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Anthropometric Measurements that Discriminate between Low and High Birth Weight Among the Urban and Rural Neonates in Kano State Nigeria

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Abstract
Birth weight (BW) is the baby's total body weight at birth. It is best taken within 24 hours of life before the onset of postnatal weight loss. Low birth weight (LBW) and high birth weight (HBW) are defined as weight at birth of less than 2.5 kg and higher than 4.5 kg, respectively. Newborn babies usually experience weight loss within the first three days after birth and may regain the weight lost after breastfeeding in about the second or third week of delivery. A weight loss of about 5% and loss of about 10 to 15% were observed in pre-term and sick babies at birth, respectively. This makes taking BW within the first 24 hours of life more appropriate. The receiver (relative) operator characteristic (ROC) curve is a graphical representation of the relationship between sensitivity and specificity for the determination of the possible cut off values. It is carried out between two variables to determine the sensitivity and specificity of the given variables. A prospective cross-sectional study was from six hospitals within Kano State (three selected hospitals from urban and three from rural areas). The study aims to determine the cut off values between low and high birth weight babies using anthropometric parameters among the urban and rural neonates in Kano State Nigeria. Materials used for the study include a digital weighing scale (EBSA-20, Kologn Industrial Limited, China), plastic meter rule, and a non-elastic measuring tape. Ethical clearance to conduct the study was obtained from the Ministry of Heath Kano State through its ethical committee, and written consent was obtained from the mothers of the neonates. A total of 717 and 486 neonates from the urban and rural areas were enrolled for the study. Among urban neonates, the thigh circumference ($P < 0.001$) is the best discriminator between the low and high birth weights, followed by birth length ($P < 0.001$). The least discriminator is the head circumference ($P = 0.244$). However, among the rural neonate, the best discriminator between the low and high birth weight is a birth length ($P < 0.001$) followed by the thigh circumference ($P < 0.001$). The least discriminator in this category of neonates is the head circumference ($P = 0.231$). Therefore, in conclusion, the neonatal anthropometric parameters that can be used to discriminate against low and high birth weight in the urban and rural areas of Kano State have been determined.

Keywords: Birth Weight, Kano State, Receiver Operator Characteristic Curve, Rural Area, Urban Area

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INTRODUCTION

Birth weight (BW) is the baby's body weight at birth. It is best taken within 24 hours of life before the onset of postnatal weight loss (Chandrashekar *et al*., 2008). Low birth weight (LBW) and high birth weight (HBW) are defined as weight at birth of less than 2.5 k g and higher than 4.5 kg (WHOSIS, 2011). Newborn babies normally experience weight loss within the first three days after birth and may regain the weight lost after breastfeeding in about the second or third week of delivery. A weight loss of about 5% and loss of about 10 to 15% was observed in pre-term and sick babies at birth (MacDonald *et al*., 2003). This makes taking BW within the first 24 hours of life more appropriate. It has been documented earlier that in Nigeria, LBW affects about 56 million children every year (Olu, 2005). However, Achebe *et al*. (2014) revealed that in the South-west of Nigeria, 11.4% of children are born with LBW, and 12.2% in northern Nigeria have LBW at delivery. It has been revealed that nearly all of the newborns who die immediately after their delivery are of LBW and are mostly in rural communities where weighing scales are not readily available (Lawn, 2009; Lawn *et al*., 2010; Marchant *et al*., 2010; Wall *et al*., 2010). Similarly, HBW (termed as foetal macrosomia) has been associated with perinatal complications such as prolong (neglected) labour, shoulder dystocia, brachial plexus palsy, increase rate of unplanned caesarean section, among others.

It has been found recently that the increase in BW may lead to an increased incidence of childhood cancer development (Hill, 2018). Also, HBW has been shown to be associated with an increased risk of disease conditions such as obesity, cardiovascular diseases, diabetes mellitus, and carcinomas (Szostak-Wegierek *et al*., 2011; Cnattingius *et al*., 2012; O'Neill *et al*., 2015; Zimmermann *et al*., 2015). Rossi and Vasconcelos (2010) have concluded that HBW is associated with overweight/obesity.

