Original Article

Gender Specific Fetal Weight Calculation

Comparison of Accuracy of Schild's Gender Specific Fetal Weight Formula with Hadlock's, Shepard's and Aoki's Fetal Weight Formulae in Pakistani Population

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ABSTRACT

Objective: Large number of fetal weight formulae derived using different populations suggest that there is no fetal weight formula which is acceptable worldwide. Ethnicity and gender of the fetus are the well reported and recognized causes of inaccuracies in these fetal weight formulae. The aim of this study was to compare the accuracies of Schild's gender specific formula with Hadlock's, Shepard's and Aoki's formulae in Pakistani population.

Study Design: Cross sectional study

Place and Duration of Study: This study was conducted at Ziauddin University Hospital, from May 2014 to May 2015.

Material and Methods: This cross sectional study recruited 150 primary gravida with singleton pregnancy. Patients with hypertension, diabetes and smoking were excluded. Sonographic evaluation for fetal parameters was done during 36.39 ± 0.684 weeks of gestation. Mean fetal weight was estimated from these formulae. Mean error, mean percentage error and the limit of agreement by Bland –Altman plot was determined. Anova was applied to compare the means of estimated fetal weight, error and percentage error. Gender and weight was noted after birth.

Results: No significant difference was found between the means of estimated fetal weightobtained by these formulae. Statistically significant difference was found between mean error of these formulae (p -value = 0.012) ranging between -217.24 gram to – 310.93 gram. Insignificant difference in mean percentage errors was noted which was between - 6.74% to - 9.37%. The narrowest and widest limit of agreement was found with Schild's formula and Hadlock's formula respectively.

Conclusion: In our population,for pregnancies with in normal range of fetal weight, Hadlock's, Shepard's, Aoki's and Schild's fetal weight formulae, all showed low values of mean errors and mean percentage errors which were within acceptable range.

Key Words: Pregnancy, fetal weight, fetal weight formula

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INTRODUCTION

Evaluation of fetal weight is an essential part of obstetrics as it can monitor the growth of the fetus and can minimize fetal, maternal complications by influencing clinical decision making during and after delivery.[1,2]During the last 30 years, many fetal weight formulae were developed and applied all over the world.Most of the fetal weight formulae are based on different combinations of fetal biometric parameters like head circumference (HC), biparietal diameter (BPD), abdominal circumference (AC) and femur length (FL).[3]The inaccuracies of these formulae are well reported and recognized.[4] Accurate fetal weight estimation is more important when dealing with high risk pregnanciesbut unfortunately error in fetal weight estimation is greatest for low weight and high weight babies.[5] Apart from the ethnicity and breech presentation, fetal gender is also reported as a factor influencing the accuracy of the fetal weight formulae.[6,7]None of the standard fetal weight formulae considers the effect of fetal gender.In 2004 Schild etal published a gender specific formula for fetal weight

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estimation whose better accuracy has been reported by few studies.[8]To date, no study has been reported comparing the accuracy of Schild's fetal weight formulawith commonly used formulae in Pakistani population.

The aim of this study was to compare the accuracy of fetal gender specific Schild's fetal weight formula with commonly used formulaein Pakistani population.

MATERIALSAND METHODS

We conducted a cross sectional study conducted at ZiauddinUniversity hospital after the approval of local ethical review board. The duration of study was one year from May 2014 to May 2015. 150 patients were recruited for the study. Convenience sampling was done.Gender of the babies was determined after birth and birth weight (BW) was also measured. Sonographic evaluation of the fetus was done by expert sonographer on standard 2D ultrasound machine with standard 3.5 MHz convex probe at 36weeks (36.39 ± 0.684) within 7 days prior to delivery.Only primary gravida with normal singleton pregnancy were included. Patients with history of drug abuse, hypertension, diabetes, smoking and high risk pregnancies were excluded. Standard fetal biometric parameters (Biparietal diameter, head circumference, abdominal circumference, femur length) and additional fetal measurement (abdominal area) were calculated.

