CORRELATION OF FOOT LENGTH AND HAND LENGTH AND OTHER ANTHROPOMETRIC MEASURMENTS WITH GESTIONAL AGE ASSISTED BY NEW BALLARD SCORE

By

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ABSTRACT

Background: *Gestational age is a cornerstone piece of clinical data used by physicians to conclude the timing of various screening investigations and assessments of the fetus and mother all through pregnancy. It is important to know an infant's gestational age because its behavior and anticipated problems can be predicted on this basis. It is also important for prediction of morbidity, mortality and further management.*

Objectives: *to study correlation of foot length and hand length and gestational age among preterm and term neonate.*

Methods: *This is prospective study was carried out on 1000 neonates who delivered at sayed galal hospital 24 hours of life. Their gestational age ranged from 27 to 40 weeks. Gestational assessment will be done using modified Ballard's scoring on day one. Foot Length will be measured using sliding caliper from December 2017 to November2018.*

Results: *This study showed that hand length was higher in males than in females, the differences were statistically significant beginning from week-30 until week-40.also it shows No statistical significant difference between males and females regarding Ballard score at all gestational weeks 27 till 40th also there is no statistical significant difference between males and females regarding Ballard and gestational age also there were statistical significant correlations between GA and anthropometric characteristics.(weight ,head circumference ,chest circumference ,hand length, foot length, Ballard score GA).*

Conclusion: *male fetuses have more gestational weight gain and growth patterns than female particularly from 31 gestational weeks onward .head circumference , chest circumference , foot length and hand length statistically significant higher among male than females particularly around 30 and 33 gestational weeks onwards.. No statistically significant difference was observed between males and females as regard Ballard scoring system throughout all gestations investigated.*

Key words: *foot length, hand length, gestational age. New Ballard score.*

INTRODUCTION

It is important to know an infant's gestational age because its behavior and anticipated problems can be predicted on this basis. It is also important for prediction of morbidity, mortality and further management **(Anshuman et al., 2015)**.

Also estimation of gestational age of fetus is of great medico legal importance **(Garima Sharma et al., 2015)**.

To determine gestational age in newborn, clinicians in industrialized countries rely on various prenatal and postnatal indicators such as first trimester ultrasound and last menstrual period and neonatal data such as Dubowitz or Ballard scoring systems **(Anshuman et al., 2015)**.

Menstrual period is not very reliable because many patients have irregular cycles. Ultrasound is out of reach of many poor patients. Different scoring systems use a number of neurological and physical criteria which are suitable for doctors but are cumbersome to use at remote places by paramedical staff **(Anshuman et al., 2015)**.

Anthropometric measures are non-invasive methods to calculate gestational age, simple to carry on without any prior special training. It is also less time consuming and more economical **(Mukta et al., 2014)**.

Anthropometric measures such as: birth weight, crown heel length and head circumference are the commonly used measures of growth in neonates, and they do correlate fairly with maturity. Weight measurements are significantly affected by changes in water, carbohydrate, fat, protein, and mineral levels. Although head circumference reflects brain growth, the effect of head sparing during malnutrition may result in an underestimation of growth. The foot of the newborn is usually readily accessible for measurement, even in incubators. It has been shown that foot length measurement is particularly valuable in premature babies who are so ill that conventional anthropometric measurements cannot be carried out due to the incubator and intensive care apparatus **(Sunil et al., 2016)**.

All these measurements give an accurate assessment of the fetal gestational age. However, gestational age assessment may be difficult in fetus with anencephaly, hydrocephalus, and short limb dysplasia. Study of literature suggests that fetal foot has a

characteristic pattern of normal growth and the fetal foot could be used to estimate gestational age. Evaluation of the fetal femur/ foot length ratio can also be a useful parameter to differentiate fetuses that have dysplastic limb reduction, from those whose limbs are short because of constitutional factors/IUGR **(Mukta et al., 2014)**.

