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REGRESSION EQUATIONS FOR BIRTH WEIGHT ESTIMATION USING ANTHROPOMETRIC MEASUREMENTS OF HAND AND FOOT OF HAUSA NEW BORN BABIES IN KANO-NIGERIA

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ABSTRACT
It has long been established that birth weight is a major determinant of infant morbidity and mortality in the first year of life. This is because it is an important predictor and an indicator of newborn morbidity and mortality, and has been accepted as the most reliable index of health status of the community. In this study, Birth Weight has been estimated from anthropometric measurements of hand and foot. Linear regression equations were formed from each of the measured variables. These simple equations can be used to estimate Birth Weight of new born babies, in order to identify those with low birth weight and referred to the appropriate health centre. A sample of 551 neonates (295 males and 256 females) were randomly selected and measured for each of the parameter (hand length, hand breadth, foot length and foot breadth). It was shown that the four measured parameters correlate with Birth Weight at different degrees (Pearson's correlation analysis was used in calculating the level of significance), and the p - value was significant at 0.01 level (2-tailed). Among the measured variables, foot length had the highest correlation value of 0.657, followed by hand breadth with correlation value of 0.601.Hand length had correlation value of 0.513 and then foot breadth was having the least correlation value of 0.507. This study highlighted a strong correlation between birth weight and the measured variables, and multiple regression equations were formed for each of the measured variables which can be used to estimate birth weight.
Keywords: Hausa, Birth Weight, Hand Length, Hand Breadth, Foot Length, Foot Breadth.

INTRODUCTION

In the first year of life, birth weight has been identified as a major determinant of infant mortality (Steer *et al.*, 1995). McCormick (1985) showed that weight at birth is an important predictor and an indicator of newborn morbidity and mortality. In a study conducted by Kumar and Datta (1994), birth weight has been accepted as the most reliable index of health status of the community. Earlier study as The World Health Report (1996) revealed that, of the approximately four million global neonatal deaths that occur annually, 98% occur in developing countries, (Nigeria inclusive), where most newborns die at home while they are being cared by their parents and the traditional birth attendants (TBAs). About 38% of total under-five mortality occurs during the first month of life and of these deaths, almost three quarters occur during the first week of life (Lawn *et al.,* 2005). A study conducted by United Nations Children's Fund (2005), showed that an estimated 18 million babies are born with low birth weight. In an earlier report by Bang *et al.,* (2002), these low birth weight babies accounts for 14% of the total deliveries, which account for 60–80% of neonatal deaths. In developing countries, most deliveries occur at home or rural health centers where scales for determining weight at birth are not always readily available, therefore mostly weight at birth is not known. Thus, the need to develop simple, inexpensive and practical methods to estimate birth weight in newborns soon after birth, so as to identify those with low birth weights (Mullany *et al.*, 2006), for subsequent referral to the appropriate health center for further management. The variation in weight after birth is much greater than the variation in anthropometric measurements like length, head and chest circumferences (Bhatia and Thyagi 1984). Several studies have attempted to predict birth weight from simple anthropometric measurements (Sharma *et al.,* 1988; Sharma *et al.,* 1989). Simple measurement of anthropometric variables from hand and foot (hand length, hand breadth, foot length and foot breadth) and the derived linear regression equations models from these variables can be used to calculate weight at birth, so as to immediately identify those neonates with low birth weight.

MATERIALS AND METHODS

The subjects

The study is cross-sectional, consisting of 551 full terms, randomly selected new born babies born to Hausa parents of Kano State origin, with no external congenital anomaly or physical deformity. Grand parentage criteria were used in selecting the new born babies of Hausa origin.

The study area

Kano State is located between latitude 12.2º North and longitude 9.4º East with the Kano city as the capital of the State. The State at present is the most populous in Nigeria, with over 9,000,000 people (NPC/FGN 2007).

Instruments

Tools used for the study include: - Digital weighing scale (Model: ACS – 20, Country: China), Sliding vernier caliper and plastic measuring tape.

