Validity of common ultrasound methods of fetal weight estimation in late pregnancy among women in Kwale, Niger Delta region, Nigeria.

Charles Ugwoke Eze[1], Kester Ikechukwu Egwuanumku[2], Kennedy Kenechukwu Agwuna[3], Lazarus Odidi[4], Kalu Ochie[1], Innocent Uchechukwu Nwadike[1]

1. University of Nigeria, Enugu Campus, Medical Radiography and Radiological Sciences
2. Central Hospital, Kwale, Delta State, Nigeria, Radiology
3. University of Nigeria, Enugu Campus, Radiation Medicine
4. Central Hospital, Kwale, Delta State, Nigeria, Obstetrics and Gynaecology

Abstract

Background: Accuracy of some ultrasound equations used in our locality for fetal weight estimation is doubtful.

Objective: To assess the accuracy of common ultrasound equations used for fetal weight estimation.

Subjects and Methods: A longitudinal study was conducted on selected Nigerian obstetric population at Central Hospital, Kwale between March, 2009 and January, 2011. Sonography was performed on 412 women with advanced singleton cyesis and measurements of BPD, HC, AC, and FL were obtained and figured into 12 common ultrasound equations for the estimation of fetal weight. The actual birth weight at delivery was recorded.

Results: The highest intraclass correlation coefficient was generated by the Hadlock 5 and Hsieh 2 equations. The least mean absolute percent error was obtained with Hsieh 2 equation, followed by Woo 3, and Hadlock 5. These equations also had the least percentage error and the least range of limits of agreement in the same order with no significant difference between their mean fetal weight estimates and that of the actual birth weight ($p > 0.05$). All twelve equations had strong positive correlation with the actual birth weight with Nzeh 2 equation the least.

Conclusion: Hsieh 2 equation has the best accuracy in fetal weight estimation studied.

Key Words: Validation; Fetal Weight; Sonography; Advanced Cyesis; Nigerian Population.

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Introduction

The fetus is thought to have an inherent growth potential that under normal circumstances, yields a healthy newborn of appropriate size. Limitations of growth potential in the fetus are analogous to failure to thrive in the infant, the cause of which can be intrinsic or environmental[1]. Fetal weights at both extremes of large and small values are of concern to clinicians because of risk of complications during labour and puerperium.

Corresponding author:
Charles Ugwoke Eze
Department of Medical Radiography and Radiological Sciences, Faculty of Health Sciences and Technology, University of Nigeria, Enugu Campus, Enugu State, Nigeria
Phone: +2348052805214;
E-mail: ugwoke.eze@unn.edu.ng ; ezecharlesu@yahoo.com

The value of ultrasonography in the management of fetal macrosomia may be its ability to rule out the diagnosis[1]. However, most formulae tend to over diagnose macrosomia at term[3]. It is also an essential tool in efforts to identify the pregnancy at risk of fetal growth restrictions[4]. Maternal risks associated with excessively large fetuses include obstructed labour, uterine rupture, cervical and vaginal laceration and pelvic floor injuries as well as postpartum haemorrhage[4-6]. Also, the occurrence of cephalopelvic disproportion is more prevalent with increasing incidence of operative vaginal delivery[7]. Fetal risks associated with macrosomia fetuses include intrapartum asphyxia, fracture, and brachial plexus injuries. The prenatal complications associated with low birth weight are attributable to either preterm delivery or intrauterine growth restriction or both[7,8].

Accurate determination of fetal weight is critical in preventing labour complications and permitting obstetricians to plan deliveries. This helps in minimizing intrapartum and peripartum risks for both the fetus and the mother.

Ultrasound imaging is considered significantly accurate for estimation of fetal weight that can be clinically applicable. It has been documented that ultrasound can determine fetal weight within 10% of actual birth weight in as many as 75% of cases estimated. An accuracy of within 5% of actual birth weight (ABW) has also been documented in as many as 40% of cases[9].

Errors associated with fetal weight estimation for both small and large fetuses can lead to harmful outcome if clinical decisions based on such erroneous values result in an inappropriate preterm delivery; it can also lead to an unnecessary surgical delivery in an attempt to avert the potential hazards of delivering a macrosomic fetus vaginally[5]. In Nigeria, most of the ultrasound equations used for fetal weight estimation was derived from fetal data obtained in Western population and genetic as well as racial factors are known to affect birth weight[10,11]. Such equations derived from other races may not be applicable to a Nigerian population. Also, it has been reported that birth weight standards change over time[12].