Aim of the Work

The aim of this study is to study correlation of foot length and hand length and gestational age among preterm and term neonate.

PATIENTS AND MATERIALS

A prospective research study conducted on 1000 neonates delivered at Sayed Galal hospital within 24 hours of birth. The gestational age range was 27 to 40 weeks. Gestational assessment was performed using modified Ballard's scoring on day one. Foot and hand length was measured by usage of sliding caliper.

Inclusion Criteria: was:

Babies delivered at gestational age range from 27 to 40 weeks.

Exclusion Criteria: were:

- Neonates who are products of multifetal gestation.
- Infants with undetermined sex.
- Babies with congenital foot and hand deformities and other major congenital anomalies.
- Evidence of intrauterine infection.
- Infants of mothers who had medical diseases (e.g. hypertension and diabetes).
- Mother having irregular menstrual history and unsure of her last date of menstruation.

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Ethical Consideration:

1. A written informed consent was obtained from their legal guardians.
2. An approval by the local ethical committee was obtained before the study.
3. The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.
4. All the data of the patients and results of the study are confidential and the patients have the right to keep it.

Statistical Analysis:

Data were collected, coded, revised and entered to the statistical package for social science (SPSS) version 20. Qualitative data were presented as number and percentages while quantitative data were presented as mean, standard deviation and range. The comparison between two groups with quantitative and parametric data was done by using independent t-test.The comparison between more than two groups with quantitative and parametric data was done by using one way analysis of variance (ANOVA) test. Spearman correlation coefficient was used to assess the relation between two parameters in the same group. P value below 0.05 was considered significant.

RESULTS

Table (1): Comparison between the 2 Groups in Demographic Data

Time	Measures	Total	Male	Female	P
All cases	**Mean±SD**	6.4±0.5	6.5±0.5	6.3±0.5	**<0.001***
	Range	4.2–7.9	4.6–7.9	4.2–7.8	
Week-27	**Mean±SD**	4.5±0.3	4.7±0.1	4.4±0.2	0.192
	Range	4.2–4.8	4.6–4.8	4.2–4.5	
Week-28	**Mean±SD**	4.7±0.1	4.8±0.1	4.6±0.2	0.238
	Range	4.4–4.8	4.8–4.8	4.4–4.7	
Week-29	**Mean±SD**	5.0±0.4	5.0±0.3	4.9±0.6	0.666
	Range	4.4–5.3	4.8–5.3	4.4–5.3	
Week-30	**Mean±SD**	5.2±0.3	5.4±0.1	4.9±0.1	**0.026***
	Range	4.8–5.5	5.3–5.5	4.8–5.0	
Week-31	**Mean±SD**	5.3±0.4	5.6±0.1	5.0±0.2	**0.004***
	Range	4.8–5.8	5.5–5.8	4.8–5.1	
Week-32	**Mean±SD**	5.3±0.3	5.7±0.0	5.2±0.2	**0.010***
	Range	4.9–5.7	5.7–5.7	4.9–5.4	
Week-33	**Mean±SD**	5.8±0.5	6.0±0.4	5.3±0.1	**0.020***
	Range	5.3–6.5	5.5–6.5	5.3–5.4	
Week-34	**Mean±SD**	5.7±0.4	6.1±0.3	5.5±0.3	**0.020***
	Range	5.1–6.4	5.9–6.4	5.1–6.0	
Week-35	**Mean±SD**	6.1±0.4	6.2±0.4	5.8±0.2	**0.008***
	Range	5.5–6.6	5.5–6.6	5.6–6.0	
Week-36	**Mean±SD**	5.9±0.5	6.2±0.5	5.7±0.3	**0.004***
	Range	5.4–7.0	5.6–7.0	5.4–6.0	
Week-37	**Mean±SD**	6.1±0.5	6.3±0.5	5.9±0.4	**0.005***
	Range	5.2–7.4	5.2–7.4	5.3–6.6	
Week-38	**Mean±SD**	6.3±0.4	6.4±0.4	6.3±0.4	**0.040***
	Range	5.1–7.3	5.6–7.3	5.1–7.1	
Week-39	**Mean±SD**	6.6±0.4	6.7±0.4	6.5±0.4	**<0.001***
	Range	5.6–7.8	6.0–7.7	5.6–7.8	
Week-40	**Mean±SD**	6.7±0.4	6.8±0.4	6.7±0.4	**0.041***
	Range	5.7–7.9	5.7–7.9	5.7–7.5	

