Assessment of the Accuracy of Multiple Sonographic Fetal Weight Estimation Formulas

A 10-Year Experience From a Single Center

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Objectives—The primary aim of this study was to compare the accuracy of sonographic fetal weight estimation models. The secondary aim was to define the most accurate time (4–7 or 3 days before delivery) for evaluating fetal weight.

Methods—In this retrospective cohort study, a total of 12,798 sonographic fetal weight estimations were analyzed, of which 9459 were performed within 3 days of delivery and 3339 within 4 to 7 days. The cohort included all singleton pregnancies recorded at a single medical center from January 2000 to December 2010, with 24 weeks' gestation minimum. Predicted birth weights were calculated according to 23 sonographic fetal weight estimation models; in total, 294,354 sonographic weight estimations were evaluated and compared to the actual birth weights.

Results—The accuracy of the models in predicting birth weight differed considerably. The most accurate models used 3 or more fetal measurements followed by models using abdominal circumference only. The models developed by Sabbagha et al (*Am J Obstet Gynecol* 1989; 160:854–862) proved most accurate, with a mean percent error of –0.2% and greater than 92% of estimates within 15% of birth weight ($P < .05$). Nineteen sonographic fetal weight estimation models (82.6%) better predicted fetal weight at 4 to 7 days before delivery ($P < .001$). Twenty-two (95%) of the models were less accurate at the extreme ends of fetal weight.

Conclusions—Different formulas for fetal weight estimation vary greatly; we recommend that each center should evaluate the most accurate formula according to its attending population. Estimation of fetal weight performed 4 to 7 days before delivery using most models was more accurate than estimations performed 3 days before delivery.

Key Words—accuracy; estimation; fetal weight; models; sonography

Accurate determination of fetal weight is important for planning optimal pregnancy follow-up and the timing and mode of delivery for both small- and large-for-gestational-age fetuses. Clinical assessment of fetal weight is useful and quite accurate[1–3]; nevertheless, sonographic fetal weight estimation has become common practice. Many models have been developed that use single or combined fetal measurements, mainly the fetal abdominal circumference, biparietal diameter, head circumference, and femur length. There is still no consensus as to which model yields the best sonographic fetal weight estimations.[4–6] Although some models report insignificant systematic errors, random errors (the standard

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deviations of errors) usually exceed 7%.[4] Most studies that compared the accuracy of existing models were limited by a small number of sonographic examinations or by assessment of few models.[6–13] It has been claimed that, due to fetal growth, measurements performed within 3 days of delivery are more accurate than those made 4 to 7 days before delivery.[14] On the other hand, estimations made close to delivery might be influenced by other parameters such as oligohydramnios or engagement of the fetal head in the delivery process.

The primary aim of this study was to assess the accuracy of 23 sonographic fetal weight estimation models in predicting birth weight based on measurements made within a week of delivery. The secondary aim was to determine the most accurate time (4–7 or 3 days before delivery) for evaluating fetal weight.

Materials and Methods

Data Collection

This retrospective cohort study assessed sonographic and obstetric data of deliveries at Assaf Harofe Medical Center. It is our custom to perform sonographic fetal weight estimation for each parturient reporting to our institution for any reason if such estimation was not performed in the previous 2 weeks. Using an Excel spreadsheet (Microsoft Corporation, Redmond, WA), we used sonographic fetal measurements taken up to 1 week before delivery and have calculated the expected birth weight using 23 different formulas. The expected birth weight was compared to the actual birth weight. Sonographic fetal weight estimations were performed in our obstetric and gynecologic sonography unit by specialized sonographers. The study cohort comprised parturient women referred to our unit between January 2000 and December 2010 for sonographic fetal weight estimation. Inclusion criteria were a live-birth singleton pregnancy, birth weight of greater than 500 g, and gestational age of greater than 24 weeks. Exclusion criteria were detection of a fetal abnormality or malformation, active labor at the time of sonographic fetal weight estimation, incomplete medical records, and ruptured membranes.

