Archives of Gynecology and Obstetrics (2019) 299:97–103
https://doi.org/10.1007/s00404-018-4934-y

MATERNAL-FETAL MEDICINE

Sonographic prediction of macrosomia in pregnancies complicated by maternal diabetes: finding the best formula

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Received: 14 August 2018 / Accepted: 4 October 2018 / Published online: 16 October 2018

Abstract

Purpose To evaluate the best performing formula for macrosomia prediction in pregnancies complicated by diabetes.

Methods A retrospective analysis was performed of 1060 sonographic fetal biometrical measurements performed within 7 days of delivery in term pregnancies (37–42 gestational weeks) complicated by diabetes. Sonographic prediction of macrosomia (≥ 4000, ≥ 4250, and ≥ 4500 g) was evaluated utilizing ten previously published formulas by: (1) calculating for each macrosomia threshold the sensitivity, specificity, positive and negative predictive value, and ± likelihood ratio for macrosomia prediction; (2) comparing the systematic and random error and the proportion of estimates < 10% of birth weights between macrosomic and non-macrosomic neonates. Best performing formula was determined based on Euclidean distance.

Results 97 (9.2%) macrosomic neonates (> 4000 g) were included. Median birth weight was 3380 (1866–3998) g for non-macrosomic and 4198 (4000–5180) g for macrosomic neonates. Higher macrosomia cutoff was associated with higher specificity and lower sensitivity. We found a considerable variation between formulas in different accuracy parameters. Hadlock's formula (1985), based on abdominal circumference, femur length, head circumference and biparietal diameter, had the shortest Euclidean distance, reflecting the highest accuracy.

Conclusion Prediction of macrosomia among women with diabetes differs significantly between formulas. In our cohort, the best performing formula for macrosomia prediction was Hadlock's formula (1985).

Keywords Macrosomia · Fetal weight estimation · Diabetes in pregnancy

Introduction

Sonographic fetal weight estimation (sEFW) is an important tool for the obstetrician during pregnancy follow-up and delivery planning. Available weight estimation formulas vary considerably in weight prediction depending on biometrical measurements that enter the formula and their coefficients. Despite abundance of literature, currently, no formula has been proved superior to the others.

Overall, sEFW has a reported standard deviation of errors of more than 7% [1]. Accuracy is especially challenged for the extreme weights—the small and the large for gestational age fetuses [2–4].

Prediction of fetal macrosomia is important for the decision of mode of delivery. In pregnancies complicated by maternal diabetes it is even more important as macrosomia is up to three times more frequent [5, 6] with higher rates of shoulder dystocia [7–10]. Altered distribution of body fat [11] stimulated by elevated fetal insulin and insulin growth-like factor levels [12, 13] is the commonly suggested explanation.

Previous studies on macrosomia prediction in the general population demonstrated overall low prediction rate. Phillips et al. [14] reported a 33% identification rate of macrosomia when sEFW was performed within 2 weeks prior to delivery.

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Melamed et al. [15] compared 21 formulas for sEFW and abdominal circumference (AC) as a single predictor for fetal macrosomia, and reported a considerable variation among the models in both sensitivity (range 13.6–98.5%) and specificity (range 63.6–99.8%). Other studies suggested that diabetes does not influence sonographic weight prediction; however, these studies included pregnancies with diet-controlled diabetes [16] and had small sample size, without focusing on macrosomia prediction [17–19].

Given the suggested differences in fetal proportions and the clinical importance of prediction of macrosomia in pregnancies complicated by diabetes, in this study, we aimed to determine the best performing sEFW formula for macrosomia prediction in pregnancies complicated by diabetes.

Materials and methods

A retrospective cohort study was performed of all women delivered in a single, tertiary, university affiliated medical center with sEFW performed within 7 days prior to delivery between July 1, 2007 and December 31, 2014. Inclusion criteria were live-birth, term (37–42 gestational weeks), singleton pregnancy, with maternal diabetes and absence of major malformations or chromosomal abnormalities. Both pre-gestational and gestational diabetes were included. We excluded women without documentation of all biometric measurements [biparietal diameter (BPD), head circumference (HC), femur length (FL) and abdominal circumference (AC)] or women that were in active labor or with ruptured membranes at the time of sonographic assessment. The study was approved by the local Institutional Review Board at Rabin Medical Center, Petah Tikva, Israel.