Although the two formulae of Nzeh et al[13] were opined to be more accurate in the fetal weight estimation in South Western Nigeria, there is need to re – validate them in the target population for this study since birth weight standards change over time.

The accuracy of various sonographic methods of fetal weight estimation is completely dependent on the ultrasound equations developed by experts and programmed into ultrasound equipment for automatic calculation of fetal weight given that the necessary parameters have been measured. These equations make use of biparietal diameter (BPD), femoral length (FL), abdominal circumference (AC), head circumference (HC) and some other fetal biometric parameters. It is clinically important to validate the various equations since there is no single equation that has been proved to be the best or most accurate for fetal weight prediction in all circumstances. Furthermore, the choice of any particular equation is usually the sole decision of the user, a matter of guessing and preference. Since these equations have not been validated in the population under study, clinical decisions based on such sonographic weight estimation could be misleading. This study is, therefore, aimed at assessing the accuracy of 12 ultrasound equations used for fetal weight estimation in order to determine the reliability of ultrasound imaging in fetal weight estimation and to deduce a good equation model for use in the locality under study. These 12 formulas (excluding that of Nzeh 1 and 2) were chosen because they are the commonest formulas used in sonographic foetal weight estimation in different races. We are of the opinion that their inclusion would strengthen this study.

Subjects and methods

This is a prospective longitudinal study conducted at the Central Hospital, Kwale, Delta State, Nigeria between March, 2009 and January 2011. Ethical clearance was obtained from the ethical committee of the hospital and verbal informed consent was obtained from the patients included in the study.

The sample size of the study included 412 pregnant women in labour expected to deliver live single newborn without any noticeable congenital anomaly within 48 hours from the time of scanning. A convenient sampling method was used in selecting the subjects and the sample size was determined using Taylor's formula as described by Colditz and colleagues[14].

Inclusion Criteria: (i) Singleton term pregnancy with scanning performed less than or 48 hours prior to delivery. (ii) Live babies without any noticeable congenital anomaly or hydrops. Exclusion Criteria: (i) Multiple pregnancy. (ii) Known or suspected fetal anomaly. (iii) Oligohydramnios/abnormal amniotic fluid index. (iv) Poorly visualized fetal parts. (iv) Abnormal fetal position. (v) Delivery after 48 hours from the time of scanning.

A Picker ultrasound machine (Diagnostic), model EZU-MT 16 – 51, SE1879401, with a curvilinear probe of frequency 3.5MHz was used to carry out the scanning. While the infant scale of model RGZ-20, made by Health line, China was used for the baby's weight determination immediately after delivery. The accuracy of the weighing scale at the labour ward was validated by the local hospital medical physicist prior to the study. A known 2Kg weight placed on the weighing scale gave an accurate result before the scale was used for the investigation. Care was taken to ensure that the calibrated scale was on zero reading before use.

Fetal parametric measurements including BPD, FL, AC, and HC were taken by a single observer with twelve years experience in obstetric sonography at the point of scanning and the time of scanning noted. All the four parameters (BPD, FL, AC, and HC) were measured using standard techniques. The BPD was measured as the distance between the outer edge of the cranium nearest to the transducer and the inner edge of the cranium distal to the transducer at the level of the paired hypoechoic thalami and cavum septum pellucidum[15].

The HC was measured using the elliptical calipers over the four points of BPD and occipital frontal diameter in the same plane as BPD, between the leading edge of the frontal bone and the outer edge of the occiput[16]. The AC was measured as the length of the outer perimeter of fetal abdomen at the level of umbilical vein junction with the portal vein in a transverse plane perpendicular to the spine[17], and the FL was measured as the length of the ossified diaphysis of the fetal femur from the greater trochanter to the femoral condyles[18].

These measurements were later figured into the 12 chosen ultrasound equation models for the calculation of fetal weight using BASIC computer programming language. BASIC computer program is a kind of language used in computer for solving problems.
After delivery, the actual birth weight and the time of delivery as recorded by the attending mid wife were collected from the labour records book. Apart from the equations of Nzeh et al (1 and 2)[13], all other equations used for foetal weight estimation were selected from commonly used equations in the locality at random.

Statistical Analysis: Analysis of data was performed with a personal computer using the Statistical Package for Social Sciences (SPSS) version 16.0 (SPSS Inc., Chicago, III). Since the data was normally distributed, the hypothesis of zero bias was assessed by paired samples t –test.