The receiver (relative) operator characteristic (ROC) curve is a graphical representation of the relationship between sensitivity and specificity for the determination of the possible cut off values. It is carried out between two variables to determine the sensitivity and specificity of the given variables. The ROC curve is also said to be a popular method for displaying sensitivity and specificity (Patrick *et al*., 2004). There is a need to develop a simple and practical methods for estimating neonatal birth weights, so as to plan for delivery especially in rural areas, or places where the weighing scale, ultrasound machine or manpower (expertise) are not readily available in order to identify those with LBW or HBW for prompt and appropriate action. This will go a long way in reducing neonatal and maternal mortality rates. One such method could be through the use of regression equations or having cut off values for low and high birth weight among the neonates that can discriminate between low and high birth weight.

MATERIALS AND METHODS

A prospective cross-sectional study was undertaken from six hospitals within Kano State (three selected hospitals from the urban and three from the rural areas). Materials used for the study include a digital weighing scale (EBSA-20, Kologn Industrial Limited, China), plastic meter rule, and a non-elastic measuring tape. Ethical clearance to conduct the study was obtained from the Ministry of Heath Kano State through its ethical committee, and written consent was obtained from the mothers of the neonates. Data were taken at random from the neonates that satisfy the criteria of being a singleton, full-term and, delivered with no limb deformity.

A sample of 1203 neonates comprising of 717 and 486 from the urban and rural hospitals respectively, who were born within 24 hours of delivery were taken and recorded into the

preformed proforma from November 2018 to May 2019. The neonatal parameters of BW, birth length (BL), foot length (FL), foot breadth (FB), thigh circumference (TC), hand length (HL), hand breadth (HB), neonatal arm circumference (NAC), chest circumference (CC) and head circumference (HC) were taken using standard techniques as described by Sharma *et al*. (1988).

Statistical Analyses

Data collected were expressed as mean ± standard deviation (SD). Tables and graphs were used in expressing the data. An independent sample *t*-test was used to determine the differences between the variables. The ROC curve was used to determine the cut off values of the measured neonatal anthropometric parameters that discriminate between low and high birth weight. Data analyses were carried out using IBM SPSS version 25.0 statistical software. $P < 0.05$ was considered statistically significant.

RESULTS

Table 1 highlighted the descriptive statistics of the anthropometric parameters among the neonates in the urban and rural areas in Kano State, Nigeria. Among the urban neonates, the mean BW and that of BL were found to be 3174.60 ± 508.30 and 48.69 ± 3.37. Similarly, the FL, FB, HL, and HB have mean values of 8.12 ± 0.67, 3.20 ± 0.41, 6.77 ± 0.54, and 3.44 ± 0.34. The thigh, neonatal arm, chest and the head circumferences were having mean values of 14.79 ± 2.03, 10.97 ± 1.35, 30.25 ± 3.32 and 32.60 ± 3.44 respectively. Considering the rural neonates, the mean BW and BL were 2938.70 ± 429.80 and 513.51 ± 72.43. The FL (8.21 ± 0.63) have a higher mean value than HL (6.82 ± 0.47); similarly, the HB (3.42 ± 0.31) have a higher mean value than FB (3.12 ± 0.36). The thigh, neonatal arm, chest, and the head circumferences were 14.76 ± 2.13, 11.06 ± 1.37, 29.75 ± 3.60 and 32.05 ± 3.82 respectively.

Table 1: The Descriptive Statistics of the Anthropometric Parameters among the Neonates in Urban and Rural areas in Kano State Nigeria

Variables (cm)	Domicile	n	Mean ± SD	Minimum	Maximum
Birth weight	Urban	717	3174.60 ± 508.30	1800.00	4600.00
	Rural	486	2938.70 ± 429.80	1900.00	4100.00
Birth length	Urban	717	48.69 ± 3.37	38.00	56.00
	Rural	486	49.48 ± 3.26	40.00	56.00
Foot length	Urban	717	8.12 ± 0.67	6.00	9.80
	Rural	486	8.21 ± 0.63	5.10	9.80
Foot breadth	Urban	717	3.20 ± 0.41	2.20	4.50
	Rural	486	3.12 ± 0.36	2.20	4.50
Thigh circumference	Urban	717	14.79 ± 2.03	9.80	18.50
	Rural	486	14.76 ± 2.13	9.80	18.50
Hand length	Urban	717	6.77 ± 0.54	5.50	8.50
	Rural	486	6.82 ± 0.47	5.50	8.50
Hand breadth	Urban	717	3.44 ± 0.34	2.70	4.80
	Rural	486	3.42 ± 0.31	2.70	4.50
Neonatal arm circumference	Urban	717	10.97 ± 1.35	7.00	13.70
	Rural	486	11.06 ± 1.37	7.00	13.70
Chest circumference	Urban	717	30.25 ± 3.32	20.20	36.00
	Rural	486	29.75 ± 3.60	20.20	36.00
Head circumference	Urban	717	32.60 ± 3.44	20.00	39.20
	Rural	486	32.05 ± 3.82	20.00	39.20

