INTRAPARTUM PREDICTION OF BIRTH WEIGHT USING MATERNAL ANTHROPOMETRIC MEASUREMENTS AND ULTRASOUND SCAN

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ABSTRACT

This prospective study was conducted at Federal Medical Centre, Owo, Nigeria, between April 1st and 31st of July, 2013 to predict birth weight in labour using four clinical methods and ultrasound scan independently and comparatively to determine which is closest to the actual birth weight. The four clinical methods are Ojwang's formula, Johnson's formula, 5% of maternal weight and 10% of maternal body mass index. A total of 100 women who fulfilled the inclusion criteria had their foetal weight estimated using the methods. Accuracy of the prediction was determined by mean weight difference, percentage error and proportion of estimates within 10% of actual birth weight.Tests of significant difference were done and the level of significance was set at 0.05.Correlation and regression analyses were carried out.Of the five methods used, ultrasound scan estimation had the highest correlation coefficient of 0.681($P<0.001$) followed by Ojwang's rule with correlation coefficient of 0.675($P<0.001$). The prediction using Johnson's method performed next to Ojwang's rule with correlation coefficient of 0.629($P<0.001$).The methods using 5% maternal weight and 10% maternal BMI had correlation coefficients of 0.312($P<0.001$) and 0.220($P<0.001$) respectively. It was then concluded that there is positive significant correlation between the methods used and actual birth weight. The method using 10% maternal BMI is the least reliable while the ultrasound scan estimate was the most reliable. Ojwang's rule estimation performed next to ultrasound and should be considered first in settings where ultrasound machine or the expertise to use the machine is lacking.

Keywords: Birth weight, Foetal weight, Ultrasonography, Pregnancy, Delivery, Prospective studies

INTRODUCTION

Birth weight is an extremely significant predictor of an individual baby's survival. In general the lower the weight, the higher a baby's risk of infant mortality.[1]On a population level, mean birth weight is correlated with infant mortality such that groups with lower mean birth weight often have higher infant

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mortality.[2,3]

Accurate estimation of birth weight is an important measurement at the beginning of labour. This is especially important in developing countries where many births occur at home or at birth centres without adequate facilities. In these circumstances diagnosis of macrosomic and light foetuses can result in timely referral of diagnosed cases to well-equipped hospitals. Management of diabetic pregnancy, intrapartum management of foetuses presenting by breech, and vaginal birth after caesarean section will be greatly influenced by estimated foetal weight.[4]

Perinatal morbidity and mortality can be decreased through accurate estimation of the foetal weight by influencing labour management and the immediate care of the newborn.[4]

There are two common methods of estimation of birth weight: clinical method based on abdominal palpation of foetal parts with calculations based on fundal height and maternal weight (such as the Ojwang's method, Johnson's method, 5% of maternal weight and 10% of maternal BMI) andsonographic measurements of foetal parts.[5]

Some workers consider ultrasonic predictions to be superior to clinical predictions while others believe they have similar levels of accuracy.[4-5]

There is need for an ideal test in the determination of foetal weight before delivery. The test should be quick and easy to perform and should yield readily interpreted results that are reproducible.[6,7]

Attempts have been made to achieve the qualities of an ideal test over the years through the use of ultrasound scan and lately through the use of magnetic resonance imaging.

The various methods of predicting birth weight in utero have been classified as (a)Clinical Palpation which is also referred to as Tactile assessment of foetal size.(b) Assessment of Clinical risk factors.(c) Self-estimation by the mother. (d) Ultrasonography and Magnetic Resonance Imaging.

Clinical Palpation is believed to be the oldest technique and is the method used by Ojwang's et al and Johnson's et al. This method is widely in use because of its convenience and affordability. It may however be subjective.[8,9]

Quantitative assessment of clinical risk factor is valuable in predicting foetal weight. This has been used widely, especially in predicting foetal macrosomia.[10]

Self-estimates of foetal weight in multiparous women have been found to be comparably accurate to findings on clinical palpation in some studies.[11,12]

Obstetric ultrasonography is a modern method of assessing foetal weight. Foetal dimensions are objectively determined on ultrasound and it is reproducible. It is however interesting to know that several studies have demonstrated that ultrasonic estimates of foetal weight are not more accurate than clinical palpation in predicting birth weight in utero.[11,12]

Magnetic Resonance Imaging has recently been introduced into foetal weight estimation. It is however reserved for cases in which very accurate estimation is desired because of its cost and accessibility.