Accuracy of fetal weight estimation from the 12 different ultrasound equations was assessed by calculating the percentage error (PE) and mean absolute percent error (MAPE).

$$PE = \frac{EFW - ABW}{ABW} \times \frac{100}{1}$$

$$MAPE = \frac{\text{Absolute Error}}{ABW} \times \frac{100}{1}$$

Where ABW = Actual birth weight and EFW = Estimated fetal weight. Concordance of accepting validity of various equations was determined by intraclass correlation coefficient and Bland and Altman limits of agreement method. Actual birth weight was used as gold standard for comparison.

Limits of agreement were computed as: mean difference ± 1.96 X SD; where SD is
Standard deviation.

Results
Table 1 shows the 12 ultrasound equation models analyzed.

Table 1: Ultrasound equation models analyzed.

S/N	Author	Year	Equation
1	Campbell	1995	$LnBw = 4.564 + 0.0282 (AC) - 0.00331 (AC)^2$
2	Warsof	1977	$Log10Bw = -1.599 + 0.32(AC) -0.000111(BPD)^2(AC)$
3	Shepard	1982	$Log10Bw = -1.7492 + 0.166(BPD) + 0.046 = 0.002546 (AC) (BPD)$
4	Vintzileos	1987	$Log10Bw = -1.879 + 0.084(BPD) + 0.026(AC)$
5	Woo	1985	$Log10Bw = -1.54 + 0.15(BPD) + 0.00111(AC)^2 - 0.000076(BPD)(AC)^2 + 0.05(FL) - 0.0000992(FL)(AC)$
6	Hsieh	1987	$Log10Bw = 2.2193 + 0.0094962(AC))BPD) - 0.1432(FL) - 0.00076742(AC)(BPD)^2 + 0.001745(FL)(BPD)^2$
7	Ott	1986	$Log10Bw = 2.0661 + 0.04355(HC) + 0.05394(AC) - 0.0008582(HC)(AC) + 1.2594(FL/AC)$
8	Combs	1993	$Bw = 0.23718(AC)^2(FL) + 0.03312(HC)^3$
9	Jordaan	1983	$Log10Bw = 2.3231 + 0.02904(AC) + 0.0079(HC) - 0.0058(BPD)$
10	Hadlock	1985	$Log10Bw = 1.3596 + 0.0064(HC) + 0.0424(AC)(FL)$
11	Nzeh 1	1992	$Log10Bw = 0.470 + 0.488 Log BPD + 0.554 Log10 FL + 1.377 Log10AC$
12	Nzeh 2	1992	$Log10Bw = 0.326 + 0.0045(SDI) + 0.383Log10BPD + 0.614 Log10FL + 1.485Log10AC$

Table 2 reveals EFW from the 12 ultrasound equations and ABW. The actual birth weight had a mean of 3332 ± 513g. The formula of Hsieh 2 had a mean estimate of 3317g which is closest to the mean of actual birth weight of 3332g. Shepard had a mean of 3579g, which is, farthest away from the ABW.

Table 2: Mean EFW from the 12 ultrasound equations and ABW in grams.

		Mean (g)			
Author	N	Weight	Std. Error	Std. Deviation	Range
Campbell	412	3275	21.34	433.14	2294
Warsof	412	3173	24.86	504.99	2619
Shepard	412	3579	28.82	584.99	3036
Vintzileos	412	3521	31.41	639.59	3416
Woo	412	3291	23.48	476.76	2465
Hsieh	412	3317	26.23	532.71	2614
Ott	412	3199	21.36	433.75	2397
Combs	412	3130	19.77	401.22	2218
Jordan	412	3260	24.60	499.35	2757
Hadlock	412	3289	22.99	466.73	2757
Nzeh 1	412	3524	2.912	59113	328
Nzeh 2	412	3501	5.206	105.65	884
ABW	412	3332	25.28	513.03	3400

Table 3 shows the Paired t- test conducted to compare the mean of estimated fetal weight for each equation with the mean of the actual birth weight. There was no significant difference between the EFW for Woo, Hsieh and Hadlock equations (p > 0.05). However, there was a significant difference between the means of fetal weight estimates and actual birth weight for the equations of Campell, Warsof, Shepard, Vintzileous, Ott, Combs, Jordaan, Nzeh 1 and Nzeh 2 (p < 0.05).

Table 3: Comparison of mean of EFW and ABW using paired samples T-test.