Data were retrieved from a computerized comprehensive database of sonographic examinations. Gestational age at the time of sonographic evaluation was calculated by the last menstrual period or by first trimester ultrasound if discrepancy between them exceeded 7 days. sEFWs included all standard fetal biometry measurements (AC, FL, BPD and HC), presenting part, placental location and amniotic fluid estimation. The examinations were performed trans-abdominally using a high-quality ultrasound system (Voluson E8 and Voluson 730 Expert, GE Medical Systems, Zipf, Austria and ATL 5000, Philips Healthcare, Eindhoven, The Netherland) by senior physicians who were ultrasound specialists or by experienced ultrasound technicians. In the latter case, examinations were reviewed by a specialized physician.

The BPD was measured from the proximal echo of the fetal skull to the proximal edge of the deep border (outer–inner) at the level of the cavum septum pellucidum. The HC was measured as an ellipse around the perimeter of the fetal skull at the same level [20]. The AC was measured in the transverse plane of the fetal abdomen at the level of the umbilical vein in the anterior third and the stomach bubble in the same plane; measurements were taken around the perimeter [21]. The FL was measured in a view in which the full femoral diaphysis is seen and is taken from one end of the diaphysis to the other, not including the distal femoral epiphysis [22].

Antenatal data, gestational age at delivery and actual birth weights were obtained from the perinatal database.

For each sonographic examination, EFW was calculated using ten sonographic fetal weight estimation formulas previously published in the literature [23–28] (Table 1). The formulas differed in the biometrical measurements included and their coefficients (Table 1).

The accuracy of each of the ten sEFW formulas for macrosomia prediction was evaluated using the following measures of accuracy: sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), positive likelihood ratio (+LR, defined as sensitivity/(1 − specificity)) and negative likelihood ratio (− LR, defined as (1 − sensitivity)/specificity). Overall accuracy was defined as (true negative + true positive cases)/all cases.

Table 1 Sonographic fetal weight estimation formulas

Formula#	Reference	Equation	
1	Hadlock et al. [23]	$=10^{1.304+0.05281(AC)+0.1938(FL)-0.004(AC)(FL)}$	AC and FL
2	Hadlock et al. [23]	$=10^{1.335-0.0034(AC)(FL)+0.0316(BPD)+0.0457(AC)+0.1623(FL)}$	AC, FL and BPD
3	Hadlock et al. [26]	$=10^{1.1134+0.05845(AC)-0.000604(AC)2-0.007365(BPD)2+0.000595(BPD)(AC)+0.1694(BPD)}$	AC and BPD
4	Jordaan [25]	$=10^{0.9119+0.488(HC)+0.0824(AC)-0.001599(HC)(AC)}$	AC and HC
5	Hadlock et al. [23]	$=10^{1.326-0.00326(AC)(FL)+0.0107(HC)+0.0438(AC)+0.158(FL)}$	AC, FL and HC
6	Hsieh et al. [27]	$=10^{2.1315+0.0056541(AC)(BPD)-0.00015515(BPD)(AC)2+0.000019782(AC)3+0.052594(BPD)}$	AC and BPD
7	Shepard et al. [24]	$=10^{-1.7492+0.166(BPD)+0.046(AC)-0.002546(AC)(BPD)}$	AC and BPD
8	Jordaan [25]	$=10^{-1.1683+0.0377(AC)+0.0950(BPD)-0.0015(BPD)(AC)}$	AC and BPD
9	Hadlock et al. [23]	$=10^{1.3596+0.0064(HC)+0.0424(AC)+0.174(FL)+0.00061(BPD)(AC)-0.00386(AC)(FL)}$	AC, FL, BPD and HC
10	Shinozuka et al. [28]	$=0.23966(AC)2(FL)+1.6230(BPD)3$	AC, FL and BPD

AC abdominal circumference, *HC* head circumference, *BPD* biparietal diameter, *FL* femur length

Systematic error (calculated as the (EFW − birth weight)/birth weight × 100, reflecting the systematic deviation of the formula from the actual birth weight, expressed as the percentage of the actual birth weight), random error (standard deviation of the systematic error), reflecting the random component of prediction error, and the proportion of estimates under 10% of the actual birth weight were calculated for every formula and compared between the macrosomic and non-macrosomic neonates. Ranking of the ten formulas for "best" macrosomia prediction sEFW formula in pregnancies complicated by maternal diabetes was determined by calculating the Euclidean distance [sqrt (systematic error^2 + random error^2)] which represents the geometric average of the systematic and random error.