METHODS

The study was conducted at Obstetrics and Gynaecology department in Murtala Muhammad Specialist Hospital Kano, (a referral centre). An informed consent was gotten from the mothers of the participants. A group of 10 – 15 new born babies were measured (within 24 hours of delivery) each day. The participants were measured for the following variables over a period of six weeks (February to March 2012), using the left side of the body (Martin and Sallar 1959; Allbrook 1961):

Hand length (HL) in cm: Measured from the palmar surface of the hand as a linear distance from the mid-point of the distal wrist crease, to the tip of the middle finger using a plastic measuring tape.

Hand breadth (HB) in cm: Measured at the widest point of the palmar surface of the hand (from the head of the fifth to second metacarpal bones), using a sliding vernier caliper.

Foot length (FL) in cm: Measured from the sole of the foot as a straight distance between the most posterior projecting point of the heel and anterior projecting point (the end of first or second toe), using a plastic measuring tape.

Foot breadth (FB) in cm: Was measured at the widest point of the sole, (from the metatarso-phalangeal joint of the first metatarsal and that of the fifth metatarsal of the foot using a sliding vernier caliper.

Data analysis

Minitab 16.0 statistical software was used for data analyses. The data were expressed as Mean ± Standard Deviation (S.D). $P < 0.05$ was considered statistically significant.

RESULTS

Table 1 presents the mean values ± standard deviation (S.D), and range for the measured variables. The subjects had mean birth weight (BW) of 3.08 ± 0.55 kg, with minimum and maximum values of 1.50 and 5.50 respectively. Hand length had mean value of 6.79 ± 0.48 cm, the minimum value was 5.20 cm, while the maximum value was 8.10 cm. Hand breadth had mean and S.D. values of 3.31 ± 0.31 cm, with range value between 2.50 to 4.30. Mean value for foot length was 8.12 ± 0.58 cm; the minimum value was 6.30 cm, while the maximum value was 9.50 cm. Foot breadth had mean value of 3.07 ± 0.28 cm, the minimum and maximum values were 2.20 cm and 4.00 cm respectively.

Table 1: Descriptive statistics of the measured variables (cm) among Hausa new born babies of Kano-Nigeria (n = 551)

S No.	Parameters	Mean ± S.D.	Range
1.	BIRTH WEIGHT	3.08 ± 0.55	1.50 – 5.50
2.	HAND LENGTH	6.79 ± 0.48	5.20 – 8.10
3.	HAND BREADTH	3.31 ± 0.31	2.50 – 4.30
4.	FOOT LENGTH	8.12 ± 0.58	6.30 – 9.50
5.	FOOT BREADTH	3.07 ± 0.28	2.20 – 4.00

Among the measured variables, foot length exhibits the highest value of standard deviation (0.58), while the lowest value was observed for foot breadth (0.28). Tables 2 shows the correlation between birth weight and the measured variables among the Hausa neonates of Kano-Nigeria (n=551).

Birth weight (BW) was found to correlate with the measured variables at different degrees. Birth weight correlates significantly with foot length ($r = 0.657$, $P < 0.01$). Hand breadth also had a statistically significant ($p < 0.01$) correlation with BW of 0.601. Hand length and foot breadth were having correlation values with BW of 0.513 and 0.507 respectively.

Table 2: Coefficient of correlation values of the measured variables (cm) among Hausa new born babies of Kano-Nigeria **(n = 551)**

S. No.	Variables	Coefficient of Correlation (*r*)	Regression Coefficient (*b*)	*P* - value
1.	FOOT LENGTH	0.657	0.624	< 0.01
2.	HAND BREADTH	0.601	1.080	< 0.01
3.	HAND LENGTH	0.513	0.594	< 0.01
4.	FOOT BREADTH	0.507	1.000	< 0.01

Foot length was found to have the highest correlation (r) value of 0.657, ($p < 0.01$), while foot breadth had the lowest □ r □ value of 0.507, ($p < 0.01$).

Table 3 presents the Regression equations for estimation of birth weight (BW) in Hausa neonates of Kano-Nigeria, using foot length, hand breadth, hand length and foot breadth.

