (NBS) may not be reliable as its accuracy and it is a complex score that requires skillful examiners and training of a pediatric specialist. There is a need to develop a simple, inexpensive, and practical method as anthropometric measurements to identify these high-risk newborns soon after birth **(Mullany et al., 2006)**. In contrast, anthropometric measurements collected by health workers are more reliable than clinical examination **(Ngirabega et al., 2010)**.

With the present study, we aim to investigate the relationship between gestational age and anthropometric measurements among newborns by assessing gestational age and growth measurement among newborns and investigate the relationship between gestational age and anthropometric measurements among newborns.

Significance of the study:

Newborns are usually classified regarding birth weight and/or gestational age. Birth weight, head, arm and chest circumferences, foot length .and body length of the newborns are important indicators for evaluating growth. Low birth weights newborns are at high risk

of having higher mortality and morbidity than those of appropriate weight for gestational age, and have an increased risk of complications. Body length is also considered of prognostic significance; because a small newborn weight with short body length is liable to have impaired growth.

Newborns born with excessively small or large heads may be at high risk for malformations of the central nervous system secondary to genetic or chromosomal abnormalities. The reliability of the New Ballard Score (NBS) in the assessment of GA becomes uncertain, and its accuracy depends on the skill of the examiner and the neonate's condition. Therefore, several anthropometric parameters can be determined in neonates by using simple measuring instruments that are not expensive to identify high-risk newborns soon after birth. Measurements are quick and reliable parameters that can be used as an anthropometric surrogate for the estimation of GA. Based on the importance of anthropometric measurements; in the estimation of GA, the purpose of the study was to investigate the relationship between gestational age and anthropometric measurements among newborns.

Aim of the study

The study aimed to investigate the relationship between gestational age and anthropometric measurements among newborns through:

1- Assessing gestational age and growth measurements among newborns.

2- Investigate the relation between gestational age and anthropometric measurements among newborns.

Research questions:

1. What are the growth measurements among newborns according to their gestational age?
2. What is the relation between gestational age and anthropometric measurements among newborns?

Subjects and methods:

Research design:

A cross-sectional design was adopted in this study. In a cross-sectional study, the investigator measured the outcome and the exposures in the study participants at the same time. This type of research can be used to describe characteristics that exist in a community, but not to determine cause-and-effect relationships between different variables. This method is often used to make inferences about possible relationships or to gather preliminary data to support further research and experimentation **(Kendra, 2019).**

Setting

This study was conducted in the Obstetrics and Gynecology ward at Sohag University Hospital and from two maternal and child health centers. Dar El –Salam Abed- Allah Maternal and Child Health Center at Sohag City and Maternal and Child Health Center at Talkha City belonging to Dakhahlia Governorate in Egypt.

Subjects and Sampling:

A purposeful sample of 280 newborns was recruited from the previously mentioned settings for a period of 6 months. The inclusion criteria were all live newborns from both sexes

(male and female) who did not have congenital malformation or any abnormalities. Newborns with congenital anomalies were excluded from the study.

Tools and techniques of data collection:-

It was developed by the researcher after reviewing related literature. There were three tools used in the present study as follows:

Tool (1): A **structured questionnaire** to gather information related to socio-demographic characteristics of newborns, type of delivery, residence, and gestational age.

Tool (2): Anthropometric measurement tool: This tool includes the anthropometric measurement of newborns which is used to record weight, length, arm, chest, head circumference and feet length.

Tool (3): Percentile charts of the10 th, 50th, and 90th percentiles for birth weight, head circumference, and length according to gestational age **(Hockenberry and Wilson, 2007).**

Validity and reliability Face and content validity of the tools for clarity, comprehensiveness, appropriateness, and relevance by a board of five experts in pediatric nursing and community health nursing with more than ten years of experience in the field were assessed. The board ascertained the face and content validity of the tools. Examination of the content validity index (CVI) showed that CVI = 86%. Reliability was assessed through Cronbach's alpha reliability test α= 89% which revealed that each of the two tools consisted of relatively homogenous items as indicated by the moderate to high reliability of each tool.

Methods:

The official letters were obtained to conduct the study. The researchers explained the aim of the study at the beginning for all participants of the newborn mothers or caregivers, so they were reassured that all gathered information would be confidential. The study was conducted in the previously mentioned settings for a period of six months (from March 2019 to August 2019).