Table 2 shows the cut off value (CV) that discriminate between low and high birth weight among the neonates in Kano state Nigeria. Among urban neonates, the TC (P < 0.001) is the best discriminator between the low and high birth weight having CV of 13.55 cm and covering area under the curve (AUC) of 78.20 %. This is followed by BL (CV = 46.65 cm, AUC = 78.10%), having a P value of < 0.001. The least discriminator is HC (P = 0.244) having a CV and AUC of 25.90 cm and 54.60 %. However, among the rural neonates, the best discriminator between the low and high birth weight is BL (CV = 43.10 cm, AUC = 78.40 %, *P* < 0.001) followed by TC (CV = 13.05 cm, AUC = 76.80 %, *P* < 0.001). The least discriminator is the HC (CV = 25.15 cm, AUC = 45.50 %, *P* = 0.231).

Table 2: The Cutoff Values that Discrimination between Low and High Birth weight Among the Urban and Rural Neonates in Kano State Nigeria

Variables (cm)	**Domicile**	**Cut off value (cm)**	**AUC (%)**	**Sensitivity (%)**	**Specificity (%)**	***P*-value**
Birth length	Urban	46.65	78.10	80.70	69.00	< 0.001
	Rural	43.10	78.40	96.70	17.60	< 0.001
Foot length	Urban	7.65	77.80	83.50	62.10	< 0.001
	Rural	7.65	72.50	89.50	48.50	< 0.001
Foot breadth	Urban	2.85	67.40	82.50	51.70	< 0.001
	Rural	2.95	65.80	70.80	58.80	< 0.001
Thigh circumference	Urban	13.55	78.20	75.00	75.90	< 0.001
	Rural	13.05	76.80	80.60	63.20	< 0.001
Hand length	Urban	6.55	73.70	67.10	74.10	< 0.001
	Rural	6.45	69.40	82.80	54.40	< 0.001
Hand breadth	Urban	3.25	77.20	72.70	74.10	< 0.001
	Rural	3.25	74.70	78.00	70.60	< 0.001
Neonatal arm circumference	Urban	8.55	70.10	94.50	37.90	< 0.001
	Rural	11.35	67.90	49.30	77.90	< 0.001
Chest circumference	Urban	24.80	58.30	91.50	25.90	< 0.037
	Rural	21.60	48.70	96.20	88.20	< 0.729
Head circumference	Urban	25.90	54.60	95.60	22.40	< 0.244
	Rural	25.15	45.50	94.30	14.70	< 0.231

