COMPARATIVE STUDY OF VARIOUS METHODS OF FETAL WEIGHT ESTIMATION AT TERM PREGNANCY

By

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SUMMARY

One hundred cases of full term pregnancy or in early labour admitted in LNJPN Hospital, New Delhi were examined and included in this study. Fetal weight was estimated by clinical palpation, Dawn's formula, Johnson's formula and ultrasonographic Warsof's formula. Actual birth weight was recorded when the baby was born and it was compared with the weight estimated by various methods. Over all average error per case for all cases was 198.6 gm by Warsof's formula and 222.8, 327.28 and 364.96 gm by Dawn's, Johnson's and clinical method respectively. Average error by Warsof's formula was significantly less than that found by clinical method, Dawn's formula and Johnson's formula ($P < 0.01$, 0.05 and 0.01 respectively). Average error in weight group up to 2000 gm was least by Dawn's formula and the difference from other methods was statistically significant ($p < 0.05$).

Warsof's formula had a better balance between over and under estimation as compared to other methods Analysis of results indicates that Warsof's formula is significantly superior to other methods of fetal weight estimation.

Introduction

Assessment of fetal weight in utero leads to an improved prospective management of high risk pregnancies and considerable reduction in perinatal morbidity and mortality. According to Taylor and Ward, the fetal weight is the greatest single factor determining the survival of the fetus. Various methods are used for estimation of fetal weight in utero. This study was undertaken to evaluate comparative accuracy of fetal weight estimation by clinical palpation, Dawn's formula, Johnson's formula and ultrasonographic Warsof's formula.

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Material and Methods

This study was conducted in the Department of Obstetrics and Gynaecology, Maulana Azad Medical College and Associated LNJPN Hospital, New Delhi during the year 1985-86. One hundred cases of term pregnancy or in early labour, who delivered within 72 hours of measurements were included in this

study. Clinical examination including abdominal palpation for clinical assessment of fetal weight was done. Longitudinal (L) and maximum Transverse (T) diameter of the uterus was measured with pelvimeter which was just at or above the umbilicus. Double abdominal wall thickness (DAWT) was recorded at mid point between umbilicus and symphysis pubis. McDonald's measurement of height or fundus (M) was recorded with a measuring tape. Crown rump length using the tape measure were substituted for McDonald's measurement, when the presenting part was above the symphysis pubis.

For ultrasonographic measurement—an ADR sector liner Real time Scanner was used. Biparietal diameter of fetal skull was recorded, three readings were taken with different images and the largest reading consistent with a good image was considered as B.P.D. A good image for B.P.D. appears as an ovoid bisected by a broken mid-line echo of falx-cerebri. To record abdominal diameters a cross section of the fetal abdomen at the level of umbilical vein was taken in the correct plane, the cross section of the pulsating abdominal aorta was seen in front of the spine and stomach on the left side. After freezing this image, the two diameters, perpendicular to each other were taken one antero-posterior and the other transverse.

Calculation of the Fetal Weight

The fetal weights were then calculated by using the above mentioned data with the help of the following formulae:

Dawn's formula

$$\text{Weight (in gm)} = L \times \frac{(T)^2}{2} \times 1.44$$

This formula is applicable if DAWT is 3 cm or less for maternal weight upto 50 kg. If DAWT is more than 3 cm, half of the excess DAWT over 3 cm is deducted from T.

Johnson's Formula

Weight in gm = (M-X) × 155

M – Mc Donald's measurement

X – 11, 12 or 13 depending upon the position of the head in relation to the maternal ischoal spines. Eleven, when head is at minus one station, 12, when head at ischoal spine and 13 when head is below Ischoal spines (+ 1 station).

If the patient weighs more than 200 pounds, one cm is substracted from the fundal height measurement.

Calculation of Abdominal Circumference

The abdominal circumference was calculated by taking the average of antero-posterior diameter (D_1) and the transverse diameter (D_2) and multiplying it by π (22/7).

Mathematically—

$$AC = \pi \frac{(D_1 + D_2)}{2} \text{ in cm.}$$

The fetal weight was then calculated by using Warsof's formula (1977).

Log_{10} weight = –1.7492 + 0.166 (BPD) + 0.046 (AC) – 0.0026646 x BPD x AC.

After birth weight was taken and the calculated weights by various methods were compared with the actual birth weight and analysed.

Results and Discussion

A comparison of the average error in various foetal weight groups by various methods is shown in Table I.

This is calculated by adding the error of estimation of fetal weight from actual birth weight in all cases and dividing it by total number of cases. These calculations have been done for each method separately.

As shown in Table I average error in weight group up to 2000 gm and in the group more than 3500 gm was found to be quite larger by clinical and Johnson's methods. The results in weight group 2000 to 3500 gm were comparable by clinical, Johnson's and Dawn's methods.

Average error by Dawn's formula in weight group 3.500 gms was comparable to clinical and Johnson's method but Dawn's formula was found to be most accurate for fetal weight estimation in weight group less than 2000 gms.