Earlier studies have evaluated the accuracy of maternal anthropometric measurements(using one clinical method) and ultrasound separately and comparatively.[4, 5,13]There is limited data comparing the accuracy of the individual clinical methods with that of ultrasound. Having comparable results will encourage clinicians in the developing world where ultrasound may not be available, or where limitation exists with a particular clinical method to develop or strengthen their skill in using other clinical means to estimate foetal weight.

This study aims to compare the accuracy of ultrasound estimation of birth weight with the individual methods of clinical estimation using maternal anthropometric measurements.

MATERIALS AND METHODS

Study Site

This prospective comparative study was carried out at the Department of Obstetrics and Gynaecology of the Federal Medical Centre,Owo,Ondo State, Nigeria. This hospital has an average of 1,600 total deliveries every year and serves as referral centre for hospitals in Ondo State, parts of Ekiti, Edo, Kogi and Osun States.

STUDY POPULATION

The study population consisted of parturients of all parities who were sure of their dates of last menstrual period, with normal singleton foetuses in cephalic presentation, longitudinal lie, presenting at term in labour in the centre.

Exclusion Criteria

Exclusion criteria included parturients in critical or emergency condition whose parameters were difficult to take before delivery. These parturients were cases with antepartum haemorrhage, severe hypertension, prolonged obstructed labour or severe cardiac disease in labour. Parturients with polyhydramnios, oligohydramnios, intrauterine growth restriction, fibroid co-existing with pregnancy, abnormal lie, multiple gestation and gross congenital anomalies were also excluded from the study.

A parturient who met criteria for inclusion in the study was counselled to gain her consent. The height and weight of the mother were checked usingstadiometer with weighing scale by DetectorR. The body mass index, blood pressure and pulse rate were determined. The symphysiofundal height, and abdominal girth(at the level of the umbilicus) were checked using a non-elastic tape measure. The fetomaternalwellbeing and packed cell volume were assessed. Ultrasound scan estimation using Hadlock formula was carried out. The ultrasound machine (ALOKA SSD-500) in our labour ward was used. A 3.5MHz transducer was used for ultrasonic assessment.

After delivery, foetal APGAR scores, length, head circumference, abdominal circumference, weight and wellbeing were recorded. The placenta weight and normality was also noted. The birth weight of the baby to the nearest 50grams within one hour of delivery using Model 180 SALTER weighing scale was measured. The actual birth weight was then compared with the estimated intrapartum birth weight values from different maternal anthropometric variables and ultrasound scan using Hadlock formula to determine which is the most accurate in predicting birth weight.

In essence, all eligible parturients had parametric measurement in labour and birth weights of their babies were taken following delivery. Birth weights were predicted using:[1]Ojwang's formula: estimated foetal weight in grams=SFHxAG. [2]Johnson's formula: estimated foetal weight in grams=[SFH-X]x155, where X=12 when foetal head is not engaged and X=11 when foetal head is engaged.[3]5% of maternal weight in labour.[4]10% of maternal body mass index. [5]Ultrasound scan estimation using Hadlock formula.

DATA COLLECTION

All data were obtained using data collection form specifically designed for this study.

SAMPLE SIZE

The minimum sample size for the study was calculated using the following formula:

$$N = \frac{[(Z \propto + Z\beta)\sigma]2}{[\mu 1 - \mu 0]2}$$

Where N=

Zα=Standard normal deviate corresponding to a significance level of

5%=1.96

Zβ= Standard normal deviate corresponding to a statistical power of a two tailed test=0.84

σ= Standard deviation=0.5

μ1-μ0= Magnitude of the mean difference to be detected

μ1= Mean birth weight using weighing scale at birth

μ0= Mean estimated birth weight using ultrasound

Assuming a difference17(μ1-μ0) of 0.15

N = [(1.96+0.84)0.5]2

____

(0.15)2

N = 87

Assuming a percentage attrition of 10%, that is 10% of 87 which is equal to 8.7(approximately 9). This takes the minimum sample size to 96. The sample size will be approximated to 100.