Data collection:

The researchers attended the setting of the study two times / a week from 8.30 am to 12 pm. the subjects at first were determined through inclusion criteria which include all new born baby's recruited within the first 24 hours after birth and free from any congenital abnormalities .The data was collected by using study tools .Assessment of gestational age of the study subjects was calculated from the obstetric history record of their mother in previous mentioned study setting , through last menstrual period (LMP) by using Naegele's formula by adding 9 months and 7 days to the first day of LMP.

All measurements, such as the baby's weight, length, feet length, and head, chest and arm circumference were measured by the researchers in the previously mentioned setting. Newborns weights were measured using an electronic weighing scale, and the scale records weights in kilograms. It was adjusted to zero before each reading. The length was measured in centimeters using a metal anthropometric linear rule

fixed to a horizontal flat board. It was recorded with baby in the supine position, an assistant held the baby in a position, making sure that knee fully extended and straight and soles of the feet held firmly against the footboard and head touching the fixed board.

The feet length of each subject was measured using a stiff plastic transparent ruler from the heel to the tip of the great toe. Head circumference was measured by placing the measuring tape anteriorly at the glabella and posteriorly along with the most prominent point, using a non-stretchable paper measuring tape. Chest circumference was measured at the level of the nipples using a measuring tape, and the circumference was measured below the xiphoid and scapula. The arm-circumference was measured at the midpoint between the tip of the acromion and the olecranon process of the left upper arm. The results of the measurements were documented in percentile charts of the10 th, 50 th, and 90 th percentiles for birth weight, head circumference, and length according to the gestational age of the newborn to determine the relation between study variables.

Pilot study:

A pilot study was carried out on 28 newborn babies (10% of the study sample) excluded from the total sample. It was done to notice any ambiguity in the tools, to ensure transparency of the items, as well as, to determine the time devoted to data collection. Clarification and estimation of the time needed for filling the study tools, and testing the feasibility of the research process needed modifications were carried out based on the results of the pilot study to develop the final form of the tools.

Ethical considerations:

Official permission was obtained from Sohag University Hospital administrators and the manager of the Obstetrics and Gynecology wards. Permission was also obtained from the head nurse of the Obstetrics and Gynecology ward at Sohag University Hospital and the authorities of the maternal and child health center (Dar El –Salam Abed- Allah Health Center) at Sohag city and Maternal and Child Health Center at Talkha City belonged to Dakhahlia Governorate in Egypt. Oral consent was obtained from each mother or caregiver. The researcher informed participants that in the study are voluntary; they have the right to withdraw from the study at any time, without giving any reason and that their responses would be held confidentially.

Statistical analysis:

The data obtained were reviewed, prepared for computer entry, coded and scored, then analyzed and tabulated. Data entry and analysis were performed using SPSS (statistical software package) version 17.0. Data are expressed as the means, SD, and percentage distribution. A person's correlation was used to estimate the correlation between the study variables. r: Pearson correlation P-value significant if ≤ 0.05 If $r \leq 0.5$= weak correlation If $r > 0.5$= strong correlation.

Results:

A total of 280 newborns participated in this study. Of all subjects, 71.0% were full term, 29.0% were preterm, (55.3%) were female in full-term newborns and

(66.0%) were female in preterm newborns. Most full-term newborns (90.0%) were born by vaginal delivery, and all preterm newborns (100%) were born by cesarean section. Additionally 95.0% of full-term newborns were from urban areas compared to 92.0% of preterm newborns. Regarding gestational-age (13.0%) full- term newborns were small – for - gestational-age (SGA); compared to (80.0%) preterm newborns (Table 1).

Figure 1 shows that the gestational age of newborns and (71 %) of them their gestational ages ranging from 35 ≥ 40 weeks and (29%) ranged from 30 < 35 weeks.

Concerning newborns' weight, (figure 2) pointed out that out of 280 newborns, (17%) were low-birth-weight (<2.5 kg) and (3%) were high birth weight (≥4 kg), while (80%) weighed between 2. 5 kg and 3.9 kg

Concerning mean differences in anthropometric measurements among newborns, there were statistically significant differences between full-term and preterm newborns regarding their birth weight, length, AC, CC, HC, and FL at P-values of 0.000, 0.003, 0.000, 0.001, 0.001, and 0.001, respectively (Table 2).