Data about live births were obtained by a computerized search of women's medical and demographic records and included maternal age, obstetric history, the week of gestation at delivery, abnormal sonographic findings and karyotype (if performed), mode of delivery, birth weight, and sonographic fetal measurements, including biparietal diameter, head circumference, abdominal circumference, and femur length, which were performed according to formal standards.[15–17] We did not record ethnicity because the rate of intermarriage between individuals of widely different geographic and ethnic origins is currently high in Israel.

The study was approved by the local Institutional Review Board.

Statistical Analysis

Data were collected on a standard spreadsheet (Microsoft Excel). Fetal sonographic measurements were used in the calculations of the formulas for the models analyzed (Table 1), and their accuracy in predicting birth weight was assessed. Descriptive parameters are expressed as mean ± standard deviation. Frequencies are presented as percentages.

The analysis was performed in several ways:

1. Limits of agreement of mean error from birth weight according to Bland and Altman,[30] which were calculated between the mean differences of sonographic fetal weight estimation from the actual birth weight ± 1.96 SDs;
2. The mean systematic percent error of sonographic fetal weight estimations from the actual birth weight: mean of (sonographic fetal weight estimation – birth weight)/birth weight × 100; it was also presented according to limits of agreement;
3. Standard deviation of errors (random error);
4. Correlation of sonographic fetal weight estimation with the actual birth weight using the Pearson correlation coefficient; and
5. The proportion of estimates within 10% and within 15% of the actual birth weight.

The proportion of estimates within 10% of the actual birth weight was compared for measurements taken 4 to 7 days before delivery to those within 3 days of delivery.

Overall accuracy was determined by combining the rating of all models according to systematic error, random errors, and proportions of estimates within 10% and 15% of actual birth weight.

The paired *t* test with Bonferroni adjustments for nonindependence was used to compare systematic percent errors between methods. Random errors were compared using the Pitman test of variance with Bonferroni adjustments for nonindependence. The McNemar and χ^2 tests were used to compare the rates of evaluations that were within 10% and 15% of the actual birth weight among models. Statistical analysis was performed using SPSS version 15 software (SPSS Inc, Chicago, IL) by the Tel Aviv University Statistical Laboratory; $P < .05$ was considered statistically significant.

Results

Included in this study were 12,798 sonographic fetal weight estimations performed during the week before delivery. Of them, 9459 were performed within 3 days of delivery and 3339 within 4 to 7 days. The mean maternal age was 30.4 years (range, 13–53 years; SD, 5.1 years); the median gravidity status was 2 (range, 1–18; SD, 1.8); and the median parity status was 2 (range, 1–15; SD, 1.3). The mean fetal weight was 3210 g (range, 500–5600 g; SD, 607 g); 922 neonates (7.2%) weighed 4000 g or more. The mean gestational age at delivery was 39 weeks (range, 24–44 weeks; SD, 2.3 weeks).

Twenty-three sonographic fetal weight estimation models were assessed (Table 1), and their accuracy in predicting actual birth weight was summarized (Table 2). In total, 294,354 fetal weight estimations were compared to actual birth weights. Correlations between sonographic fetal weight estimation models and actual birth weights ranged from 0.795 in a model using only femur length (model 6 by Warsof et al[23]) to 0.913 for a model using abdominal circumference, biparietal diameter, and femur length (model 18 by Hadlock et al[24]). For model 9 by Woo et al,[25] based on abdominal circumference and femur length, the mean systematic percent error for sonographic fetal weight estimation was the highest, reaching a mean deviation of 20.8% from the actual birth weight. The mean