DATA ANALYSIS

The data obtained during the study were analyzed using SPSS 20.Measures of central tendency and dispersion for all quantitative variables were done while frequency distribution was generated for categorical variables. To examine the association between categorical variables in the contingency tables the Chi-square was used. Correlation and regression analyses were done to examine the relationship between two quantitative variables while the t-test was used to test for significance of correlation or regression coefficients.

Analysis of variance was done for comparison of two or more means. Where the variances were not homogenous, the parametric option, Kruskall Wallis or Mann Whitney test was performed. Determining how close the predicted weights were to the actual weight involved finding the difference between observed weight and the actual birth weight. The mean of the differences revealed the degree of accuracy of each method. Prediction within ± 10% actual birth weight was done for easy comparison with some previous findings.

LIMITATION OF THE STUDY

There were some difficulties in weighing and scanning patients in advanced stage of labour.

RESULTS

There were 100 women who met the inclusion criteria during the period of study. Their age ranged from 18 to 46years with mean age of 30.07±5.368 and a modal value of 27 as shown on Table 3.Their parity prior to the index pregnancy ranged from 0 to 7. Nulliparous parturients were 28%, 27% were primiparous, 39% were multiparous while 6% were grandmultiparous. The mean gestational age was 38.9 ± 1.421 and ranged between 37 and 42 weeks. The maternal height ranged from 146 to 178cm with mean value of 161.28 ± 5.529 while the maternal pre-delivery weight had a mean value of 71.28 ± 13.791 and ranged from 42 to 107kg. Mothers that weighed less than 90kg were 89% of the population while 11% weighed more than 90kg. The pre-delivery body mass index ranged from 18.3 to 46.7kg/m2 with a mean value of 27.38 ± 5.056 kg/m2. The symphysiofundal height ranged from 31 to 41cm with a mean value of 36.25 ± 2.139cm while the abdominal circumference at the level of the umbilicus ranged from 78 to 124cm with a mean value of 96.32 ± 9.313cm.The presenting part was not engaged in 79% of the foetuses while it was engaged in 21% at the time of study.

Table 1: Cross tabulation of maternal age with classes of birth weight

MATERNAL AGE IN YEARS	BIRTH WEIGHT IN GRAM			
	<2500	2500-3999	=4000	TOTAL
14-19	0	2	0	2
20-29	4	42	1	47
30-39	1	45	1	47
40-46	1	2	1	4
TOTAL	6	91	3	100

Table 2: Cross tabulation of birth weight with mode of delivery

BIRTH WEIGHT IN GRAM	MODE OF DELIVERY		
	SVD	C/S	TOTAL
<2500	6	0	6
2500-3999	71	20	91
=4000	1	2	3
TOTAL	78	22	100

SVD-vaginal delivery C/S-Caesarean section

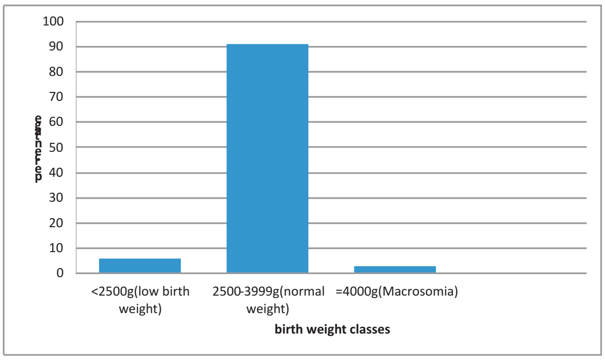

Figure 1: Actual birth weight classes of the babies

Table 3: Sociodemographic Characteristics With Their Mean, Standard Error Of The Mean, Mode, Standard Deviation And Range

	N	Mean	Std error of mean	Mode	Stddev	Range
Maternal age(years)	100	30.07	0.537	27	5.368	18-46
Parity	100	1.55	0.150	0	1.500	0-7
Gestational Age(wks)	100	38.96	0.142	39	1.421	37-42
Maternal weight(kg)	100	71.27	0.138	55	13.791	42-107
BMI(kg/m^2)	100	27.38	0.506	30	5.056	18.3-46.7
SFH(cm)	100	36.25	o.214	36	2.139	31-41
Abdominal circumference(cm)	100	96.32	0.931	100	9.313	78-124
Ojwang's rule estimate(g)	100	3504.68	49.138	3800	491.381	2574-5100
Johnson's rule estimate(g)	100	3786.18	34.797	3720	347.968	2945-4650
5% maternal weight(g)	100	3560.23	68.773	2750	687.731	2100-5400
10% maternal BMI estimate(g)	100	2740.35	55.993	3000	504.766	1830-4600
Ultrasound estimate(g)	100	3180.38	38.241	3050	382.406	2200-4100
Actual birth weight(g)	100	3139.80	44.252	2900	442.525	2100-4450
APGAR at 1min	100	7.90	0.144	9	1.439	2-10
APGAR at 5mins	100	9.53	o.095	10	0.948	6-10