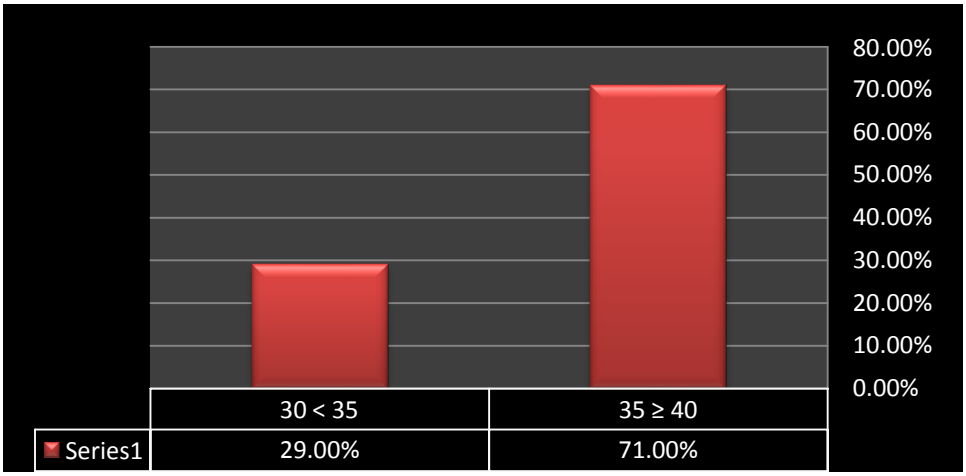
As shown in Table 3 newborns' mean standard deviation (SD) distribution of birth weight, head circumference, chest circumference, and feet length with their gestational age (GA). Birth weight increased with increasing GA (i.e., from 1.41 ± 0.37 cm at 30 weeks to 3.1 ± 0.58 cm at 40 weeks). Head circumference increased with increasing GA (i.e., from 27.4 ± 1.7 cm at 30 weeks to 33.7 ± 2.2 cm at 40 weeks). chest circumference increased with increasing GA (i.e., from 24.4 ± 1.7 cm at 30 weeks to 33.8 ± 1.3 cm at 40 weeks. Feet length FL increased with increasing GA (i.e., from 5.87 ± 0.17 cm at 30 weeks to 8.04 ± 0.16 cm at 40 weeks.

A significant positive correlation was found between gestational age and anthropometric variables such as FL, HC, AC, CC, length, and Wt. The mean values for FL HC, AC, CC, length, and BW were significantly higher in term babies than in preterm babies with a P-value of <0.0001(Table 4).

Percentile charts of the 10th, 50th, and 90th percentiles for birth weight, head circumference, and length according to gestational age were generated. According to this centile chart, at 40 weeks gestational age, the mean birth weight was 3.3 kg, HC was 34.9 cm and the length was 49.7 cm (Tables 5), respectively.

Table (1): Frequency and percentage distribution of newborns according to their Sociodemographic data, type of delivery and gestational age (N=280)

Items	Full-term (200)		Preterm (80)	
	No	%	No	%
Gender :				
- **Male**	89	44.7	27	34.0
- **Female**	111	55.3	53	66.0
Type of delivery				
- **Normal delivery**	180	90.0	0.0	0.0
- **Caesarean**	20	10.0	80	100.0
Residence				
- **Urban**	190	95.0	74	92.0
- **Rural**	10	5.0	6	8.0
Gestational age				
- **Small for Gestational age**	26	13.0	64	80.0
- **Appropriate for Gestational age**	166	83.0	16	20.0
- **Large for Gestational age**	8	4.0	0.0	00.0



(71.0%) 35 ≥ 40 weeks and (29%) ranged from 30 < 35 weeks.

Figure (1): Percentage distribution of newborns according to their gestational age range (N=280)