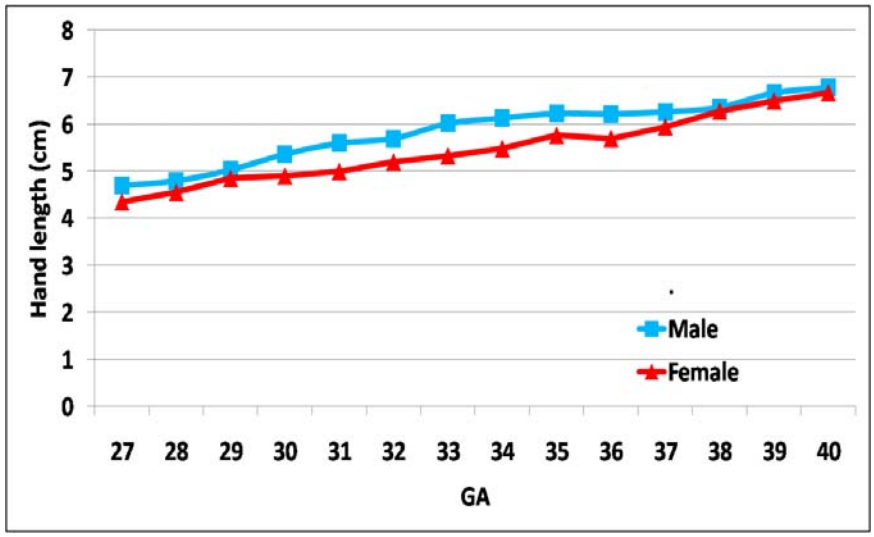

Figure (2): Hand length according to sex among the studied cases

Table (1) and figure (2) show that hand length was higher in males than in females; the differences were statistically significant beginning from week-30 until week-40. (pvalues=0.026,0.004,0.01,0.02, 0.0.02,0.008,0.004,0.005,0.04,<0 .001,0.041 consecutively)