Std-standard wks-weeks
dev-deviation g-gram BMI-Body Mass Index Mins -Minutes

The estimated weight using Ojwang's rule ranged from 2574 to 5100g with a mean value of 3786.68 ± 491.381g.Using Johnson's rule the estimated weight ranged between 2945 and 4650g with a mean value of 3786.18 ± 347.968 while it ranged between 2100 and 5400g with a mean value of 3560.23 ± 687g using 5% maternal weight. The estimated weight ranged between 1830 and 4600g with a mean value of 2740.35 ± 504.76 using 10% maternal body mass index while it ranged between 2200 and 4100g with a mean value of 3180.38 ± 382.406g using ultrasound scan estimation as shown on Table 3.

The actual birth weight ranged from 2100 to 4450g with a mean value of 3139.80 ± 442.525g.The percentage low birth weight babies were 6%, babies with birth weight greater than 4000g were 3% while those with normal birth weight formed 91% as depicted in Figure 1.The length of the babies ranged from 35 to 37cm with a mean value of 49.14 ± 2.992cm and the placental weight ranged from 350 to 1200g with a mean value of 603.55 ± 121.596cm.All caesarean sections were emergency and the rate was 22% while 78% had vaginal delivery as depicted on Table 2. The APGAR scores at 1 minute ranged from 2 to 10 with a modal score of 9 while the scores at 5 minutes ranged from 6 to 10 with a modal score of 10. Fifty-seven percent of the babies were males while 43% of the babies were females.

The social class of the patients was derived using the method described by Olusanyaet al.[14]This ranged from Class I to V:18% of the parturients were of class I, 21% were of class II, 26% were of class III, 25% were of class IV while 10% were of class V. Therefore, the population was predominantly middle and low socioeconomic class.

There was a statistically significant positive correlation between weight predicted by the Ojwang's rule and the actual birth weight as depicted in Figure 2 below. Figures 3 to 6 show positive correlation between actual birth weight and weights predicted by Johnson's rule, 5% maternal weight, 10%maternal BMI and ultrasound scan estimation respectively. The ultrasound scan prediction was the strongest followed by Ojwang's rule. Prediction using Johnson's rule was next to Ojwang's prediction. The prediction using 5% maternal weight and 10% maternal BMI had the least correlation with the actual birth weight.

Table 4 below shows the mean weight difference and mean percentage error for each method. The ultrasound estimation had the least mean weight difference and mean percentage error. This was followed by Ojwang's rule. The prediction using 10% maternal BMI had a negative mean weight difference and mean percentage error. These indicate an underestimation associated with the use of the method.

Tables 5 to7 show mean weight difference and mean percentage error for the three birth weight classes that is, low birth weight(<2500g), macrosomia(≥4000g) and normal weight babies. For the low birth weight class, 10% maternal BMI had the least mean weight difference and the mean percentage error followed by ultrasound scan estimation, Ojwang's rule, 5% maternal weight and Johnson's rule estimation respectively. Ultrasound scan estimation had the least mean weight difference and mean percentage error for macrosomic babies followed by Ojwang's rule, 5% maternal weight and Johnson's rule in that order. There was underestimation of this class of birth weight by 10% maternal BMI. Johnson's rule and Ojwang's rule had positive mean weight difference and mean percentage error for the normal sized babies while the other methods had negative mean weight difference and mean percentage error indicating underestimation.