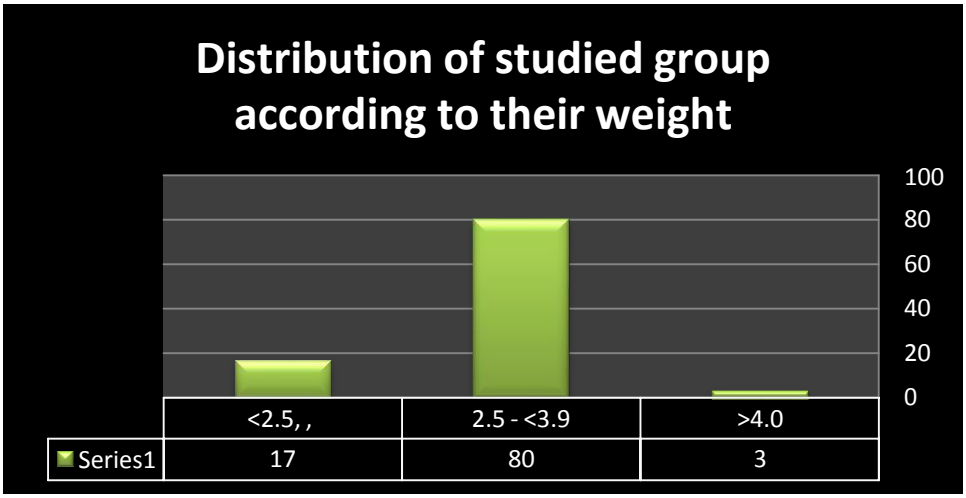


Figure (2): Percentage distribution of newborns according to their birth weight (N=280)

Low-birth-weight (<2.5 kg) and (3%) were high birth weight (≥4 kg), while (80%) weighed between 2. 5 kg and 3.9 kg

Table (2): Mean differences of anthropometric measurements in full-term and preterm newborns (N=280)

Items	Full-term	Preterm	t- test	p-value
- **Weight (Bw)**	3.1± 0.5	2 ± 227	12.87	0.000
- **Length**	46.0 ± 2.19	44.2 ± 1.24	5.49	0.003
- **Arm circumference(AC)**	10.1± 1	8,3 ± 0,17	2.79	0.000
- **Chest circumference (CC)**	32.0 ± 1.5	26.0 ± 2.75	5.64	0.001
- **Head circumference (HC)**	33.4± 2.5	32.0 ± 0.99	3.64	0.001
- **Feet length (FL)**	7.70 ±0.5	5.8± 0.5	2.64	0.001

P – Value was highly significant

Table (3): Mean standard deviation (SD) **distribution of** birth weight, head circumference, chest circumference and Feet length with gestational age (GA**) among newborns (N=280)**

Gestational age (wks.)	Birth weight	N0	Head circumference	N0	Chest circumference	N0	Feet length	No
30	1.41 ± 0.37	4	27.4 ± 1.7	8	24.4 ± 1.7	3	5.87 ± 0.17	4
31	1.36 ± 0.14	7	28.3 ± 1.8	6	26.3 ± 1.8	7	6.31± 0.14	7
32	1.41 ± .14	5	29.4 ± 4.7	13	25.4 ± 4.8	8	6.45± 0.27	10
33	1.7 ± 0.37	14	29.3 ± 1.5	25	28.4 ± 1.4	15	6.55 ± 0.25	15
34	1.77± 0.33	26	30.7 ± 1.8	11	28.7 ± 1.9	20	6.65 ± 0.46	15
35	1.87 ± 0.45	24	31.9 ± 1.5	17	28.6 ± 1.6	27	7.03 ± 0.34	29
36	2.33 ± 0.58	31	32.9 ± 1.6	41	30.7 ± 1.4	42	7.41 ± 0.63	90
37	2.55 ± 0.47	41	33.5 ± 1.8	41	30.5 ± 1.7	36	7.58 ± 0.4	18
38	2.89 ± 0.22	44	33.0 ± 1.3	50	32.2 ± 1.3	41	7.68 ± 0.22	19
39	2.81 ± 0.47	53	33.2 ± 1.4	40	33.2 ± 1.3	33	7.9 ± 0.24	19
40	3.1 ± 0.58	31	33.7 ± 2.2	28	33.8 ± 1.3	28	8.04 ± 0.16	54

Table (4): Correlation between gestational age and anthropometric variables among newborns (N=280)

Item	Gestational age			
	Maturity	**r- value**	**Mean standard deviation**	**p-value**
Feet length	**Full-term (200)**	0.963	8.04 ± 0.16	0.001
	Preterm (80)		5.87 ± 0.17	
Head circumference	**Full-term (200)**	0.611	33.7 ± 2.2	0.001
	Preterm (80)		27.4 ± 1.7	
Arm circumference	**Full-term (200)**	0.606	10.1± 1	0.001
	Preterm (80)		8,3 ± 0,17	
Chest circumference	**Full-term (200)**	0.579	33.8 ± 1.3	0.001
	Preterm (80)		24.4 ± 1.7	
Length	**Full-term (200)**	0.665	46.0 ± 2.19	0.001
	Preterm (80)		44.2 ± 1.24	
Weight	**Full-term (200)**	0.676	3.1 ± 0.58	0.001
	Preterm (80)		1.41 ± 0.37	

r: Pearson correlation P-value significant if ≤ 0.05 If r≤0.5= weak correlation If r> 0.5= strong correlation