Table (2) Foot length according to sex among the studied cases

Time	Measures	Total	Male	Female	p
All cases	**Mean±SD**	5.1±0.1	5.2±0.0	5.0±0.1	**<0.001***
	Range	4.9–5.2	5.2–5.2	4.9–5.1	
Week-27	**Mean±SD**	5.2±0.1	5.3±0.0	5.1±0.1	0.184
	Range	5.0–5.3	5.3–5.3	5.0–5.2	
Week-28	**Mean±SD**	5.2±0.6	5.6±0.3	4.8±0.6	0.184
	Range	4.3–5.9	5.3–5.9	4.3–5.2	
Week-29	**Mean±SD**	5.2±0.6	5.6±0.2	4.5±0.1	0.137
	Range	4.4–5.8	5.5–5.8	4.4–4.6	
Week-30	**Mean±SD**	5.7±0.2	5.8±0.1	5.5±0.1	**0.004***
	Range	5.5–6.0	5.7–6.0	5.5–5.6	
Week-31	**Mean±SD**	5.7±0.3	6.1±0.2	5.6±0.2	**0.029***
	Range	5.3–6.2	5.9–6.2	5.3–5.8	
Week-32	**Mean±SD**	6.1±0.3	6.3±0.1	5.8±0.2	**0.025***
	Range	5.6–6.4	6.2–6.4	5.6–5.9	
Week-33	**Mean±SD**	6.2±0.4	6.6±0.3	6.0±0.3	**0.001***
	Range	5.6–6.9	6.4–6.9	5.6–6.5	
Week-34	**Mean±SD**	6.6±0.3	6.8±0.2	6.3±0.3	**0.020***
	Range	6.1–7.0	6.4–7.0	6.1–6.6	
Week-35	**Mean±SD**	6.7±0.4	6.8±0.3	6.5±0.3	**0.040***
	Range	6.0–7.3	6.4–7.3	6.0–6.9	
Week-36	**Mean±SD**	6.8±0.4	7.0±0.4	6.7±0.4	**0.021***
	Range	6.2–7.7	6.4–7.7	6.2–7.6	
Week-37	**Mean±SD**	7.1±0.3	7.2±0.3	7.0±0.3	**0.003***
	Range	6.3–7.9	6.5–7.9	6.3–7.7	
Week-38	**Mean±SD**	7.4±0.3	7.5±0.3	7.3±0.3	**<0.001***
	Range	6.5–8.1	6.7–8.1	6.5–8.1	
Week-39	**Mean±SD**	7.6±0.3	7.7±0.3	7.5±0.3	**<0.001***
	Range	6.7–8.3	6.7–8.3	6.8–8.3	
Week-40	**Mean±SD**	5.1±0.1	5.2±0.0	5.0±0.1	**0.002***
	Range	4.9–5.2	5.2–5.2	4.9–5.1	

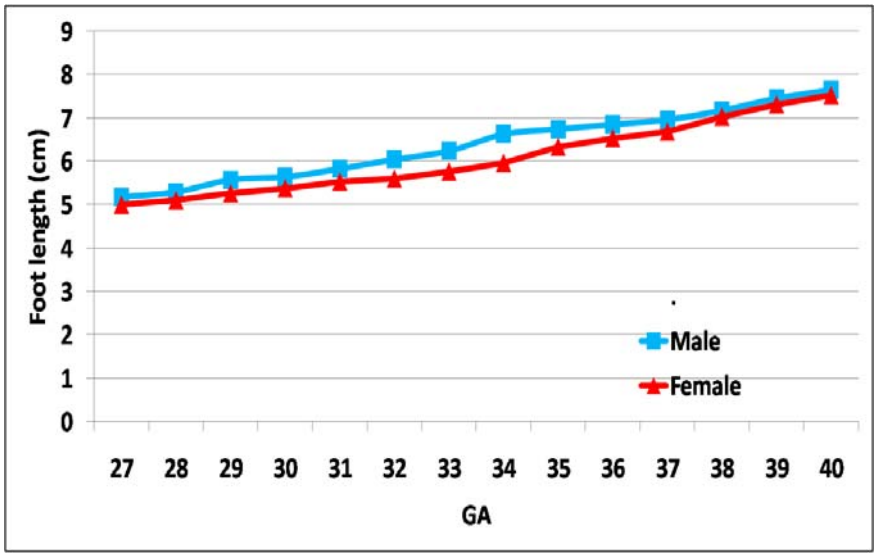

Figure (3): foot length according to sex among the studied cases

Table (2) Figure (3) show that: show that: Foot length was higher in males than in females, the differences were significant beginning from week-30 until week-40.(p values = 0.004, 0.029, 0.025, 0.001, 0.001, 0.020, 0.040, 0.021, 0.003, <0.001, <0.001, 0.002 consecutively)