The correlation coefficient with 95% confidence interval, P value and coefficient of determination(R2) between predicted weights by various methods and actual birth weights are shown on Table 8. All the methods had positive correlation coefficients which were statistically significant. Ultrasound scan estimation however had the strongest(0.681,P<0.001) and this was closely followed by estimation using Ojwang's rule(0.675,P<0.001). Prediction using 10% maternal BMI had the weakest correlation coefficient (0.220,P=0.002). Seventy-four percent of predicted weights using ultrasound scan were within ± 10% of the actual birth weight followed by Ojwang's rule estimation(46%). Ten percent maternal BMI estimation was 34%, 5% maternal weight was 32% while 17% of Johnson's rule prediction was within ± 10% of the actual birth weight as shown on Table 10.

This study has modified the various clinical formulae and ultrasound scan results that would be more accurate for this population. The predicted birth weight by these new equations will be very close to the actual birth weight. The regression equations for the different methods are as stated below (weight in grams):

For Ojwang's rule: $Y = 0.608X + 1009$

For Johnson's rule: $Y = 0.800X + 112$

For 5% maternal weight: $Y = 0.201X + 2425$

For 10% maternal BMI: $Y = 0.274X + 2389$

For Ultrasound scan estimation: $Y = 0.789X + 632$

Where Y is the corrected weight using the equation (in gram) and X, the predicted weight using the method(in gram).

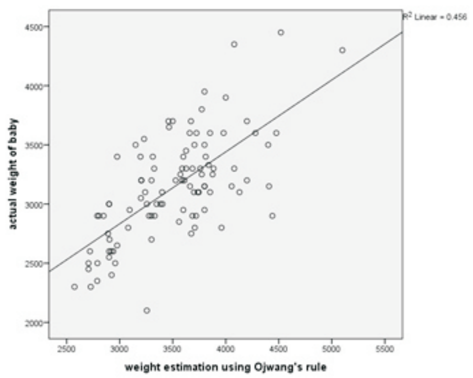

Figure 2: Scatter diagram of correlation between weight predicted using Ojwang's rule and actual birth weight.

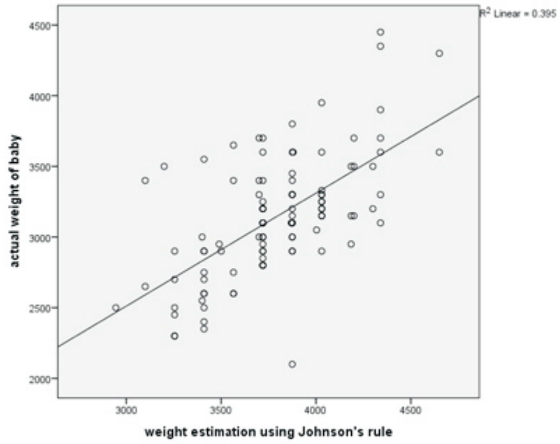

Figure3: Scatter diagram of correlation between weight predicted using Johnson's rule andactual birth weight.

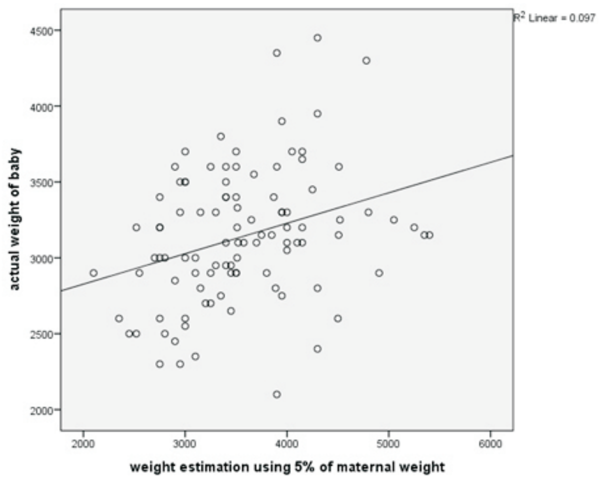

Figure 4: Scatter diagram of correlation between weight predicted using 5% maternal weight and actual birth weight.

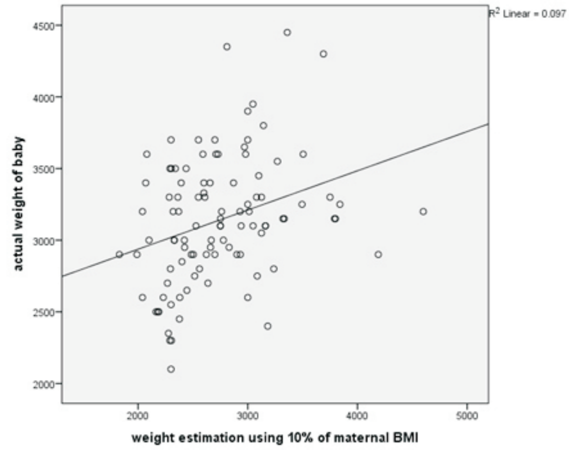

Figure 5: Scatter diagram of correlation between weight predicted using 10% maternal body mass index and actual birth weight.