Since the definition of fetal macrosomia differs according to national guidelines, we established three birth weight thresholds by which we assessed the sEFW formulas: 4000 g, 4250 g and 4500 g.

Data analysis was performed using SPSS version 15.0 software (SPSS, Inc., Chicago, IL, USA). $P < 0.05$ was considered significant. Categorical data were analyzed using Fisher's exact test and continuous variables were compared using Mann–Whitney–Wilcoxon test as appropriate.

Results

Overall, 62,102 women with singleton gestation delivered in our institution during the study period, of which 7,977 had fetal weight estimation performed within 7 days from delivery. Of these women, 1060 had a diagnosis of maternal diabetes and were eligible for our analysis. Nine-hundred and fifty-four (90%) of these women had gestational diabetes, 54 (5.1%) had type 2 diabetes and the remaining 52 (4.9%) had type 1 diabetes. Eight (0.8%), 39 (3.7%) and 97 (9.2%) neonates had birth weights equal or greater than 4500, 4250 or 4000 g, respectively.

Demographic and obstetrical characteristics of the cohort are shown in Table 2. Maternal age and nulliparity rate did not differ significantly between women with macrosomic (≥ 4000 g) and non-macrosomic fetuses. Within the 7-day period in which all sEFW were performed, a greater proportion of macrosomic fetuses underwent a more recent sEFW (up to 3 days prior to delivery), compared with non-macrosomic fetuses ($p = 0.021$). Gestational age at delivery, as well as fetal gender, was similar. However, polyhydramnios was significantly more prevalent among macrosomic fetuses ($p = 0.007$). Moreover, 73.2% of the macrosomic fetuses were delivered by cesarean delivery (CD), whereas only 27.7% of the non-macrosomic fetuses were delivered by CD ($p < 0.0001$).

Tables 3, 4 and 5 demonstrate the accuracy parameters for the formulas, according to macrosomia cutoff (≥ 4000, ≥ 4250, and ≥ 4500 g). The median sensitivity for all formulas was highest for a 4000 g cutoff (51.6, 20.6–81.4) and lowest for 4500 g cutoff (25, 0–75), whereas median specificity was highest for 4500 g cutoff (98.9, 94.8–99.9) and lowest for 4000 g cutoff (92.5, 76.6–97.1) [median (%), range]. While PPV showed considerable variation between the formulas [(41.1, 15.8–52.5), (46.8, 5.4–88.9), and (11.8, 0–28.6), for ≥ 4000 g, ≥ 4250 g, and ≥ 4500 g, respectively, (median, range(%))], the NPV was relatively high for all formulas in all three cutoff points, with a median of 95.0 (91.8–97.6) for a ≥ 4000 g cutoff, 97.9 (96.4–98.8) for ≥ 4250 g cutoff, and 99.4 (99.2–99.8) for ≥ 4500 g cutoff [median (%), range]. Considerable inter-formula as well as inter-cutoff variation was seen in the +LR, with values ranging 1.87–10.99 (median of 7.04) for the ≥ 4000 g cutoff, 1.5–209.44 (median of 23.28) for the ≥ 4250 g cutoff and 0–52.6 (median of 17.61) for the ≥ 4500 g cutoff. On the other hand, − LR demonstrated mild inter-formula and inter-cutoff variation, with a median of 0.53 (0.24–0.89) for the ≥ 4000 g cutoff, 0.56 (0.32–0.98) for the ≥ 4250 g cutoff and 0.75 (0.26–1.01) for the ≥ 4500 g cutoff.

Overall accuracy was highest for all formulas in the ≥ 4500 g cutoff, and lowest for the ≥ 4000 g cutoff (88.8 vs. 96.0 vs. 98.3 for ≥ 4000, ≥ 4250, and ≥ 4500 g, respectively).

Systematic error, as well as the random error, varied greatly between the formulas, ranging from 4.81% to 11.58% (SE), and 4.52–14.39% (RE). Formula 9, based on AC, FL, BPD and HC [23], had the lowest systematic error (4.81%), while Formula 1, based on FL and AC [23], had the highest systematic error (11.58%) (Table 6).