Table (3) Ballard GA among the studied cases

Time	Measures	Total	Male	Female	P
All cases	**Mean±SD**	39.1±2.4	39.1±2.4	39.1±2.4	0.877
	Range	27.2–44.4	27.6–44.4	27.2–43.2	
Week-27	**Mean±SD**	27.9±0.7	27.8±0.3	28.0±1.1	0.831
	Range	27.2–28.8	27.6–28.0	27.2–28.8	
Week-28	**Mean±SD**	28.4±0.3	28.4±0.0	28.4±0.6	1.000
	Range	28.0–28.8	28.4–28.4	28.0–28.8	
Week-29	**Mean±SD**	29.6±0.7	30.0±0.7	29.0±0.3	0.160
	Range	28.8–30.4	29.2–30.4	28.8–29.2	
Week-30	**Mean±SD**	30.1±0.7	29.9±0.2	30.4±1.1	0.453
	Range	29.6–31.2	29.6–30.0	29.6–31.2	
Week-31	**Mean±SD**	31.1±1.2	31.3±1.4	30.8±1.1	0.623
	Range	30.0–33.2	30.0–33.2	30.0–32.0	
Week-32	**Mean±SD**	32.9±0.6	32.8±0.6	32.9±0.6	0.901
	Range	32.0–33.6	32.4–33.2	32.0–33.6	
Week-33	**Mean±SD**	33.4±0.6	33.3±0.8	33.5±0.5	0.721
	Range	32.4–34.4	32.4–34.4	33.2–34.0	
Week-34	**Mean±SD**	33.9±0.6	33.9±0.6	33.9±0.6	1.000
	Range	33.2–34.8	33.2–34.4	33.2–34.8	
Week-35	**Mean±SD**	34.6±0.8	34.6±0.7	34.5±1.0	0.913
	Range	33.2–35.6	33.2–35.2	33.6–35.6	
Week-36	**Mean±SD**	36.7±1.1	37.0±0.7	36.4±1.3	0.413
	Range	34.8–38.8	36.4–38.0	34.8–38.8	
Week-37	**Mean±SD**	37.6±1.1	37.3±1.1	37.9±1.1	0.124
	Range	35.2–40.4	35.2–40.4	35.6–40.0	
Week-38	**Mean±SD**	38.8±1.1	38.8±1.1	38.8±1.2	0.914
	Range	36.0–41.2	36.0–41.2	36.4–41.2	
Week-39	**Mean±SD**	39.8±1.2	39.9±1.2	39.8±1.1	0.268
	Range	37.2–42.8	37.2–42.8	37.2–42.4	
Week-40	**Mean±SD**	40.8±1.2	40.8±1.2	40.9±1.1	0.260
	Range	37.6–44.4	37.6–44.4	37.6–43.2	

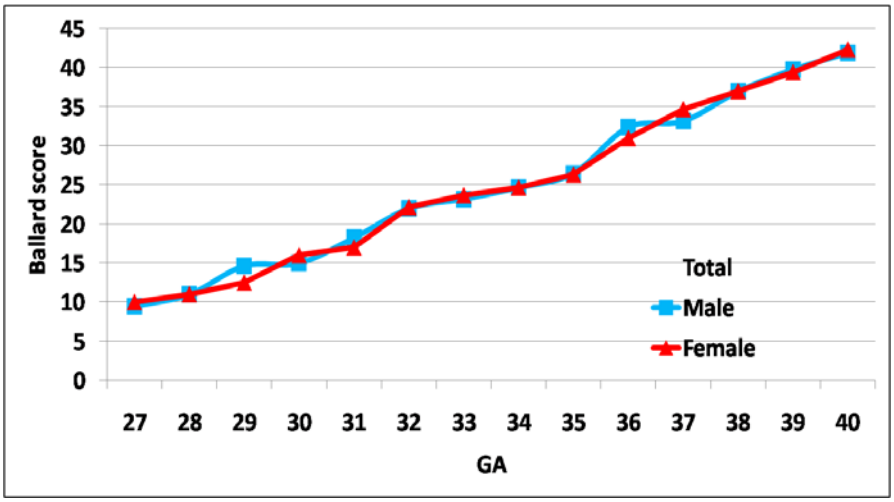

Figure (4): Ballard score according to sex among the studied cases

Table (3) and figure (4) show that: No statistical significant difference between males and females regarding Ballard GA.(p values = 0.831, 1.000, 0.160, 0.453, 0.623, 0.901, 0.721, 1.000, 0.913, 0.413, 0.124, 0.914, 0.268, 0.260 consecutively)