Table 1. Models for Estimation of Fetal Weight

Model	Source	Year	Formula
AC			
1	Campbell and Wilkin[18]	1975	$\ln EFW = -4.564 + 0.282(AC) - 0.00331(AC)^2$
2	Hadlock et al[19]	1984	$\ln EFW = 2.695 + 0.253(AC) - 0.00275(AC)^2$
3	Jordaan[20]	1983	$\log_{10} EFW = 0.6328 + 0.1881(AC) - 0.0043(AC)^2 + 0.000036239(AC)^3$
4	Warsof et al[21]	1977	$\log_{10} EFW = -1.8367 + 0.092(AC) - 0.000019(AC)^3$
5	Higginbottom et al[22]	1975	$EFW = 0.0816(AC)^3$
FL			
6	Warsof et al[23]	1986	$\ln EFW = 4.6914 + 0.151(FL)^2 - 0.0119(FL)^3$
AC/FL			
7	Hadlock et al[24]	1985	$\log_{10} EFW = 1.304 + 0.05281(AC) + 0.1938(FL) - 0.004(AC)(FL)$
8	Warsof et al[23]	1986	$\ln EFW = 2.792 + 1.08(FL) + 0.0036(AC)^2 - 0.027(FL)(AC)$
9	Woo et al[25]	1985	$\log_{10} EFW = 0.59 + 0.08(AC) + 0.28(FL) - 0.00716(AC)(FL)$
AC/BPD			
10	Hadlock et al[19]	1984	$\log_{10} EFW = 1.1134 + 0.05845(AC) - 0.000604(AC)^2 - 0.007365(BPD)^2 + 0.000595(BPD)(AC) + 0.1694(BPD)$
11	Woo et al[25]	1985	$\log_{10} EFW = 1.63 + 0.16(BPD) + 0.00111(AC)^2 - 0.0000859(BPD)(AC)^2$
12	Vintzileos et al[26]	1987	$\log_{10} EFW = 1.879 + 0.084(BPD) + 0.026(AC)$
AC/BPD/FL			
13	Woo et al[25]	1985	$\log_{10} EFW = 1.54 + 0.15(BPD) + 0.00111(AC)^2 - 0.0000764(BPD)(AC)^2 + 0.05(FL) - 0.000992(FL)(AC)$
14	Shinozuka et al[27]	1987	$EFW = 0.23966(AC)^2 (FL) + 1.6230(BPD)^3$
15	Hadlock et al[24]	1985	$\log_{10} EFW = 1.335 - 0.0034(AC)(FL) + 0.0316(BPD) + 0.0457(AC) + 0.1623(FL)$
AC/HC/FL			
16	Hadlock et al[24]	1985	$\log_{10} EFW = 1.326 - 0.00326(AC)(FL) + 0.0107(HC) + 0.0438(AC) + 0.158(FL)$
17	Combs et al[28]	1993	$EFW = 0.23718(AC)^2 (FL) + 0.03312(HC)^3$
AC/HC/BPD ± FL			
18	Hadlock et al[24]	1985	$\log_{10} EFW = 1.3596 + 0.0064(HC) + 0.0424(AC) + 0.174(FL) + 0.00061(BPD)(AC) - 0.00386(AC)(FL)$
19	Jordaan[20]	1983	$\log_{10} EFW = 2.3231 + 0.02904(AC) + 0.0079(HC) - 0.0058(BPD)$
20	Hadlock et al[19]	1984	$\log_{10} EFW = 1.182 + 0.0273(HC) + 0.07057(AC) - 0.00063 (AC)^2 - 0.0002184(AC)(HC)$
AC/HC/FL + GA			
21	Sabbagha et al[29]	1989	$5426.9 - 94.98(SUM) + 0.54262(SUM)^2$
22	Sabbagha et al[29]	1989	$-55.3 - 16.35(SUM) + 0.25838(SUM)^2$
23	Sabbagha et al[29]	1989	$1849.4 - 47.13(SUM) + 0.37721(SUM)^2$

AC indicates abdominal circumference; BPD, biparietal diameter; EFW, estimated fetal weight; FL, femur length; GA, gestational age; HC, head circumference; and SUM, GA (weeks) + 2AC (centimeters) + HC (centimeters) + FL (centimeters).