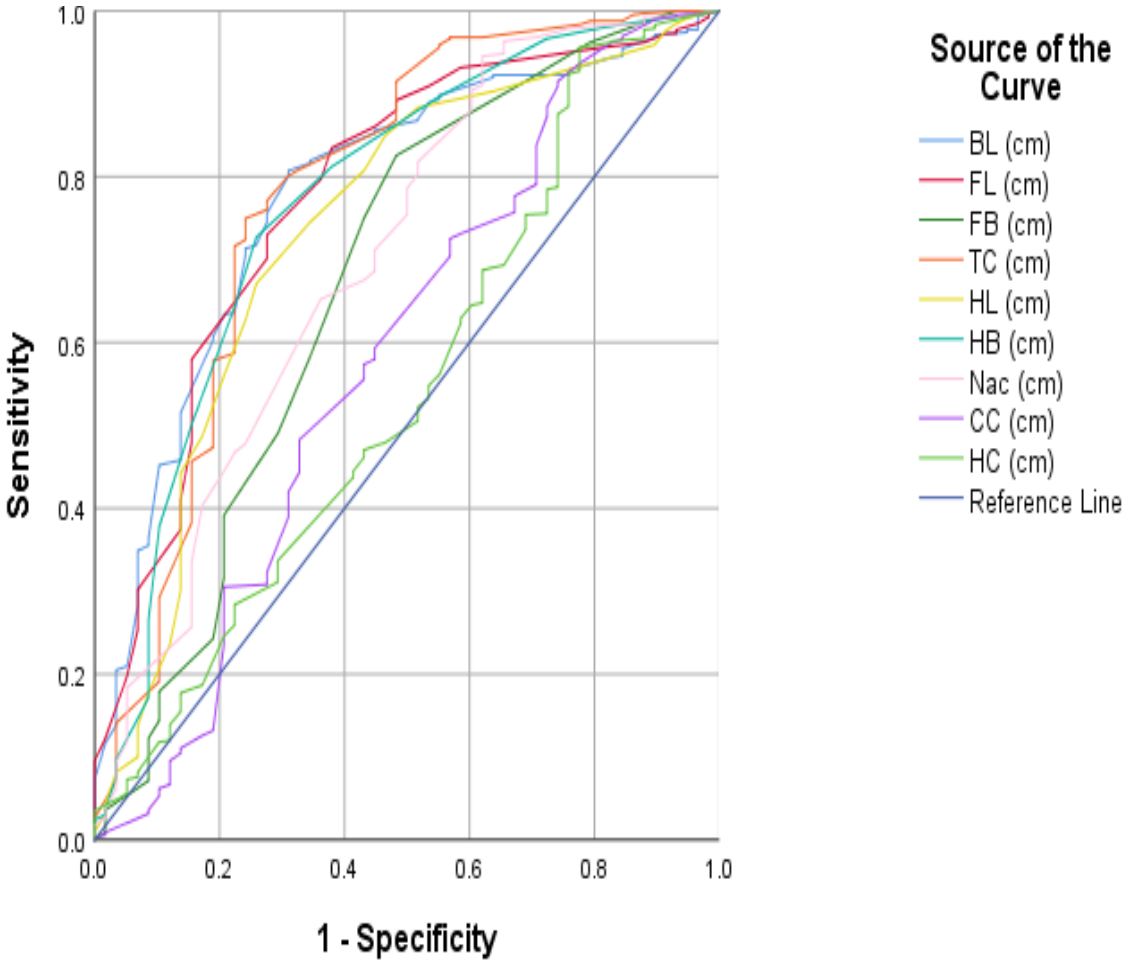

Figure 1: Shows the cut off value that discriminate between low and high birth weight among the neonates in the urban area. Among the neonates, the TC (CV = 13.55cm, AUC = 78.20 %, P < 0.001) is the best discriminator between the low and high birth weight followed by the BL (CV = 46.65 cm, AUC = 78.10 %, P < 0.001). The least discriminator is the HC (CV = 25.90 cm, AUC = 54.60%, P = 0.244)