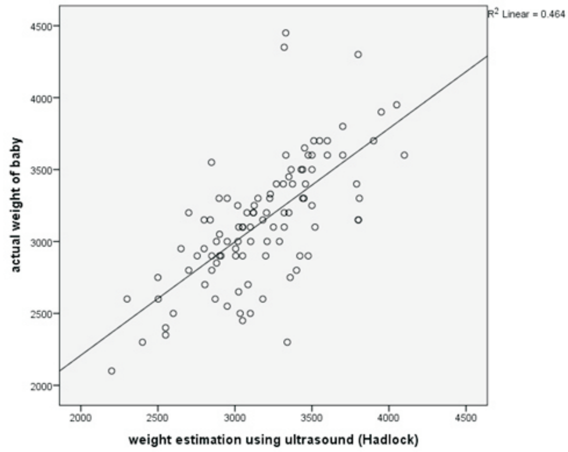

Figure 6: Scatter diagram of correlation between weight predicted using ultrasound scan andactual birth weight.

Table 4: Mean weight difference and mean percentage error for each method(weight in gram)

Formula	Mean	Standard error of mean	Standard deviation	Range
Weight difference				
Ojwang's rule	364	37.9	379	-424 to 1540
Johnson's rule	646	35.1	351	-300 to 1775
5% maternal weight	420	69.2	692	-800 to 2250
10%maternal BMI	-399	55.7	557	-1540 to 1400
Ultrasound scan	41	33.4	334	-1120 to 1040
Percentage error				
Ojwang's rule	12.3	1.27	12.7	-12.5 to 55.1
Johnson's rule	22.0	1.35	13.5	-8.8 to 84.5
5% maternal weight	14.7	2.36	23.6	-27.6 to 85.7
10% maternal BMI	-11.8	1.69	16.9	-42.2 to 44.5
Ultrasound scan	2.1	1.09	10.9	-25.2 to 45.2

Table 5: Mean weight difference and mean percentage error for low birth weight (<2500g)

Formula	Mean	Standard error of mean	Standard deviation	Range
Weight difference				
Ojwang's rule	512	135	331	256 to 1156
Johnson's rule	1093	140	344	805 to 1775
5% maternal weight	1000	273	669	450 to 1900
10%maternal BMI	138	135	330	-73 to 782
Ultrasound scan	365	155	380	100 to 1040
Percentage error				
Ojwang's rule	22.7	6.7	16.4	10.5 to 55.1
Johnson's rule	47.9	7.5	18.4	32.9 to 85.4
5% maternal weight	43.8	12.4	30.4	18.4 to 85.7
10% maternal BMI	5.9	5.6	13.8	-3.1 to32.6
Ultrasound scan	15.6	6.7	16.4	4.4 to 45.2

Table 6: Mean weight difference and mean percentage error for macrosomic babies (≥4000g)

Formula	Mean	Standard error of mean	Standard deviation	Range
Weight difference				
Ojwang's rule	360	39	378	-424 to 1540
Johnson's rule	635	33	321	-300 to 1240
5% maternal weight	397	71	683	-800 to 2250
10%maternal BMI	-412	57	544	-1520 to 1400
Ultrasound scan	49	28	276	-702 to 652
Percentage error			\	
Ojwang's rule	11.9	1.3	12.3	-12.5 to 53.1
Johnson's rule	20.9	1.2	11.0	-8.8 to 41.9
5% maternal weight	13.3	2.3	22.2	-27.6 to 73.1
10% maternal BMI	-12.5	1.7	16.6	-42.2 to 44.5
Ultrasound scan	1.9	1.0	9.3	-19.8 to 24.0

Table 7: Mean weight difference and mean percentage error for normal weight babies (2500g-3999g)