Table 3: Linear Regression Equations of the measured variables (cm)

S.No.	Variables	Linear Regression Equations	*b*	*r*	r^2	S.E.E.
1.	Foot Length	BW = - 1.98 + 0.624 FL	0.624	0.657	0.432	± 0.415
2.	Hand Breadth	BW = - 0.503 + 1.08 HB	1.080	0.601	0.361	± 0.440
3.	Hand Length	BW = - 0.947 + 0.594 HL	0.594	0.513	0.263	± 0.473
4.	Foot Breadth	BW = 0.009 + 1.00 FB	1.000	0.507	0.257	± 0.475

DISCUSSION

The main aim of the study is to find the relationship (correlation) between birth weight and the measured variables (*hand length, hand breadth, foot length and foot breadth*), and to form multiple linear regression equations which can be used to estimate weight at birth in Hausa newborn babies of Kano-Nigeria.

The mean birth weight in this study was found to be 3.08 kg (≈ 3.1 kg). Earlier studies by Jinadu *et al*., (1983) in a retrospective study on the Effects of antenatal care and parity on birth weights of Nigerian children, 2,804 spontaneous vaginal deliveries were considered. Birth weights of the new born babies were found to be 3.113 kg (≈ 3.1 kg). This is similar to the birth weight of Hausa new born babies found in this study. Another study conducted by Lawoyin (1991) in Ilorin, Kwara State Nigeria showed mean birth weight of 3.167 ± 0.45kg. Recently, a study was conducted by Akinola *et al*., (2007) on Clinical versus Sonographic Estimation of Foetal Weight in Southwest Nigeria, 100 pregnant women were considered. Foetal weight was estimated using clinical and ultrasonogragrahic methods and found to be 3.255 kg (≈ 3.3 kg). This had also agreed with previous values obtained. The study found no significant difference between weights among Hausa new born babies and weight at birth in Southwest and Nigeria new born babies at large. Studies by World Health Organization multicenter study (1994) revealed average birth weight for newborn babies in Sri Lanka to be 3.840 kg (≈ 3.8 kg), while for India and Nepal were reported as 2.630 kg (≈ 2.6 kg) and 2.780 kg (≈ 2.8 kg) respectively. The birth weights of the Sri Lanka's new born babies were similar to that found in the Hausa new born babies, while it is higher than the birth weights of new born babies from India and Nepal.

Many researchers have attempted to identify suitable anthropometric parameters to estimate birth weight in babies, which are simple and reliable, so as to immediately identify those neonates with low birth weight in our rural health centres, where weighing scale is not readily available. Some studies had recommended that Chest Head Circumference (CHC), Mid Upper Arm Circumference (MUAC) and Head Circumference (HC) may be used as anthropometric surrogates to identify low birth weight babies (Akinola *et al.,* 2009; Lawn *et al.,* 2005). Some other studies have recommended Chest Circumference (CC) and Thigh Circumference (TC) as suitable anthropometric surrogates to identify low birth weight babies (Naik *et al.,* 2003; Samal and Swain 2001; Arisoy and Sarman 1995). It is argued that measurement of HC may not be accurate due to moulding of head during birth, especially during prolonged and obstructed labour (Lawn *et al.,* 2005).

In this study, other easily measured anthropometric parameters of hand length, hand breadth foot length and foot breadth were considered. It was found that foot length had the highest correlation value with birth weight (0.657, $p < 0.01$), followed by, hand breadth with correlation value of 0.601 ($p < 0.01$), while hand length and foot breadth had correlation values of 0.513 and 0.507 respectively all at $p < 0.01$. These parameters are easy to measure and can therefore be used to estimate weight at birth using the linear multiple equations without difficulty or ambiguity.

CONCLUSION

The study had been successful in determining the average birth weight of Hausa new born babies, and formulating regression equations for calculation of birth weight in new borns of Hausa ethnic group, with foot length having the highest correlation value and foot breadth had the lowest correlation value. Therefore, foot length equation will give a better estimation of birth weight among the Hausa new born babies. This study will also help in estimating birth weight in new born babies of Kano State-Nigeria; therefore can be substituted to estimate the weight at birth of the new born babies in our health centers with ease.

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