systematic percent error was the lowest for models 21 and 22 by Sabbagha et al,[29] based on abdominal circumference, head circumference, femur length, and gestational age, with 0.2% to 1.5% mean deviation from actual birth weight. We compared mean systematic percent error between all models, pair-wise, using the paired *t* test with Bonferroni adjustments. All models differed significantly in terms of the mean systematic percent error ($P < .05$) except for models 5 and 21 and models 6, 7, 15, and 19 (Figure 1A), which were not significantly different from each other. Random error was the lowest (7.8%) for model 11 by Woo et al[25] ($P < .05$) compared to all other models, closely followed by models 23, 17, and 16 by Sabbagha et al,[29] Combs et al,[28] and Hadlock et al,[24] which were not significantly different from each other but had significantly lower random errors than all of the other models ($P < .05$; Table 2). Each model was evaluated according to the systematic prediction error and random error (Figure 2). When expressed in grams, most

Table 2. Measures of Accuracy for Different Models

Model	Source	Correlation With Birth Weight	Mean Error (g) ± 95% CI[a]	Mean % Error[b]	Random Error	Mean % Error ± 95% CI,[a]	Predictions (%) Within ±10%	Predictions (%) Within ±15%	Overall Rating
AC									
1	Campbell and Wilkin[18]	0.897	106.1 ± 530.5	4.3	9.2[c]	4.3 ± 18.0	70.7	87.7	9
2	Hadlock et al[19]	0.901	179.6 ± 521.3	6.3	9.0[c]	6.3 ± 17.6	65.1	83.8	15
3	Jordaan[20]	0.899	–152.7 ± 570.8	–3.3	9.7[d]	–3.3 ± 19.0	68.7	87.9	6
4	Warsof et al[21]	0.891	280.6 ± 540.8	9.6	9.7[d]	9.6 ± 19.0	51.6	72.4	19
5	Higginbottom et al[22]	0.890	113.8 ± 659.0	3.3	10.4	3.3 ± 20.4	65.5	83.9	12
FL									
6	Warsof et al[23]	0.795	162.9 ± 721.9	6.7	12.6	6.7 ± 24.7	55.6	73.3	20
AC/FDL									
7	Hadlock et al[24]	0.906	225.2 ± 530.0	7.4	8.8[c]	7.4 ± 17.2	60.9	81.0	17
8	Warsof et al[23]	0.9	350.2 ± 558.1	11.4	9.4	11.4 ± 18.4	44.1	65.9	21
9	Woo et al[25]	0.907	664.5 ± 630.7	20.8	10.5[e]	20.8 ± 20.6	13.2	27.1	23
AC/BPD									
10	Hadlock et al[19]	0.908	188.5 ± 514.1	6.4	8.7[c]	6.4 ± 17.1	64.7	84.3	14
11	Woo et al[25]	0.907	–181.7 ± 501.0	–5.2	**7.8**	–5.2 ± 15.3	70.4	89.5	4
12	Vintzileos et al[26]	0.894	366.2 ± 703.0	11.3	10.8[e]	11.3 ± 21.2	44.2	64.1	22
AC/BPD/FL									
13	Woo et al[25]	0.909	109.5 ± 511.9	3.8	8.5[c]	3.8 ± 16.7	73.3	89.7	8
14	Shinozuka et al[27]	0.908	166.6 ± 501.6	5.9	8.6[c]	5.9 ± 16.9	67.9	85.9	11
15	Hadlock et al[24]	**0.912**	212.3 ± 512.5	7.0	8.5[c]	7.0 ± 16.7	63.3	82.9	16
AC/HC/FL									
16	Hadlock et al[24]	0.911	168.8 ± 509.5	5.7	8.4[c]	5.7 ± 16.5	68.0	86.5	10
17	Combs et al[28]	0.909	92.9 ± 494.7	3.7	8.4[f]	3.7 ± 16.5	74.8	90.4	3
AC/HC/BPD ± FL									
18	Hadlock et al[24]	**0.913**	180.7 ± 506.0	6.0	8.4[f]	6.0 ± 16.5	67.3	86	13
19	Jordaan[20]	0.894	206.5 ± 558.5	7.3	10.2	7.3 ± 20.0	62.2	81	18
20	Hadlock et al[19]	0.905	106.9 ± 511.8	3.9	8.5[c]	3.9 ± 16.7	73.4	89.9	7
AC/HC/FL + GA									
21	Sabbagha et al[29]	0.9	61.4 ± 522.4	3.3	11.2	3.3 ± 22.0	75.2	90.3	5
22	Sabbagha et al[29]	0.901	**–32.4 ± 519.0**	**–0.2**	8.5[c]	–0.2 ± 16.7	**78.0**	**92.9**	**2**
23	Sabbagha et al[29]	0.902	**–71.7 ± 513.6**	**–1.5**	**8.2[f]**	–1.5 ± 16.1	**78.0**	**93.1**	**1**