Table (4): Correlation between anthropometric characteristics

Variables		GA	Weight	Head circum.	Chest circum.	Hand length	Foot length
Weight	**r**	0.836					
	p	**<0.001***					
Head circum.	**r**	0.821	0.917				
	p	**<0.001***	**<0.001***				
Chest circum.	**r**	0.432	0.825	0.741			
	p	**<0.001***	**<0.001***	**<0.001***			
Hand length	**r**	0.639	0.795	0.747	0.696		
	p	**<0.001***	**<0.001***	**<0.001***	**<0.001***		
Foot length	**r**	0.804	0.866	0.803	0.642	0.684	
	p	**<0.001***	**<0.001***	**<0.001***	**<0.001***	**<0.001***	
Ballard score /GA	**r**	0.877	0.730	0.714	0.363	0.548	0.693
	p	**<0.001***	**<0.001***	**<0.001***	**<0.001***	**<0.001***	**<0.001***

Table (4) shows there were statistical significant correlations between GA and anthropometric characteristics. (Weight, head circumference, chest circumference, hand length, foot length, Ballard score GA) p values<0.001.

DISCUSSION

To determine gestational age in the neonates, physicians in industrialized countries depend on numerous prenatal and postnatal tools, e.g first trimester solography and last menstrual period, Dubowitz or Ballard scoring systems **(Oza et al., 2015)**.

Calculation of gestational age is affected by maternal malnutrition and intrauterine growth restriction. Relying on Dubowitz and Ballard scores, instead of LMP, and/or clinical estimates of gestational age requires technical skills and may not work as well among malnourished populations, due to intrauterine stress and potential premature neurological maturation, even though a comparison of scoring system performance and accuracy in Cameroon revealed and displayed that the Dubowitz and Ballard to be rather precise. Some researcher groups of investigators have made an effort to simplify existing neonatal gestational age-estimation scores e.g the Dubowitz and Ballard scores **(Lee et al., 2016)**.

The New Ballard Score used for GA assessment has both physical and neuronal criteria. It has fallacies 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 than clinical examination **(Gandhi et al., 2014)**.

The current research findings revealed that hand length was higher in males than in females, the differences were statistically significant beginning from week-30 until week-40.(p values = 0.026, 0.004, 0.010, 0.020, 0.0.020, 0.008, 0.004, 0.005, 0.040, <0.001, 0.041 consecutively).

As regard Foot length it was higher in males than in females, the differences were significant beginning from week-30 until week-40.(p values = 0.004, 0.029, 0.025, 0.001, 0.001, 0.020, 0.040, 0.021, 0.003, <0.001, <0.001, 0.002 consecutively).

A prior research study performed to investigate postnatal foot length measurement capability to accurately define gestational age in which Foot length was measured with a plastic Venire's caliper. The research group of investigators revealed and displayed among their research study results that the Foot length correlates in a statistically significant fashion to gestational

age (p value <0.001). Furthermore it was shown that the Intra-observer and inter-observer variability of foot length measurements was minimal. The research team came to the conclusion that Foot length could be used with high precision to determine the gestational age in a population where there is poor access to or utilization of antenatal sonar **(Lee et al., 2016)**.