Table (5): Distribution of the studied group according to percentile chart: weight for age (kg), head circumference for age (cm) and length for age (cm) (N=280)

Gestational weeks	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
	Weight for age (kg)										
10th percentile	1.44	1.20	1.70	1.82	2.15	2.44	2.48	2.53	2.55	2.74	2.49
50th percentile	1.72	1.95	2.24	2.27	2.56	2.75	3.00	3.15	3.20	3.25	3.30
90th percentile	2.50	2.70	2.85	3.30	3.35	3.38	3.55	3.62	3.67	3.69	3.76
	Head circumference (cm)										
10th percentile	27.1	28.0	28.5	29.5	30.4	31.4	32.0	32.3	32.5	32.8	32.9
50th percentile	30.3	31.0	31.5	32.5	33.0	33.5	34.0	34.2	34.5	34.6	34.9
90th percentile	33.0	33.4	33.7	34.5	35.2	35.5	35.8	36.0	36.0	35.2	35.3
	length for age (cm)										
10th percentile	41.3	42.4	40.8	44.0	45.3	46.0	47.0	47.1	46.0	46.8	47.8
50th percentile	45.3	46.0	46.4	48.1	48.6	49.0	49.0	49.1	49.2	49.6	49.7
90th percentile	47.5	48.3	49.1	50.1	51.2	51.7	51.5	52.0	51.3	52.5	52.3

Discussion

The NBS score used for GA assessment has both physical and neuronal criteria in developing countries, within 24 hours of birth as it requires a person trained in pediatrics and furthermore it is a subjective test. Neurological examination requires both skill and training. In contrast, anthropometric measurements collected by health workers have been shown to be more reliable, not expensive and not require skills than clinical examination. From the approach based on the importance of anthropometric measurements, the purpose of the study was to investigate the relationship between gestational age and anthropometric measurements among newborns

In the present study, three-fourths were full-term and one-fourth was preterm. These results were close to those of a study of neonates delivered in a Western Indian population by **Thawani et al., (2014)** in their study about "Estimation of gestational age, using neonatal anthropometry: a cross-sectional study in India" who observed that 373 neonates (37.3%) were preterm and 62.7% were full term.

The current study revealed that more than ten percent of full-term newborns were small-for-gestational-age (SGA); this result was in agreement with **Gupta et al., (2014),** who reported the same in their study about "Study of correlation between gestational age and new-born foot length and chest circumference".

The current study revealed that a positive correlation was found between gestational - age and other anthropometric variables namely BW, length, AC, CC, HC, and FL. These results were similar to those of a study conducted by **Gandhi et al., (2014)** in a Western Indian population about "A simple method for assessment of gestational age in neonates using head circumference" and found a strong correlation between GA and HC (r = 0.977). **(Rajat et al., 2013)**, stated in their study about " Estimation of Gestational Age, Using Neonatal Anthropometry" that there was a good correlation between gestational age and birth weight, foot length, mid-upper arm circumference, and head circumference.

Arm circumference in this study has been found to have a significant correlation with gestational age in neonates. **(Sasanow et al., 1986)**, also stated that, there was a significant ($p<0.001$) correlation between MUAC ($R=0.93$) and estimated gestational age.

These findings were the following **(Gupta et al., 2014))**, who found that foot length and chest circumference were significantly associated with both gestational age with a p-value of < 0.05 and a highly positive correlation coefficient.

In term neonates, foot length and birth weight correlated significantly with gestational age ($p = 0.0001$). Additionally, chest circumference is significant which is consistent with studies performed by (**Sreeramareddy et al., 2008 Shastry et al., 2015 and Naik et al., 2003** in his study about "Birth weight and anthropometry of newborns in Indian, and stated that the correlation of chest circumference to

gestational age was significant and matched to studies done by **(Narendra et al., 2014)** with an r-value of 0.523) and (**Sharma et al., 2015)** in their study about "To study the correlation of foot length and gestational age of newborn by new Ballard score" (r-value 0.649).