Formula	Mean	Standard error of mean	Standard deviation	Range
Weight difference				
Ojwang's rule	200	315	546	-270 to 800
Johnson's rule	76	139	241	-110 to 350
5% maternal weight	-40	274	474	-450 to 480
10%maternal BMI	-1080	268	465	-1540 to -610
Ultrasound scan	-883	193	335	
				-1120 to -500
Percentage error	4.6	7.3	12.7	-6.2 to 18.6
Ojwang's rule	1.8	3.2	5.6	-2.5 to 8.1
Johnson's rule	-0.9	6.3	10.9	-10.3 to 11.2
5% maternal weight	-24.7	6.1	10.6	-35.4 to -14.2
10% maternal BMI	-20.2	4.3	7.4	
Ultrasound scan				-25.2 to -11.6

Table 8: Correlations between predicted weights by various methods and actual weight.

Method	Correlation coefficient	95% confidence interval	P value	R^2
Ojwang's rule	0.675	0.585-0.914	<0.001	0.456
Johnson's rule	0.629	0.372-0.617	<0.001	0.395
5%maternal weight	0.312	0.189-0.781	0.002	0.097
10%maternal BMI	0.220	0.107-0.526	0.002	0.048
Ultrasound scan	0.681	0.462-0.716	<0.001	0.464

Table 9:Predictions that are within ± 10% actual birth weight

Method	Frequency	Percentage
Ojwang's rule	46	46%
Johnson's rule	17	17%
5% maternal weight	32	32%
10% maternal BMI	34	34%
Ultrasound scan	74	74%

DISCUSSION

Birth weight abnormalities, namely, low birth weight and excessive foetalweight at delivery

are associated with an increased risk of newborn complications during labour and the puerperium. Depending on many factors, the optimal birth weight range to minimize the risk of foetal and maternal morbidity and mortality is between 2500 and 4000g.[15] Limiting the potential complications associated with the birth of both small and excessively large foetuses requires an accurate estimation of the weight before delivery. Different methods have been used by many workers to estimate foetal weight. Studies that compared the individual clinical methods of foetal weight estimation with one another, then with ultrasound and eventually with the actual birth weight are limited. This study has done this and the findings from the study will contribute to the present body of knowledge.

The study revealed correlation between maternal anthropometric variables and the actual birth weight. This is however at varying degrees as the rule involving the use of the symphysiofundal height and abdominal girth (Ojwang's rule) had the closest correlation to the actual birth weight. Hadlock estimation using the ultrasound scan as in previous studies[13, 16] was more accurate than the clinical methods but results are comparable.

The average maternal height in the study was found to be 161.3cm which is similar to what was described as the average height of pregnant women by Morley et al in 1968 quoted to be 159.0cm.[17] The mean birth weight in the study population was 3139 ± 442g which is similar to what was found in 1990 by Dare et al in the same region of the country quoted to be 3230 ± 387g.[18] In a study carried out on an Asian population, the mean birth weights of Malay, Chinese, and Indian babies were 3140g, 3125g and 3067g respectively.[19]

In the study carried out by Ojwang et al in 1984[8] the mean estimated foetal weight was 2971 ± 449g and the mean actual weight was 2978 ± 452g compared to the mean estimated foetal weight of 3786 ± 491g and an actual weight of 3139 ± 442g found in this study. There was some degree of over estimation in this study. Unlike the study by Ojwang et al, where the widest region of the abdominal girth was used, the level of the umbilicus was chosen in this study to give room for uniformity and to minimize subjectivity. This study also subjected the degree of difference to further statistical analysis. A mean difference in weight of 364g was found with a mean percentage error of 12.3%(table 4). The prediction within ± 10% of the actual weight using this method was 46%(table 9).The reliability testing revealed a correlation coefficient of 0.675 with a P value of <0.001 which is statistically significant. The scatter diagram(figure 2) shows a linear relationship between the weights predicted by the method and actual weight.

Johnson's rule in this study overestimated the birth weight by an average of 646g with a standard deviation of 351g with the prediction within ± 10% of the actual birth weight being 17%. The method was accurate within 800g in the 64% of the newborn as against accuracy within 375g in 75% of the newborn reported by Johnson et al in 1954.[9] The difference may be due to the difference in the characteristics of the study population.