	Paired Differences 95% C1 of the Difference						
Pair	Mean	Std. Error Mean	Lower	Upper	T-Value	Df	P value
EFW Campbell – ABW	-56.99	24.96	106.05	-7.92	-2.283	411	0.023+
EFW Warsof – ABW	158.35	26.35	210.16	106.55	-6.009	411	0.000*
EFW Shepard – ABW	247.78	28.54	191.67	303.90	8.680	411	0.000*
EFW Vintziless – ABW	189.30	30.25	129.82	248.77	6.257	411	0.000*
EFW Woo – ABW	-40.73	25.76	-91.37	9.90	-1.581	411	0.115+
EFW Hsieh – ABW	-14.23	27.00	-67.31	38.84	-0.527	411	0.598+
EFW Ott – ABW	132.15	24.67	180.60	-83.70	-5.362	411	0.000*
EFW Combs – ABW	201.72	24.24	249.67	154.02	-8.319	411	0.000*
EFW Jordaan – ABW	-71.97	26.81	124.67	-1926	-2.684	411	0.008+
EFW Hadlock –ABW	-42.15	25.45	-92.18	7.87	-1.656	411	0.098+
EFW Nzeh 1 – ABW	192.16	24.19	144.61	239.71	7.943	411	0.000*
EFW Nzeh 2 – ABW	168.93	24.48	120.79	217.06	6.899	411	0.000*

* = significant p value; + = not significant p value

Table 4 shows that the formula of Hsieh 2 had the least percentage error (-0.45%) and the least mean absolute percent error (0.27%). Woo 3 and Hadlock 5 had the second and third smallest percentage error and mean absolute percent error of (-1.23%, and 1.04% for Woo 3) and (-1.29% and 1.16% for Hadlock 5) respectively. The least accurate was Shepard which had the largest percentage error (7.41%) and the largest percentage mean absolute percent error (7.62%).

Table 4: Accuracy of individual equations in predicting birth weight.

Equation	Percentage Error (%)	Mean Absolute Percent Error (%)	Fraction of Estimates within 10% of ABW (%)
Campbell	-1.71	1.61	67
Warsof	-4.77	4.59	64
Shepard	7.41	7.62	45
Vintzileos	5.67	6.01	48
Woo	-1.23	1.04	66
Hsieh	-0.45	0.27	68
Ott	-399	3.84	66
Combs	-6.06	5.91	63
Jordaan	-2.16	2.06	63
Hadlock	-1.29	1.16	70
Nzeh 1	5.76	5.87	58
Nzeh 2	5.07	4.76	57

Also, the percentage error from Table 4 shows that the formula of Shepard, Vintzileos, Nzeh 1 and Nzeh 2 tended to over – estimate fetal weight. All other formulas tended to under – estimate fetal weight. From Table 5, Shepard and Vintzileos showed the worst agreement, having the largest mean difference of 254g and 200g respectively and the largest range of limits of agreement (Shepard = -609 to 1117g, Vintzileos = -722 to 1122g), while Hsieh the smallest mean difference (-9.0g) and the smallest range of limits of agreement (-821 to 803).

Table 5: Mean difference and 95% Bland and Altman limits of agreement in ultrasound EFW and ABW.

Equation/ Author	Mean Difference	95% Limits of agreement
Campbell	-53.67	-798.7 to 691.3
Wars of	-152.83	-942.2 to 636.6
Shepard	254.31	-609.0 to 1117.6
Vintzileos	200.18	-722.0 to 1122.4
Woo	-34.52	-801.8 to 732.7
Hsieh	-9.04	-821.3 to 803.2
Ott	-127.61	-881.4 to 626.2
Combs	-196.94	-939.5 to 545.6
Jordaan	-68.75	-1065.1 to 9276
Hadlock	-38.69	-788.3 to 710.9
Nzeh 1	195.45	-739.6 to 1130.6
Nzeh 2	158.67	-776.0 to 1113.3

All the 12 formulas had strong positive correlation with ABW as obtained from the intraclass correlation coefficient table (Table 6). The highest intraclass correlation coefficient was generated by the Hadlock 5 (0.874) and Hsieh 2 (0.873) equations; the lowest being 0.656, obtained from Nzeh 2 equation.

Table 6: Intraclass correlation between ultrasonic fetal weight estimates and ABW.