Correlations of different sonographic fetal weight estimation models with the actual birth weights are presented using the Pearson correlation coefficient. The mean deviation from actual birth weight is the mean error in grams ± 95% confidence interval (CI), Systematic error is the mean percent error of the sonographic fetal weight estimation models calculated as the mean of (sonographic fetal weight estimation – birth weight)/birth weight × 100. Random error is the standard deviation of the mean percent error. Mean percentage error ± 95% CI. Predictions within ±10% and ± 15% are the proportions of estimates in percent within 10% and 15% of the actual birth weight. The most prominent results in each comparison are boldface. Abbreviations are as in Table 1.

[a]According to the limits of agreement method.

[b]All mean percent error values were compared between each pair of formulas using the paired t test; all mean values were significantly different ($P < .05$) except for the comparisons between models 5 and 21, which reached the same result, and models 7 and 19.

[c–f]Random errors were compared using the Pitman test with Bonferroni adjustments. All comparisons were significantly different from each other ($P < .05$) except for models marked with [c], [d] and [e], and [f], which were similar to each other but significantly different from the rest.

models (82.6%) tended to deviate by at least 100 g over or under the actual birth weight (Figure 1B). More than 80% of sonographic fetal weight estimations calculated by most models were within 15% of actual birth weights, but only about 65% were within 10%. Model 9 by Woo et al[25] was the least accurate, with 27.1% of predictions within 15% of birth weight and 13.2% within 10%. The best were models 21 and 22 by Sabbagha et al,[29] with greater than 92% of predictions within 15% of actual birth weight and 78% within 10% ($P < .001$ compared to the other models). Overall, considering both systematic error, random error, and the percentage of estimates within 10% and 15% of actual birth weight, formulas that used 3 or more fetal measurements were more accurate than those using 1 or 2; formulas that used abdominal circumference only were next. All models except models 3, 11, 21, and 22 by Jordan,[20] Woo et al,[25] and Sabbagha et al[29] were more likely to generate a higher sonographic fetal weight estimation than the actual birth weight. The accuracy of each model for estimating a range of birth weights was evaluated. All models (except for model 19, which tended to overestimate all sonographic fetal weight estimations) were less accurate at extreme fetal weights, both small (<2000 g) and large (>4000 g) fetuses. Graphic representations of estimations of 4 of the models are depicted in Figure 3.

Nineteen (82.6%) of the models (all models except for 3, 11, 21, and 22) more accurately estimated actual birth weight within 10% when measurements were taken within 4 to 7 days before delivery than within 3 days ($P < .001$; Table 3). The percentage of predictions within 10% of actual birth weight reached 80% when model 22 by Sabbagha et al[29] was used 3 days or less before delivery.

Discussion

Intrauterine evaluation of fetal weight has major clinical importance. Fetal weight influences the management of both small-for-gestational-age fetuses and macrosomic ones. Estimated fetal weights affect the management of ongoing pregnancies and the timing and mode of delivery.

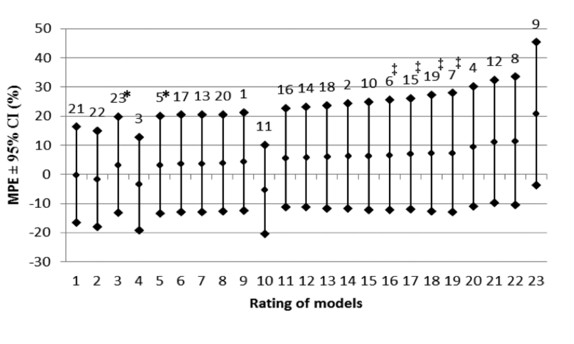
We tested almost 13,000 fetuses and compared the results of 23 sonographic fetal weight estimation models in predicting actual birth weights; in total, 294,354 results were compared to actual birth weights. Our findings show that models 21 and 22 by Sabbgha et al,[29] which incorporate gestational age into the equation, were the most accurate in our study population. Furthermore, we found that most models were more accurate in predicting fetal weight when applied 4 to 7 days before delivery.