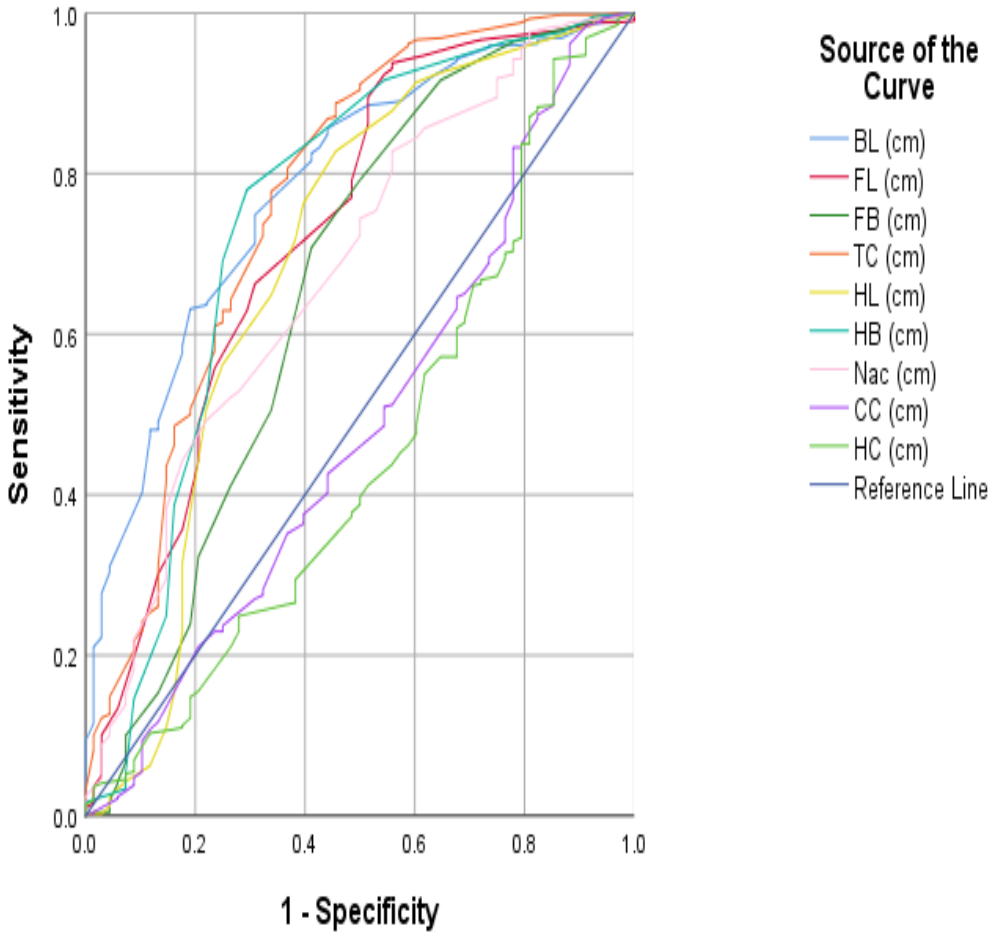

Figure 2: Shows the cut off value that discriminate between low and high birth weight among the neonates in the rural area. Among the neonates, the best discriminator between the low and high birth weight is BL (CV = 43.10 cm, AUC = 78.40 %, P < 0.001) followed by TC (CV = 13.05 cm, AUC = 76.80 %, P < 0.001). The least discriminator is the HC (CV = 25.15 cm, AUC = 45.50 %, P = 0.231).

DISCUSSION

Anthropometric measurements were carried out on neonates from urban and rural areas separately to determine the discriminating variable against birth weight. In this study, among the urban neonates, the thigh circumference was found to be the best discriminator between the low and high birth weight, while the least discriminator was the head circumference. Similarly, among the rural neonate, the best discriminator was found to be the birth length, and the least discriminator in this group of neonates was the head circumference.

Achebe *et al*. (2014) conducted a study in Nnewi, Southeast Nigeria, on neonates to determine the cut-off values of LBW. The study suggested that the maximum thigh circumference (16.75 cm) was the best predictor of LBW. This is in line with the present study that found thigh circumference as the best discriminator between the low and high birth weight. Recently, Ndubuisi *et al*. (2018) conducted a prospective, cross-sectional, hospital-based study at the Maternity Unit, University of Nigeria Teaching Hospital, Enugu, involving newborn babies delivered in the unit. He found that the best discriminator for LBW is the chest circumference with a cut off value of ≤ 30 cm. In the present study, the best discriminator was the thigh circumference. This difference may be due to ethnic variations among the study groups.

Another study by Hadush *et al*. (2017) to determine the cut-off value of LBW in Ayder Referral hospital (ARH), located in Mekelle city, Tigray region, north Ethiopia, suggested that chest and head circumferences had a cut-off points 30.15 cm and 33.25 cm respectively and are the better surrogates for detecting LBW neonates. In this study, both chest and head circumferences were found to be the least discriminators between low and high birth weight. The variations may be due to the geographical and racial differences that may exist among the study population. Other studies by (Lawoyin, 1993; Ikenna, 2013; Ndu *et al*., 2014) all found different cut-off values that discriminate against low and high birth weight. The differences in the values may be due to ethical, geographical, or genetic variations among the various study population.

CONCLUSION

In this study, neonatal anthropometric parameters were used to determine the cut-off values that can discriminate against low and high birth weight babies among the urban and rural neonates in Kano State Nigeria. The birth length has the highest discriminating potentials (CV = 43.10 cm, AUC = 78.40 %, P < 0.001), the head circumference showed the least discriminating potentials (CV = 25.15 cm, AUC = 45.50 %, P = 0.231).

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