Ultrasonographic Warsof's formula gave least average error in all weight groups except in group up to 2000 gms, where Dawn's formula was found to be superior to it.

Maximum errors were more marked by clinical method and Dawn's formula followed by Johnson's method. They were least by ultrasonographic Warsof's formula except in weight group upto 2 kg where Dawn's and Johnson's formulae gave least maximum error.

Considering all the cases, all methods except Warsof's formula had a tendency to under-estimate the weight—clinical (63%), Dawn's (62%), Johnson's formula (62%). Ultrasonographic Warsof's formula has almost an equal frequency of under and over-estimation.

Considering various weight groups, all methods had a tendency to over-estimate VLB weight group (less than 2000 gms) and under-estimate very good weight babies (more than 3000 gms).

TABLE I

Average Error in Various Fetal Weight Groups by Various Methods

Methods	Error (gm)					
	Upto 2000 gm	2001-2500	2501-3000	3001-3500	3500	Average
Clinical	500	299.5	274.7	290.6	460	364.96
Dawn's	150	283	342.1	405	365	224.82
Johnson's	370	303.5	203.4	349	411	327.28
Warsof's	290	185	110.3	163	243	198.6

TABLE II

Maximum Error in Various Fetal Weight Groups by Various Methods

Methods	Maximum error (gms)					
	Upto 2000 gm	2001-2500	2501-3000	3001-3500	3500	Average
Clinical	900	700	840	1000	700	823
Dawn's	430	800	1000	1080	810	824
Johnson's	430	740	580	1000	700	690
Warsof's	620	550	300	400	400	454

TABLE III

Number of Under and Over-Estimations by Various Methods in Various Weight Groups

Methods	Number of Cases															
	GROUPS															
	Up to 2000		2001-2500		2501-3000		3001-3500		>3500		Total	
	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under
Clinical	2	1	12	8	17	19	3	30	1	5	35	63
Dawn's	3	0	13	7	12	26	7	26	3	3	38	62
Johnson's	2	1	17	3	15	23	3	30	1	5	38	62
Warsof's	2	1	16	4	20	18	14	19	2	4	54	46

In weight group 2000-3000 gm, the results were equivocal by all methods except Warsof's formula which to some extent over estimated, this group also.

As is evident from Table IV by Warsof's formula in 92% of cases the error was within 300 gm as compared to 66% of cases by clinical method, 52% by Dawn's and 59% by Johnson's method.

Similarly, in ninety seven per cent of cases, the error was upto 400 gm by Warsof's formula. The results of other methods were comparable except those of Dawn's method were a little inferior to the other two but all of them were much poorer than those of ultrasonographic method.

As shown clearly in Table V, average error in gms/kg of birth weight was least by Warsof's formula (99.32 gms). Then comes the Dawn's method (110.77 gm) followed by Johnson's method (130.86 gm). The error was maximum by clinical estimation (142.69 gm).

Percentage Error

Finally, the percentage error of each case was calculated for four different methods. This was calculated by using the formula

$$\frac{x}{y} \times 100$$

Where x = Error in gms

y = Actual birth wt in gms.

Percentage of cases with a particular percentage error were then calculated, as shown in Table VI.

As is clear from the above table 85% of the predictions came within 10% of the birth weight by Warsof's formula as compared to 59%, 55%, and 52% by clinical, Johnson's and Dawn's formulae respectively.

TABLE IV
Percentage of Cases with Error in Grams

Error (gms)	Percentage of Cases			
	METHODS			
	Clinical	Dawn's	Johnson's	Warsof's
Upto 100	21	23	16	42
Upto 200	41	39	35	76
Upto 300	66	52	59	92
Upto 400	79	68	74	97
Upto 500	85	75	88	97

TABLE V
Error Per Kg of Birth Weight by Various Method in Different Fetal Weight Groups

Methods	Error per kg Birth weight (grams)					
	GROUPS					
	Upto 2000	2001-2500	2501-3000	3001-3500	>3500	Average
Clinical	227.7	124.4	92 74	102.29	167	142.69
Dawn's	94.3	113.25	129.18	123.45	93.67	110.77
Johnson's	204.0	104.75	122.13	115.67	108.5	130.86
Warsof's	225.5	92.9	38.68	75.21	64.33	99.32

TABLE VI
Percentage Error Per Method

Percentage error	Percentage of Cases			
	METHODS			
	Clinical	Dawn's	Johnson's	Warsof's
Upto 5%	23	28	22	52
Upto 10%	59	52	55	85
Upto 15%	74	68	78	92
Upto 20%	85	81	88	96
Upto 25%	89	86	95	97

Ninety two percentage of cases fell in 15% error range and 96% within 20% error by Warsof's formula.

Table VII shows the standard deviation of prediction error obtained by various methods.

The standard deviation of prediction error was found to be least by Warsof's formula as compared to all other methods used in the study. The difference was

TABLE VII
Standard Deviation of Prediction Error.

Method	Standard Deviation (Gms)
Clinical	462.11
Dawn's	429.13
Johnson's	338.75
Warsof's	203.02

found to be statistically significant with a p value of less than 0.05 for Dawn's and Johnson's formulae and less than 0.01 for clinical method of estimation.