It seems that no single model consistently predicts fetal weight accurately. The estimations calculated from most models predict within 10% of actual birth weights only 65% of the time. For most models, 80% of sonographic fetal weight estimations predicted within ±15% of birth weights. Some models had a tendency to overestimate fetal weight, whereas others tended to underestimate it; these results were statistically significant and allow better understanding of the specific formulas used by different institutions.

To our knowledge, this study is the largest cohort study to assess and compare the accuracy of sonographic fetal weight estimation models. We found greater accuracy for models that used 3 or more fetal biometrics, including femur length, abdominal circumference, biparietal diameter, and head circumference. Comparing estimations from

Figure 1. A, Mean percent error (MPE): deviation of sonographic fetal weight estimations from birth weight ± 95% confidence interval (CI), calculated as the difference between estimated and actual birth weights (percent) ± 1.96 × SD. Models were rated according to the absolute mean percent error value. All mean values were compared between each pair of models, and all were significant ($P < .05$) except for models marked * and ‡, which were significantly different from all other models but similar to each other. **B**, Deviation of sonographic fetal weight estimations from birth weights (grams) ± 95% CI, calculated as the mean difference between sonographic fetal weight estimations and actual birth weights (grams) ± 1.96 × SD. The model numbers refer to those listed in Tables 1–3.

A



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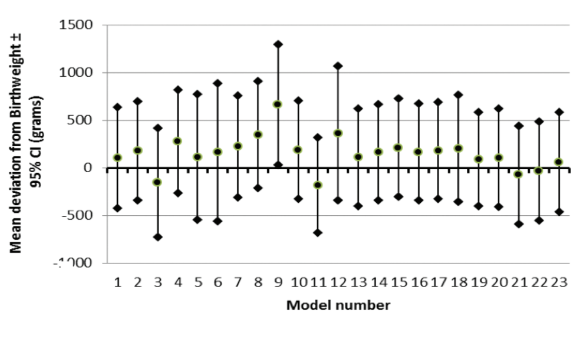