Another previous research study evaluated and investigated the correlation between gestational age and neonatal anthropometric indices, involving head circumference and crown-heel length in a cross-sectional research study with 530 consecutively live-born newborns of 28–41 weeks gestation. Anthropometric parameters were measured after three days of life. We summarized the variables using descriptive statistics, including percentile values, and the strength of association was determined through correlation analysis. The statistically correlation was powerful for HC and CHL, and linear regression analysis was done to develop predictive equations. Results: HC and CHL correlated well with GA with R-values of 0.863 and 0.859, respectively. The regression equations derived were GA (week) = 9.2671 + [0.8616 × HC (cm)] and GA (weeks) = 7.2489 + [0.621 × CHL (cm)]. Multiple regression gave the relationship as GA (weeks) = 4.0244 + [0.4058 × HC (cm)] + [0.4249 × CHL (cm)]. Application of this multiple regression equation to a test cohort of 30 babies for prediction of GA gave mean margin of error of 2.9%, indicating that it is a satisfactory tool for prediction. The research team concluded that HC and CHL can be used as simple tools for predicting GA in babies when this is in doubt. This can help in identification of high-risk newborns at primary care level without recourse to imaging modalities **(Oza et al., 2015)**, **(Katz et al., 2013)**.

Prior research teams have revealed that foot length-derived gestational age is more accurate than LMP or Ballard-determined gestational age. In a comparison of GA determination methods in a low-resource setting, it was found that the Ballard score underestimated the GA, while the Dubowitz score overestimated the gestational age in a preterm infant. The clinical usage of these neonatal scoring is compromised by the requirement of sufficient training and clinical skills needed by the health care workers to accurately apply these scores. Furthermore it was observed that Foot length measurement using

the Verniere's caliper needs minimal training, is faster and could therefore be applied by all levels of medical staff. On the other hand the neonatal scores, foot length measurements could lead to minimal disturbance to the infant **(Thawani et al., 2012)**.

Another similar South African research study. it was observed that sologra phy rates before 18 gestational weeks were low (37.3%) and only slightly better when conducted at 24 gestational weeks (65.1%).Foot length was shown to statistically correlate well with gestational ,birth weight, length and head circumference furthermore it was observed that foot length indices are not affected by sex or race. The research team of investigators have showed among their study findings high degree of inter- and intra-observer agreement, denoting that this mode of measurement is easy to apply and rapid to conduct .Foot length have been implemented in addition to identify very low birth weight babies and was capable to reduce mortality rate in Tanzania by aiding in the identification of high risk infants. In which the research study results have shown that foot lengths below 7 cm and under 8 cm were capable to identify VLBW and low birth weight (LBW)/preterm neonates , consecutively. The statistical sensitivity of foot length was75%, 87% and 93% for VLBW, LBW and prematurity, consecutively. The calculated statistical Specificity was 99%, 60% and 58%, consecutively. Positive predictive values were low (43%), but negative predictive values were high (96% for LBW and 99% for VLBW). The researchers came to the conclusion that Foot length measurement therefore is a simple, satisfactory and economic screening tool to advance neonatal health care. Level **(Lee et al., 2016)**, **(Oza et al., 2015)**.

A prior research study similar to the current research study as regards approach and methodology involved 320 neonates assessed within 72hours of birth. Have shown that in preterm neonate's correlation of foot length with weight, head circumference, crown-heel length and gestational age by Ballard's score was statistically significant. Furthermore the receiver operating characteristic curve, have shown that the cut off value obtained for predictability of prematurity was 7.35cm which had a statistical sensitivity and specificity of 80% and 78 % consecutively. The research team of investigators came to the conclusion that Neonatal foot length could be a good surrogate measurement in

prematurity prediction **(Carlo et al., 2011)**.

A study conducted on a Western Indian population found a strong correlation between GA and HC (r = 0.977).15 Another study observed a strong linear correlation between HC (r = 0.95) and the estimated GA between 25 and 42 weeks.16 In our case, in the age range of Eastern Indian babies between 28 and 41 weeks, the correlation was 0.863 **(Thawani et al., 2012)**.

Another previous study on neonates delivered in a Western Indian cohort it was observed that gestational age varied from 25 to 42 weeks, with 373 neonates (37.3%) being preterm and 62.7% being term. Interestingly the research team of investigators have revealed among their findings that there was a good statistical linear correlation between gestational age and crown heel length and they projected a linear regression formula in which GA (weeks) = 20.06 + [0.34 × CHL (cm)] **(Gandhi et al., 2014)**.