Equation/Author	Intraclass Correlation Coefficient	95% Confidence Interval	
		Lower	Upper
Campbell	0.856	0.831	0.882
Warsof	0.870	0.847	0.894
Shepard	0.862	0.837	0.886
Vintzileos	0.861	0.834	0.886
Woo	0.856	0.830	0.881
Hsieh	0.873	0.850	0.896
Ott	0.865	0.841	0.889
Combs	0.864	0.840	0.889
Jordaan	0.856	0.830	0.881
Hadlock	0.874	0.850	0.896
Nzeh 1	0.857	0.832	0.883
Nzeh 2	0.656	0.602	0.709

The paired sample t – test conducted to compare the mean of estimated fetal weight (EFW) from each of the 12 equations and the ABW showed that there was no significant difference between EFW from Hsieh 2, Woo 3, and Hadlock 5 equations ($p > 0.05$). However, there was significant difference between the EFW and ABW for the Campbell, Warsof, Shepard, Vintzileos, Ott, Combs, Jordaan, Nzeh 1 and Nzeh 2 equations ($p < 0.05$).

Table 7 shows that ultrasound slightly overestimated both microsomia and macrosomia but was found to be more accurate for the estimation of microsomia than macrosomia and this is statistically significant ($p < 0.05$).

Table 7: Comparison between ultrasound diagnosed macrosomia and microsomia and their true positive values at birth.

Microsomia				
Formula for foetal weight estimation	Percentage of weight estimation by ultrasound	Percentage of true positive at birth	P - Value	Remark
Campbell	6.80%	2.91%	0.20061	Not significant
Warsof	6.80%	2.91%	0.20061	Not significant
Shepard	5.81%	1.94%	0.156223	Not significant
Vintzileos	8.74%	2.91%	0.0783902	Not significant
Woo	7.77%	1.94%	0.055101	Not significant
Ott	6.80%	1.94%	0.0927507	Not significant
Combs	6.80%	0.00%		No true positive case
Jordan	8.74%	0.00%		No true positive case
Hadlock	7.77%	1.94%	0.055101	Not significant
Macrosomia				
Campbell	0.00%	0.00%		
Warsof	2.91%	1.94%	0.655671	Not significant
Shepard	24.30%	6.80%	0.000638522	Significant
Vintzileos	24.30%	6.80%	0.000638522	Significant
Woo	2.91%	2.91%	1.00	Not significant
Hsieh	7.77%	4.85%	0.395772	Not significant
Ott	1.94%	0.97%	0.566773	Not significant
Combs	2.91%	0.00		No true positive case
Jordan	1.94%	0.97%	0.566773	Not significant
Hadlock	2.91%	1.94%	0.655671	Not significant

Discussion

Birth weight is the principal variable affecting fetal and neonatal morbidity, especially in the preterm and small-for-date fetuses. Both fetal macrosomia and intrauterine growth restriction increase the risk of perinatal morbidity, and long-term neurologic and developmental disorders[19]. Identification of intrauterine growth restriction after 37 weeks gestation is an indication for delivery to reduce the chance of fetal mortality. Similarly, diagnosis of fetal macrosomia frequently leads to delivery by means of caesarean section. This is to reduce the risk of failed vaginal delivery and shoulder dystocia[13,19]. Accurate estimation of fetal weight is therefore of paramount importance in the management of labour and delivery to optimize safe motherhood.

The introduction of real-time ultrasound scanning has enabled clinicians to reproducibly and accurately measure fetal structures. As fetal weight cannot be measured directly, it must be estimated from fetal and anatomic characteristics. Ultrasonographic and clinical methods are the most commonly used for this purpose. Ultrasound biometry is an accurate means to estimate fetal weight at term as well as preterm gestations[3].There are a number of published ultrasound equation models used to calculate fetal weight. However, only few of these equations are widely distributed in clinical practice over different centres. In this study, some of these equations are compared for accuracy of their fetal weight estimates with respect to the actual birth weight in the population under study.

The results of this study showed that actual birth weight had a mean of 3332 ± 513g. All the twelve equation models tested gave an acceptable estimate of concordance in fetal weight estimation based on intraclass correlation coefficient alone. Among the twelve formulas, the highest intraclass correlation coefficient was generated by Hadlock 5 (0.874) and very closely followed by Hsieh 2 (0.873). The lowest intraclass correlation coefficient was obtained with the formula of Nzeh 2 (0.656). It is also observed that all twelve equations have acceptable mean absolute percent error which ranged from 0.14% for Hsieh to 7.62% for Shepard. The percentage error also ranged from 0.45% for Hsieh to 7.41% for Shepard. These results are in agreement with previous study which found that the percent error of ultrasound estimated fetal weight can vary from -4.0 ± 8.5% to 1.3 ± 8.5%20. This further suggests that all the 12 formulas have measured fetal weight reliably.