Accuracy of Hadlock's, Shepard's, Aoki's and Schild gender specific fetal weight formulae(Table 1) were assessed by calculating the mean estimated fetal weight (EFW), mean error (EFW – BW), mean percentage error [(EFW-BW)/BW x 100] and by determining the limit of agreement by Bland –Altman plot. Descriptive analysis was performed.Anova was applied to compare the means. p-value< 0.05 was considered significant.

RESULTS

150 mothers were evaluated for fetal sonographic parameters with age ranging from 16 to 39 years (27.21 ± 4.2) and mean gestational age by ultrasound ranged from 36 weeks to 39 weeks (36.39 ± 0.684). The birth weight of the babies were from 2200 grams to 4100 grams (3076 ± 331) as shown in Table 2.

Mean estimated fetal weight ranged between 2767.27 gram and 2859.42 gram with Aoki's formula showing the least estimated fetal weight while highest byShepard formula. No significant difference was found between the means of estimated fetal weight obtained by these formulae. Mean error in fetal weight estimated by these formulae were found to be between -217.24 gram to – 310.93 gram with Aoki's formula showing the least error while Shepard's formula showing highest error. Significant difference was found between the mean errors of these formulae. (p -value = 0.012).

Table No.1: Demonstrates the fetal weight formulae evaluated in the study

Name of formula	Year of publication	Equation[8,9]
Hadlock's formula:	1985	$Log_{10}EFW = 1.3596 – 0.00386(AC \times FL) + 0.0064(HC) + 0.00061(BPD \times AC) + 0.0425 (AC) +$
Shepard's formula:	1982	$Log_{10}EFW = 1.2508 + (0.166 \times BPD) + (0.046 \times AC) – (0.002646 \times AC \times BPD)$
Aoki's formula:	1990	$EFW = (1.25647 \times BPD^3) + (3.50665 \times FAA \times FL) + 6.3$
Schild formula	2004	**For Male:** $EFW= 43576.579 +1913.853 \times \log_{10} BPD + 0.01323 \times HC^3+ 55.532 \times AC^2– 13602.664 \times AC^{1/2}– 0.721 \times AC^3+ 2.31\times FL^3$
		For Female: $EFW = −4035.275 + 1.143 \times BPD^3+1159.878 \times AC^{1/2}+ 10.079 \times FL^3– 81.277 \times FL^2$

Table No.2: Shows the general characteristics of the patients.

	N	Minimum	Maximum	Mean	Std. Deviation
Age in years	150	16	39	27.21	4.208
Gestational age by U/S in weeks	150	36	39	36.39	0.684
Birth weight (gram)	150	2200	4100	3076.67	331.443

Table No.3: Comparison of mean estimated fetal weight, mean error, mean percentage error of Hadlock's, Shepard's, Aoki's and Schild's fetal weight formulae.

Fetal weight formula	Mean estimated fetal weight (gram)	Mean error (gram)	Mean percentage errors
Hadlock	2813.99	-254.96	-7.96
Shepard	2767.27	-310.93	-9.37
Aoki	2859.42	-217.24	-6.74
Schild	2854.93	-221.74	-6.92
P-value	0.062	0.012*	0.057

***indicates p-value < 0.05**

Mean percentage error in fetal weight estimated by these formulae were found to be between - 6.74% to -9.37% with Aoki's formula showing the least percentage error while Shepard's formula showing highest percentage error. No Significant difference was found between the mean percentage errors of these formulae. All the formulae tend to underestimate the fetal weightas shown in Table 3.

Table 4: Demonstrates the mean disagreement and 95% limit of agreement of Hadlock's, Shepard's, Aoki's and Schild's fetal weight formulae.