(UNICEF, 2016) reported that there was greater correlation coefficient for preterm than term newborns, **(Ritesh et al., 2016),** additionally, found in their study about "Gestational age assessment in newborns using regression equation of anthropometric parameters singly or in combination" that the best correlation for the prediction of gestational age was found by combined parameters (foot length, length, and birth weight).

Additionally **Ashish et al., (2015**) who studied "Validation of the foot length measure as an alternative tool to identify low birth weight and preterm babies in a low-resource setting such as Nepal" and stated that gestational age appears to be directly linked to anthropometric measurements and that gestational age can be estimated using anthropometric measurements. The study was in the same line with (**Iman et al., 2019),** who mentioned in their study in Yemen about "Anthropometric measurements of singleton live full-term newborns in Aden" that anthropometric parameters can be used for accurate assessment of maturity for newborns and to identify newborns at risk.

Conclusion:

The current study concluded that there was a significant correlation between gestational age and various other anthropometric measurements such as BW, FL, HC, CC, and length. Anthropometric measurements can easily be used and help to identify newborns' gestational age, can provide an important step for future standardization of anthropometric measurements that help in accurate newborn ' assessment, development and maturity and can lead to the identification of newborns who are at risk and help in good management.

Recommendation:

- Clinical practitioners and nurses should be aware of using anthropometric measurements which are important indicators for evaluating growth.
- Providing information about several anthropometric parameters that can be determined in neonates by using simple, quick and reliable measuring instruments, does not require skills and is not expensive to identify high-risk newborns soon after birth and for the estimation of GA.
- Future research should focus on addressing this research.

Conflicts of Interest

The authors declare no potential conflicts of interest concerning the research, authorship, and/or publication of this article.

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References:

Ashish, K.C., Nelin, V., Vitrakoti, R., Aryal, S., Målqvist, M. (2015): Validation of the foot length measure as an alternative tool to identify low birth weight and preterm babies in a low-resource setting such as Nepal: a cross-sectional study, BMC Pediatr; 15(1):43.

Deia, K., Khalaf, Y., K. Al- Rawi, S.A. (2018): Maaesahthe anthropometric measurements in full-term neonates in Baghdad International Journal of Current Research, 10 (7), pp. 71229-71232

Ezenwa, B., Iroha, E., Ezeaka, V., Egri-Okwaji, M. (2016): Score and proportionality indices in the assessment of fetal malnutrition in term newborns, Niger J Med, 57:124-8.

Gandhi D, Masand R, Purohit A. (2014): A simple method for assessment of gestational age in neonates using head circumference, Global Journal for Research Analysis ; 3(5): 211-213.10. 15373/ 22778160/ MAY2014/ 79

Gupta, A., Gunjan, K. M., Swati, M. (2018): Study of correlation between gestational age and new-born foot length and chest circumference, International Journal of Contemporary Pediatrics Gupta an et al. Int J Contemp Pediatr. Sep; 5(5):1875-1882 http://www. ijpediatrics. com ISSN 2349-3283 | eISSN 2349-3291 Original esearch Article.

Hockenberry, M., and Wilson, D. (2007): Wong's nursing care of infant and children, ch.24, growth and development of child.

Iman, A., Saddika, T., Omer, A. (2019): Anthropometric measurements of singleton live full-term newborns in Aden, Yemen International Journal of Pediatrics and Adolescent Medicine, https:// doi. org/ 10. 1016/ j.ijpam.08.003

Kendra, C. (2019): How Does the Cross-Sectional Research Method Work?

Lee, J. J., Valeri, L., Kapur, K., Ibne Hasan, M. O. S., Quamruzzaman, Q., Wright, R. O., … Mazumdar, M. (2018): Growth parameters at birth mediate the relationship between prenatal manganese exposure and cognitive test scores among a cohort of 2- to 3-year-old Bangladeshi children, International Journal of Epidemiology https://doi.org/ 10.1093/ ije/ dyy069, 47, 1169–1179.

Mullany, L. C., Darmstadt, G. L., Coffey, P., Khatry, S. K., LeClerq, S. C., Tielsch, J. M. (2006): A low cost, color-coded, hand-held spring scale accurately categorizes birth weight in low

resource settings, Arch Dis Child; 91:410 – 13.