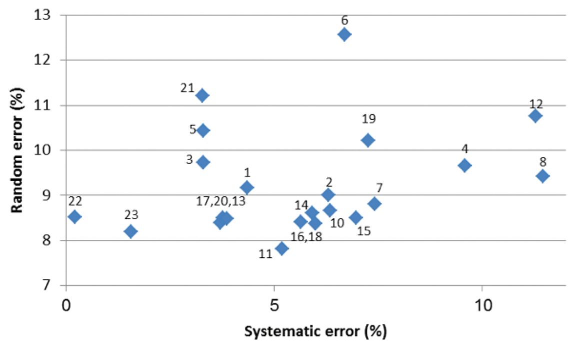
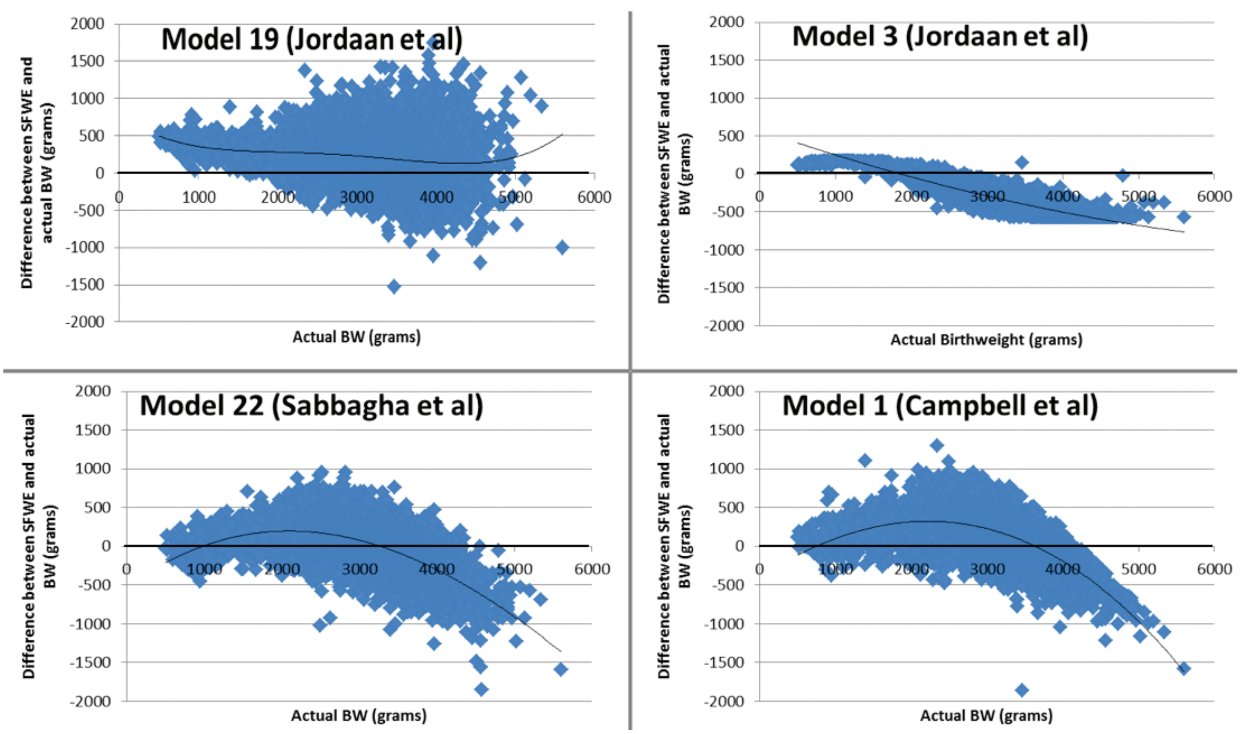


Figure 2. Division of models according to the systematic and random errors of the mean deviation of sonographic fetal weight estimation from actual birth weight. Models were plotted on the graph according to systematic error (absolute value) and random error. Model 9 was omitted from the graph because of a very high systematic error value of greater than 20%. Models based on abdominal circumference alone have low systematic errors but their random error is greater than 9%. The model numbers refer to those listed in Tables 1–3.

more than 3000 fetal measurements by means of 26 sonographic fetal weight estimation formulas, Melamed et al[5] reached the same conclusion. Models based on abdominal circumference alone were more accurate than models based on femur length, abdominal circumference + femur length, or abdominal circumference + biparietal diameter.

Although more pronounced in some models than in others, all models but one analyzed in this study showed a tendency for underestimation of small and overestimation of large fetuses. These findings support other studies.[4,13,31] In interpreting the result of a sonographic fetal weight estimation, a fetus estimated to be "small" should be expected to be smaller than the sonographic fetal weight estimation result, and a "large" fetus should be expected to be larger than the sonographic fetal weight estimation result.

Figure 3. Graphic representation of the accuracy of 4 sonographic fetal weight estimation models for a range of birth weights. The y-axis displays the difference (grams) between sonographic fetal weight estimation (SFWE) and birth weight (BW); the x-axis displays the actual birth weight, with a solid trend line computed for each model. All models have a tendency to overestimate low fetal weights between 1200 and 1800 g. The most pronounced overestimation of low birth weight is found in model 19 by Jordaan.[20] All models except model 19 tend to underestimate birth weight of greater than 4000 g; this tendency starts at weights of greater than 3500 g. Model 3 by Jordaan[20] has the most marked tendency for underestimating high birth weight. Model 22 by Sabbagha et al,[29] which is the most accurate model in our study population, similar to other accurate models such as model 1 by Campbell and Wilkin,[18] has the same inverse parabolic trend line.