Fetal weight formula	Mean disagreement (gram)	SD of disagreement (gram)	95% limit of agreement (gram)
Hadlock	-262.68	287.79	-826.75 to 301.39
Shepard	-309.39	279.79	-857.79 to 239.00
Aoki	-217.25	276.51	-759.21 to 324.71
Schild	-221.74	255.32	-722.16 to 278.68

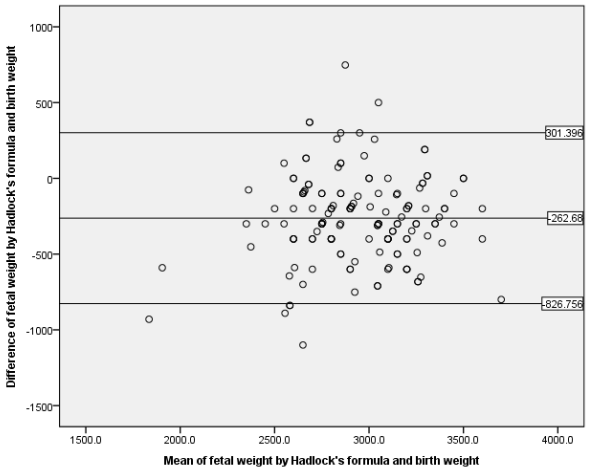

Figure No.1:Bland Altman plot illustrating agreement between fetal weight estimated by Hadlock's formula with birth weight.

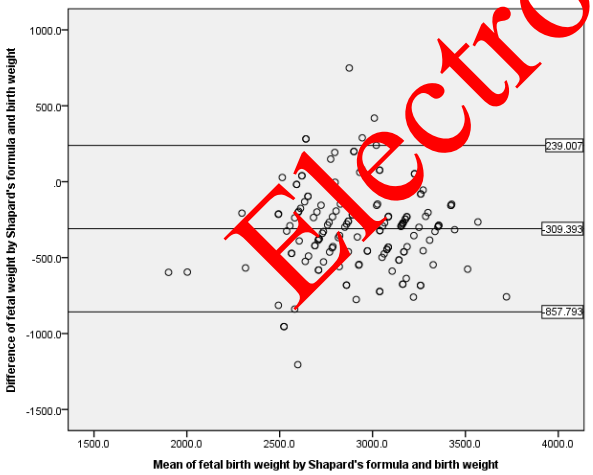

Figure No.2:Bland Altman plot illustrating agreement between fetal weight estimated by Shepard's formula with birth weight

Mean disagreement of these formulae was between –217.25 gram and -309.39 gram with Aoki's formula showing the least disagreement and Shepard's formula showing largest disagreement.The narrowest limit of agreement was found with Schild's formula and widest limit of agreement was found with Hadlock's formula. (Table 4).Bland Altman Plots demonstrating the limit of agreement of fetal weight estimated by Hadlock, Shepard, Aoki and Schild formulae are illustrated in figure1, figure2, figure3 and figure 4 respectively.

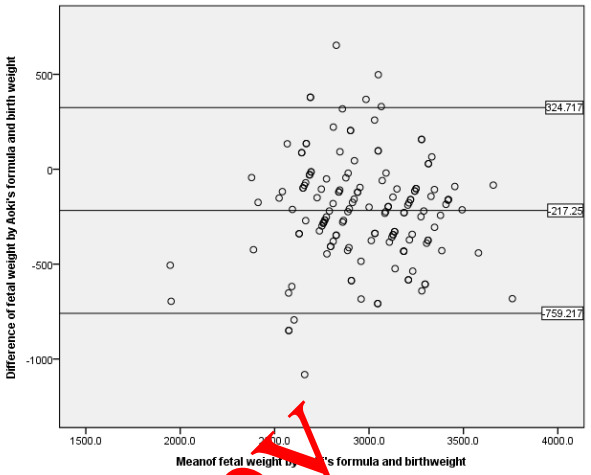

Figure No.3: Bland Altman plot illustrating agreement between fetal weight estimated by Aoki's formula with birth weight