Naik, D.B., Kulkarni, A.P., Aswar, N.R. (2003): Birth weight and anthropometry of newborns, Indian J Pediatr; 70(2):145-6.

Nair,B, U., Raju, R.N. (2016): Identification of a surrogate anthropometric measurement to birth weight in high-risk low birth weight newborns in a developing country Ann Niger Med, 10, pp. 63-67

Narendra, K.S., Madhu, G.N., Adarsha, E. (2014): Relationship of anthropometric parameters of the newborn with a varying period of gestational age, J Evol Med Dental Sci; 3(20):5484-90.

Ngirabega, J. D., Hakizimana, C., Wendy, L., Munyanshongore, C., Donnen, P., Dramaix, M. (2010): Reliability of anthropometric measurements performed by community nutrition workers in a community-based pediatric growth- monitoring program in rural Rwanda] Rev Epidemiol Sante Publique; 58: 409–14.

OOluwafemi, F., Njokanma, E., Disu, T., Ogunlesi. (2013): the current pattern of gestational age-related anthropometric parameters of term Nigerian neonates, S Afr J CH; 7(3):100-104.

Rajat, T., Pooja, D., M. Faridi, S. K., and Rajeev, Kumar. (2013): Estimation of Gestational Age, Using Neonatal Anthropometry: A Cross-sectional Study in India, J Health Popul Nutr. Dec; 31(4): 523–530. Doi: 10. 3329/ jhpn. v31i4. 20051

Ritesh, Y., J. P B., Gunjan, R. V., Shagun, G., Virendra, K. G., Sumit, B., and Alok, P. ((2016): Gestational age assessment in newborns using regression equation of anthropometric parameters singly or in combination, International Journal of Biomedical Research; 7(8): 600-605. 600 IJBR 7 (08) www.ssjournals.com International Journal of Biomedical Research ISSN: 0976-9633 (Online); 2455-0566 (Print) Journal DOI: 10.7439/ ijbr CODEN.

Sasanow, S.R., Georgieff, M. K., Pereira, G.R. (1986): Mid-arm circumference and mid-arm/head circumference ratios: standard curves for anthropometric assessment of neonatal nutritional status. J Pediatr; 109:311–5.

Sharma, U., Srivastava, A., Kumar, S. (2015): To study the correlation of foot length and gestational age of newborn by new Ballard score. Int J Res Med Sci; 3(11):3119-22.

Shastry, R., Bhat, P. (2015): Neonatal screening by chest circumference and a study of the relationship between birth weight and other anthropometric parameters, Int J Biomed Res; 6(03):160-3.

Soni, P. Kapoor, K. (2017): Correlation of birth weight with other anthropometric parameters of newborns in Himachal Pradesh, International Journal of Current Research Review; 9(15):49e54.

Sreeramareddy, C.T, Chuni, N., Patil, R., Singh, D., Shakya, B. (2008): Anthropometric surrogates to identify low birth weight Nepalese newborns: a hospital-based study, BMC Pediatr; 8:16.

Taylor, R., Denison, F. C., Beyai, S., Owens, S. (2016): The external Ballard examination does not accurately assess the gestational age of infants born at home in a rural community of the Gambia. Ann Trop Paediatr, 30:197–204.

Thawani, R., Dewan, P., Faridi, M., Arora S. K., Kumar, R. (2014): Estimation of gestational age, using neonatal anthropometry: a cross-sectional study in India. J Health Popul Nutr Dec; 31(4):523-530.

UNICEF, State of the world's children. (2016): A fair chance for every child, In Child health: A fair start in life. New York: UNICEF; 10-13.

Venkatachalam, J., Kumar, D., Gupta, M., Aggarwal, A. K. (2011): Knowledge and skills of primary health care workers trained on integrated management of neonatal and childhood illness: follow-up assessment 3 years after the training, Indian J Public Health; 55:298–302.

Victora, G., Adair, L., Fall, C., Hallal, P. C., Martorell, R., Richter, L., & Sachdev, H. S. (2008): Maternal and child undernutrition: Consequences for adult health and human capital. The Lancet, 371(9609), 340–357. https:// doi.org/ 10. 1016/ S0140-6736 (07)61692-4

World Health Organization. (2018): Global strategy for Womens's, Children's and Adolescents' health (2016–2030), monitoring report: current status and strategic priorities.