We found that the timing of sonographic fetal weight estimation affects the accuracy of the estimation. For most models assessed, fetal weight estimations performed 4 to 7 days before delivery were more accurate than those performed 3 days or less before delivery. This finding was apparently not due to measurements of the fetal head, which could have been engaged in the pelvis, as it was also true in models that did not use fetal head measurements, but may have been due to a difficulty in obtaining accurate fetal measurements so close to delivery. Only models 3, 11, 21, and 22 suggested by Sabbagha et al,[29] Woo et al,[25] and Jordaan[20] showed improved accuracy when estimations were performed 0 to 3 days before delivery ($P < .001$).

This study had a number of limitations. Although we did not include all models for sonographic fetal weight estimation that have been published, we did evaluate the most common and popular ones. We only evaluated models that used fetal parameters and gestational age in their equations and did not include models that required pelvic examination at the time of estimation or such maternal characteristics as gestational diabetes status and maternal height and weight. Although estimations incorporating such parameters have also been shown to be accurate,[32,33] these data were not available in our computerized database. Another limitation arose from the use of weight estimation function coefficients from the literature, which produce differences in systematic errors that are not found if sample specific function coefficients are used.[34] Because fetal volumes were not recorded in our study population, we also did not include models involving 3-dimensional parameters, although these models, such as one involving partial thigh volume by Lee et al,[34] have given very accu-

Table 3. Accuracy of Different Sonographic Fetal Weight Estimation Models According to the Number of Days Estimations Were Calculated Before Delivery

Model	Source	Predictions (%) Within ±10% up to 3 d Before Delivery	Predictions (%) Within ±10% 4–7 d Before Delivery
AC			
1	Campbell and Wilkin[18]	70.0	72.3[a]
2	Hadlock et al[19]	63.5	69.6[a]
3	Jordaan[20]	69.9[a]	65.4
4	Warsof et al[21]	49.7	57.4[a]
5	Higginbottom et al[22]	64.6	68.0[a]
FL			
6	Warsof et al[23]	54.6	58.4[a]
AC/FDL			
7	Hadlock et al[24]	57.8	69.5[a]
8	Warsof et al[23]	40.3	55.1[a]
9	Woo et al[25]	10.9	19.9[a]
AC/BPD			
10	Hadlock et al[19]	62.5	71.0[a]
11	Woo et al[25]	73.1[a]	62.8
12	Vintzileos et al[26]	41.1	53.2[a]
AC/BPD/FL			
13	Woo et al[25]	72.0	77.0[a]
14	Shinozuka et al[27]	65.8	73.6[a]
15	Hadlock et al[24]	60.5	71.2[a]
AC/HC/FL			
16	Hadlock et al[24]	65.7	74.6[a]
17	Combs et al[28]	73.9	77.4[a]
AC/HC/BPD ± FL			
18	Hadlock et al[24]	64.9	74.1[a]
19	Jordaan[20]	60.3	67.7[a]
20	Hadlock et al[19]	72.3	76.5[a]
AC/HC/FL + GA			
21	Sabbagha et al[29]	**78.9[a]**	**75.5**
22	Sabbagha et al[29]	**80.1[a]**	**71.8**
23	Sabbagha et al[29]	74.9	76.0[a]

All results were statistically significant ($P < .001$). The best results in terms of validity are boldface. Abbreviations are as in Table 1.
[a]Timing for which each model was more accurate.

rate weight predictions. The models by Sabbagha et al[29] were designed for use in small-, appropriate-, and large-for-gestational-age fetuses. We did not assess the accuracy of each model according to each group but sought the accuracy in our whole cohort; nevertheless, these models proved very accurate.

In conclusion, different sonographic fetal weight estimation models present a wide range of results. We recommend that each center should examine and choose the most accurate model for its parturient population. The most suitable models for sonographic fetal weight estimation in our study population were 2 models developed by Sabbagha et al[29] Models based on 3 or more fetal biometric indices showed more accuracy in predicting birth weights. For 19 of the 23 models analyzed, fetal weight estimates were more accurate when calculated 4 to 7 days before delivery than within 3 days of delivery. Knowledge of the characteristics of and distinctions between sonographic fetal weight estimation models is important for their proper clinical use and interpretation.

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