The formula of Hsieh has the least mean absolute percent error (0.27%) and the least percentage error (-0.45%). When the mean difference was examined, the formula of Hsieh had the least systematic bias with an acceptable limits of agreement (mean difference = -9.0g; limits of agreement = -821 to 803g). Hsieh also had the smallest range of limits of agreement. When the paired samples t-test was conducted, the formulas of Hsieh, Woo, and Hadlock showed no significant difference between their mean weight estimates and that of birth weight at 5% level of significance. All other formulas showed significant difference ($p < 0.05$). The above results show that the formula of Hsieh agrees with the actual birth weight more than any other formula used in this study. The formula of Woo showed the second smallest mean difference (-34.5g) and range of limits of agreement (-808 to 732g), the second smallest mean absolute percent error (1.4%) and percentage error (-1.23%), and an intraclass correlation coefficient of 0.856. The Hadlock formula had the highest intraclass correlation coefficient of 0.874, with the third smallest mean absolute percent error (1.16%), and percentage error (-1.29%), the third smallest mean difference (-38.7g), and range of limits of agreement (-788 to 710g). These results exemplify the potential problems of the use of correlation coefficient alone to compare two methods of clinical measurements because it is the strength of the relation between the variables that is being assessed, and not the agreement between them[21].

However, the formula of Vintzileos showed the worst agreement, having the largest range of limits of agreement (-722 to 1122g). Previous studies have shown that equation models which make use of multiple fetal parameters and in particular the combination of BPD, FL, AC, and HC gave the best results in fetal weight estimation[11,22]. These findings are similar to the findings of Ayoola *et al*[6].

However, the equations of both Nzeh 1 and Nzeh 2 which are valid in their studied population are not found to be valid in the present study. This disagreement could probably be from the fact that the equation models used in both studies are different. The equations of Hadlock used by Ayoola and colleagues were Hadlock 2 and Hadlock 4. Hadlock 2 uses fetal AC and FL parameters[15], while Hadlock 4 uses fetal BPD, AC, and FL parameters[23]. But in this study, Hadlock 5 was the equation used, which incorporates BPD, HC, AC, and FL, and previous studies have favoured accuracy of models which use more fetal parametric measurements[23,24]. Also, models with the addition of HC parameter (including Hadlock 5 used here) have been reported to produce better estimates of fetal weight because variations in shape of fetal head which could result in erroneous estimation of birth weight is avoided by the inclusion of HC[11]. Furthermore, the equations of Hsieh 2 and Woo 3 which were found in this study to be superior to Shepard equation were not included in their study. Perhaps if the same equations were used in both studies, similar results would have been obtained because Anderson and colleagues have identified ultrasound equation as the main source of inconsistency in fetal weight estimations using ultrasonographic methods[25].

Present study has shown that ultrasound slightly overestimated both microsomia and macrosomia but was found to be more accurate for the estimation of microsomia than macrosomia and this is statistically significant ($p < 0.05$). A previous report[2] also opined that most formulae tend to over diagnose macrosomia at term. Ultrasound was also found to be an essential tool in efforts to identify the pregnancy at risk for fetal growth restrictions[3]. This implies that a high resolution ultrasound machine if meticulously performed by an experienced operator can be reliably used to diagnose microsomia and to a lesser degree macrosomia in the studied population.

Limitations

The limitations of this study include: (1) Only a handful of known ultrasound equations were used in this study. It is possible to have different results if all known equations were to be used.
(2) Birth weight (of babies) was not taken by only one midwife. Observer variability could be a source of inconsistency in the taking of ABW.

Conclusion

The results of this study suggest that the formulas of Hsieh 2, Hadlock 5, and Woo 3 are the only valid formulas that can be used in the population under study, with Hsieh being the best. It showed the smallest percentage error, the smallest mean difference, the smallest range of limits of agreement with almost the highest intraclass correlation coefficient. Thus ultrasound imaging can be a valid method of fetal weight estimation using the right regression equation.

Recommendations

1. The authors recommend that the second formula of Hsieh which incorporates fetal parameters of BPD, AC, and FL be used for fetal weight determination in the locality. This formula is stated as follows: $\text{Log10 BW} = 2.2193 + 0.0094962\ (AC)\ (BPD) - 0.1432\ (FL) - 0.00076742\ (AC)\ (BPD)2 + 0.001745\ (FL)\ (BPD)^2$.
2. There is need to revalidate the ultrasound methods of fetal weight estimation for each population because of racial variation in fetal weight.

Conflict of interest.

None.

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