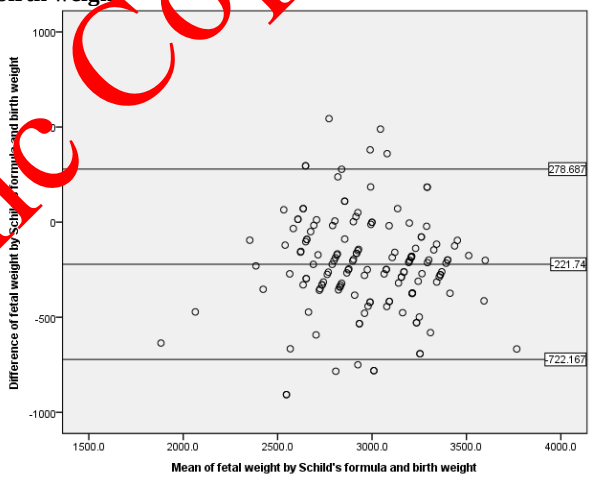

Figure No.4: Bland Altman plot illustrating agreement between fetal weight estimated by Schild's formula with birth weight

DISCUSSION

Fetal weight estimation is an essential part of sonographic evaluation done for assessing fetal well-being, deciding appropriate management plan for pregnancy and to minimize fetal and maternal complications during delivery. Precise fetal weight estimation is of key importance when dealing with high risk pregnancy, preterm labor, small for gestational age pregnancy and cases of macrosomia. .Unfortunately the inaccuracies are reported to be greatest at the two extremes of fetal weight. [10, 11, 12, 13]

It is well reported in literature that ethnicity is one of the causes of inaccuracy in the results of fetal weight formula as majority of them were developed for Western population but applied also another

populations of the world. [14,15]. In our study it was found that all fetal weight formulae (Hadlock, Shepard, Aoki and Schild) estimate fetal weight with statistically significant errors (p-value = 0.012**)** ranging between - 217.24 gram and - 310.93 gram, and statistically insignificant percentage errors ranging between - 6.74 % to - 9.37 % (p-value = 0 .057) for normal weight ,singleton pregnancies. These values of mean errors and mean percentage errors are low for causing any significant influence on clinical decision. Though our study also includes few pregnancies of babies with birth weight less than 2500 gram and greater than 4000 gram but they were very few to make any substantial conclusion. All the fetal weight formulae showed a tendency to underestimate the fetal weight, this may be due to the reason that in our study fetal weight was not adjusted for the period of days between sonographic evaluation and delivery which is reported to cause underestimation of fetal weight.[16]Adjusting the fetal weight for the period of days between sonographic evaluation and delivery could increase the accuracy of the formula. [17]

Another factor causing discrepancy in fetal weight estimation, which is well reported and recognized in the literature, is the gender of the fetus.[18] None of fetal weight formula except Schild's formula has taken into consideration the effect of gender difference in formula equation in spite of the reports that fetal biometric parameters like BPD, HC, AC are smaller in female babies. [19] Different rates of growth of two genders is also reported in literature with male fetus growing faster than the female fetus.[20] In our study Schild's gender specific formula gives the least value of mean error and mean percentage error after Aoki's formula suggesting better performance of the Schild's formula over Hadlock's and Shepard's formula, as reported by SchildRLetal. [21] Lowest mean error and percentage error observed with the Aoki's formula could be due to the fact that Aoki's formula was derived using Japanese population belonging to the same continent as that of Pakistani population and may have some similarities with Pakistani population. But this needs to be further evaluated as no previous study, to the best of our knowledge, has reported the better performance of Aoki's formula over Hadlock's and Shepard's formula for Pakistani population. The narrowest limit of agreement, found with Schild's formula in our study , is in accordance with the study of Melamedetal[22]which has suggested that incorporation of effect of gender in Schild's formula favors the accuracy of fetal weight formula.The limitation of this study is that these results could only be applied on normal weight babies. Another limitation of the study was that samples were inducted using convenience sampling technique.

CONCLUSION

In our population,for pregnancies within normal range of fetal weight Hadlock's, Shepard's, Aoki's and Schild fetal weight formulae, all showed low values of mean errors and mean percentage errors within acceptable range.

Conflict of Interest: The study has no conflict of interest to declare by any author.

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