In a recent study carried out to determine the accuracy of 5% maternal weight in predicting the actual birth weight,[16] it was discovered that the predictions within ± 10% was 38.8% and the correlation coefficient when compared to the actual birth weight was 0.325.The mean weight difference and mean percentage error were 323g and 11.8% respectively. These findings are similar to what was found in this study where the prediction within ± 10% using the method was 32% and the correlation coefficient being 0.312. The mean difference and mean percentage error were 420g and 14.7% respectively. With this consistent finding when other parameters are not known it is still a worthwhile endeavour to have an idea of the birth weight using the formula. This is in agreement with the general belief that large mothers are likely to have large babies. Maternal height, weight and BMI are positively associated with larger birth weights. Gestational age-specific birth weight charts may therefore need to incorporate maternal height, weight and BMI of the local population in order to be useful to practicing clinicians.

Only one parturient was found to have a low BMI and she subsequently had a normal sized baby. The low population of women with low BMI is due to the fact that the more epidemiologically significant pre-pregnancy BMI was not used in the study but the pre-delivery BMI. The population of low BMI parturients in this study is therefore too low to make a statistical statement. The mean birth weight using 10% maternal BMI was 2713 ± 559g. It has the least correlation coefficient of 0.220(table 8) among the methods used. Therefore, when maternal weight and height values are available in the absence of other parameters it is more useful to consider use of maternal weight alone in estimating foetal weight. The effect of BMI on birth weight may not be causal, there may be many factors associated, viz medical disorders like diabetes mellitus and hypertension, increasing age, multiparity and previous macrosomia.

However, despite the relatively low performance of 10% maternal BMI, it had the least mean weight difference and mean percentage error for low birth weight class(table 5).This may not be unconnected with the fact that the method generally underestimates foetal weight. The percentage of low birth weight and macrosomic babies in this study is too small to make a significant scientific statement.

Obstetric sonographic assessment for the purpose of obtaining foetal biometric measurements to predict foetal weight has been integrated into the mainstream of obstetric practice in the past quarter century. Modern algorithms that incorporate standardly defined foetal measurements (for example, some combination of foetal AC, FL, BPD, and HC) are generally comparable in their overall accuracy in predicting fetal weight. A large number of ultrasonographic algorithms are available, providing various types of fetal biometric information.[20] For the ultrasound scan estimation, the results of this study are similar to those obtained in previous studies. In these studies 40-75% of the estimates are within 10% of actual birth weight.[13,20] In this study, 74% of the estimates using ultrasound scan are within 10% of the actual birth weight.

The relatively high accuracy of ultrasound scan estimation in this study may be due to Hadlock 2 that was used, which has been adjudged to be one of the most accurate formulae available for ultrasonographic estimation. Hadlock 2 uses femur length and abdominal circumference. It does not make use of biparietal diameter which may be unreliable in labour due to possibility of engagement or moulding. A study in 2003 compared seven different models of ultrasonic weight estimation namely; Birnholz, Deter, Hadlock1,Hadlock 2, Jordaan, Shepard and Warsof. It was found that the method of Hadlock 2, predicted the birth weight more accurately than others.[21] With regard to Woo equation from another study,[22] the prediction of foetal weight within ±10% of actual birth weight revealed an accuracy of 31% which is far less than 46% using Ojwang's rule as found in this study.

CONCLUSION AND RECOMMENDATIONS

The main finding in this prospective study is the fact that clinical estimates using maternal anthropometric measurements (apart from the use of 10% of maternal BMI) generally overestimate the birth weight. Ultrasound estimation has the least mean percentage error and the most accurate. It is not without its drawbacks such as (1) imprecise imaging of foetal structures (due to limitations such as patient obesity, placentation, oligohydramnios, and/or foetal position), (2) the limited number of linear and/or planar measurements that can be taken of the complex 3-dimensional fetal conformation, (3) foetal tissues of similar dimensions with varying densities (for example, bone > muscle > adipose tissue density), (4) unavoidable operator- and equipment-related measurement errors and approximations, and (5) inappropriate algorithmic compounding of measurement errors and approximations by the incorporation of high-order terms.

In addition to the aforementioned problems associated with ultrasound estimation, its non-availability in many parts of the developing world makes its use impossible. In situations like this the Ojwang's rule may be used as it is the most accurate among the clinical methods used. If more accurate results are desired the generated equations from this study can be employed and this will be after subjecting them to strict processes of validation.

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