The difference between the standard deviation of prediction error by the other three methods was not found to be statistically significant ($p > 0.05$).

Fetal weight estimation has been attempted by clinical, biochemical radiographic and ultrasonographic methods. The clinical methods were criticised on the basis of being less accurate and subject to considerable observers varation. Biochemical methods were not found to be satisfactory. Radiography was abandoned because of its hazards to both fetus and mother. Recently ultrasonography has gained popularity for determination of fetal parameters and well being and also found useful for estimation of fetal weight. ($p < 0.05$). Timor-Tritsch *et al* (1981) and Dornan *et al* (1982) found an error of 228 gm and 150 gm respectively while estimation fetal weight from BPD & AC as compared to 198.6 gm by Warsof's formula in the present study.

By Warsof's formula maximum error was found to be minimum in all birth weight ranges except in the group less than or equal to 2000 gms, by Warsof's formula. Dawn's and Johnson's formulae gave less maximum error as compared to ultrasonography in the birth weight group of less than or equal to 2000 gm, but this difference was not statistically significant (p 0.05).

All the methods had a tendency to under-estimate the weight range more than 3,000 gm and over estimate the very low birth weight babies (less than 2000 gm). Similar results have been reported by Niswander *et al* and Ong and Sen (1972). In the present study using Warsof's formula ultrasound was shown to have almost an equal incidence of over and under-estimations, increasing the reliability of the method.

Eighty five per cent of cases were within 500 gm of actual birth weight when assessed by clinical methods. This was found to be in accordance with the results of Seazley and Kurja, K. (1953) who found 80% of cases within 500 gm of error. Ong and Sen (1975) also obtained 82.8% of estimates within 459.5 gm (1 pound) of error.

The results of present study are also in confirmity with those of Insler *et al* (1967) using clinical method, i.e. 27% of errors upto 100 gm and 85.2% of errors upto 500 gms as compared to 21% and 85% respectively in the present study. Dawn's formula estimated the fetal weight within 500 gm of error in 75% cases. Johnson's formula was found to give 88% estimates within 500 gm of difference from actual birth weight. The results are slightly better i.e. 77% as obtained by Niswander *et al* (1970) by using Johnson's formula. Dahiya and Rathee (1987) reported that with Dawn's formula the accuracy of fetal weight determination was 81% within $\pm$ 250 gms of birth weight while with Johnson's formula, it was 51.5% within $\pm$ 250 gms of birth weight. In present study, Warsof's formula was found to estimate 97% of cases within 500 gm error. By Warsof's formula 92% of estimates were within 300 gm of actual birth weight as compared to 66%, 52% and 59% by clinical, Dawn's and Johnson's method respectively. The difference is statistically significant for each of them ($p < 0.05$), 0.01 and 0.02 respectively). The results by Warsof's formula in the present study are shown to be better than those of Campogrande *et al* (1977) who had an error up to 200 gms in 56% of cases in

contrast to 76% in the present study; under 300 gm in 66% of cases as compared to 92% and under 400 gm in 84% as compared to 97% in the present study.

Error in gm/kg of birth weight was found to be least by Warsof's formula as compared to other methods. In weight range less or equal to 2000 gms, the error per kg birth weight was least by Dawn's formula. The error of 99.32 gms/kg birth weight by Warsof's formula compares well with other studies. Warsof's *et al* (1977) and Campbell and Wilkin (1975) obtained an error of 106 gm/kg and 160 gm/kg birth weight respectively. Thurnau *et al* (1983) obtained an error of 93 gm/kg birth weight.

In 92% of cases the percentage error was restricted to 15% or less when Warsof's formula was used. As compared to this, only 74%, 68% and 78% estimations had an error of 15% or less when clinical Dawn's and Johnson's formulae respectively used. There was no significant difference between the percentage errors obtained by the latter three methods. Campbell and Wilkin (1975) found that 98% of cases were within ± 16% error range. Timor Tritsch *et al* (1981) obtained 60% estimates within 10% of actual birth weight. Ott (1981) obtained 66.3% of results within 10% error and 62.2% within 15% error. Shepard *et al* (1982) obtained 50.7% estimates within 10% error as compared to 85%, 92% and 96% estimates within 10%, 15%, and 20% error range in the present study. Sampson *et al* (1982) found a standard deviation of ± 150 gm as compared to ± 203 gm in the present study. The standard deviation of prediction error was found to be least by Warsof's formula.

To conclude this study amply highlights the superiority of ultrasonography over other methods used for fetal weight estimation in utero. It is a safe accurate and convenient method. However, a careful assessment of fetal weight made by an experienced obstetrician is still valuable specially in places where the facility of this modern sophisticated technique of ultrasonography is not available. Moreover, the results of clinical, Dawn's and Johnson's methods of estimating fetal weight have not been found to be significantly different from each other, except average error in fetal weight group upto 2000 gm was least by Dawn's formula and the difference from other methods was statistically significant.

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