CONCLUSION

Male fetuses have more gestational weight gain and growth patterns than female particularly from 31 gestational weeks onward .head circumference , chest circumference , foot length and hand length statistically significant higher among male than females particularly around 30 and 33 gestational weeks onwards. No statistically significant difference was observed between males and females as regard Ballard scoring system throughout all gestations investigated.

RECOMMENDATION

Future research studies are recommended to be conducted in a multicentric fashion with larger sample sizes to be more representative of neonatal anthropometric parameters in correlation to gestational ages with consideration of racial and ethnic differences.

Future research efforts are required to innovate a special formula that could be applied on Egyptian neonates to reveal the gestational age more precisely .Other research variables should be investigated in future research such as maternal BMI and nutritional status that could influence the growth patterns in intrauterine life.

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تقييم مدي العلاقة بين طول القدم واليد وغيرها من القياسات الأنثروبومترية الاخري مع عمر الحمل مقيما بمقياس بالارد الجديد في الاطفال حديثي الولاده الأصحاء

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الهدف: الهدف من هذه الدراسة تقييم مدي العلاقة بين طول القدم واليد مع عمر الحمل مقيما بمقياس بالارد الجديد في الاطفال حديثي الولاده الأصحاء.

الطريقه: تم إجراء هذه الدراسة علي ألف حاله من الاطفال حديثي الولادة قد تمت ولادتهم في مستشفى السيد جلال وكانت أعمارهم الجنينيه تتراوح بين ٢٧ الي ٤٠ أسبوعًا. وتم تقديرالعمر الجنيني باستخدام سجل Ballard الجديد وتم قياس طول القدم واليد باستخدام الفرجار المنزل(sliding caliper) .

النتائج: أظهرت هذه الدراسة أن طول اليد كان أعلى عند الذكور منه عند الإناث ، وكانت الفروق ذات دلالة إحصائية تبدأ من الأسبوع ٣٠ وحتى الأسبوع، ٤٠ كما أنه لا يوجد فرق إحصائي كبير بين الذكور والإناث فيما يتعلق بمقياس بالارد الجديد في جميع أسابيع الحمل .كما لا يوجد اختلاف إحصائي كبير بين الذكور والإناث فيما يتعلق بمقياس بالارد وعمر الحمل ، كما كانت هناك

ارتباطات إحصائية ذات دلالة إحصائية بين العمر الجنيني والخصائص الأنثروبومترية (الوزن ومحيط الرأس ومحيط الصدر وطول اليد وطول القدم).

الاستنتاجات والتوصيات: لدى الأجنة الذكور زيادة في الوزن الحملي وأنماط نمو أكثر من الأجنة الأنثوية خاصة من ٣١ أسبوعًا من الحمل وما بعده. كان محيط الرأس ومحيط الصدر وطول القدم أعلى إحصائيًا بين الذكور أكثر من الإناث خاصةً بين ٣٠ و ٣٣ أسبوعًا من الحمل وما بعده.

لم يلاحظ أي فرق معتد به إحصائيا بين الذكور والإناث فيما يتعلق بمستوى تسجيل بالارد في جميع الحالات التي تم فحصها.

يوصى بإجراء دراسات بحثية مستقبلية بطريقة متعددة المراكز بأحجام أكبر للعينات لتكون أكثر تمثيلا لمقاييس الأنثروبومترية الجنينيه فيما يتعلق بعمر الحمل مع مراعاة الاختلافات العرقية.

الجهود البحثية المستقبلية مطلوبة لابتكار صيغه خاصه يمكن تطبيقها على الأطفال المصريين للكشف عن عمر الحمل بشكل أدق ويجب البحث عن متغيرات البحث الأخرى في البحوث المستقبلية مثل مؤشر كتلة جسم الأمهات و الحاله الغذائية التي يمكن أن تؤثر على أنماط النمو في الحياة داخل الرحم .