Table 2 Demographic and Obstetrical characteristics of study population stratified by macrosomia (≥ 4000 g) at birth

	Macrosomia (4000 g) $N = 97$ (9.15%)	Non-macrosomia, $N = 963$ (90.84%)	p value
Maternal age (years)	33 (21–43.8)	32.9 (20–46.4)	0.740
Nulliparity	30 (30.9%)	345(35.8%)	0.374
Ultrasound to delivery interval (days)			
1–3	81 (83.5%)	700 (72.7%)	0.021
4–7	16 (16.5%)	263 (27.3%)	
Polyhydramnios	13 (13.4%)	54 (5.6%)	0.007
Delivery data			
GA at delivery (weeks)	38 (37–41)	38 (37–41)	0.854
Birth weight (g)	4198 (4000–5180)	3380 (1866–3998)	0.000
Gender (male)	59 (60.8%)	510 (53%)	0.165
Cesarean section	71 (73.2%)	267 (27.7%)	0.000

GA gestational age

[a]Continuous variables are presented as median (range)

[b]Categorical values are *n* (%)

Table 3 Accuracy of fetal weight estimation formulas for prediction of LGA ≥ 4000 g at birth

Number	Formula	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	+LR	−LR	Accuracy
1	Hadlock et al. [23]	20.62	88.99	15.87	91.76	1.87	0.89	82.74
2	Hadlock et al. [23]	77.55	87.12	38	97.44	6.02	0.26	86.24
3	Hadlock et al. [26]	49.48	92.42	39.67	94.78	6.53	0.55	88.49
4	Jordaan [25]	62.89	90.13	39.1	96.02	6.37	0.41	87.64
5	Hadlock et al. [23]	45.36	95.64	51.16	94.56	10.4	0.57	91.04
6	Hsieh et al. [27]	55.67	92.63	43.2	95.4	7.55	0.48	89.25
7	Shepard et al. [24]	81.44	76.64	25.99	97.62	3.49	0.24	77.08
8	Jordaan [25]	53.61	93.25	44.44	95.23	7.94	0.5	89.62
9	Hadlock et al. [23]	46.39	94.60	46.39	94.6	8.59	0.57	90.19
10	Shinozuka et al. [28]	31.96	97.09	52.54	93.41	10.99	0.7	91.13
Median		51.55	92.53	41.44	95.01	7.04	0.53	88.87

PPV positive predictive value, *NPV* negative predictive value, *overall accuracy* (true positive + true negative)/total evaluations, + *LR* positive likelihood ratio, − *LR* negative likelihood ratio

Table 4 Accuracy of fetal weight estimation formulas for prediction of LGA ≥ 4250 g at birth

Number	Formula	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	+LR	− LR	Accuracy
1	Hadlock et al. [23]	5.13	96.57	5.41	96.38	1.5	0.98	93.21
2	Hadlock et al. [23]	53.85	95	29.17	98.18	10.78	0.49	93.49
3	Hadlock et al. [26]	41.03	99.22	66.67	97.78	52.36	0.59	97.08
4	Jordaan [22]	56.41	96.08	35.48	98.3	14.4	0.45	94.62
5	Hadlock et al. [23]	35.9	99.51	73.68	97.6	73.3	0.64	97.17
6	Hsieh et al. [27]	48.72	97.45	42.22	98.03	19.13	0.53	95.66
7	Shepard et al. [24]	71.79	87.56	18.06	98.78	5.77	0.32	86.98
8	Jordaan [25]	48.72	98.25	51.35	98.04	27.63	0.52	96.42
9	Hadlock et al. [23]	35.9	99.41	76	97.6	61.08	0.64	97.08
10	Shinozuka et al. [28]	20.51	99.9	88.89	97.05	209.44	0.8	96.98
Median		44.87	97.84	46.78	97.90	23.38	0.56	96.04

PPV positive predictive value, *NPV* negative predictive value, *overall accuracy* (true positive + true negative)/total evaluations, +LR positive likelihood ratio, *LR* negative likelihood ratio

Table 5 Accuracy of fetal weight estimation formulas for prediction of LGA ≥ 4500 g at birth

Number	Formula	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	+LR	−LR	Accuracy
1	Hadlock et al. [23]	0	98.67	0	99.24	0	1.01	97.92
2	Hadlock et al. [23]	62.5	98.48	23.81	99.71	41.09	0.38	98.21
3	Hadlock et al. [26]	25	99.52	28.57	99.43	52.6	0.75	98.96
4	Jordaan [25]	37.5	97.72	11.11	99.52	16.44	0.64	97.26
5	Hadlock et al. [23]	0	99.14	0	99.24	0	1.01	98.4
6	Hsieh et al. [27]	25	98.67	12.5	99.43	18.79	0.76	98.11
7	Shepard et al. [24]	75	94.77	9.84	99.8	14.35	0.26	94.62
8	Jordaan [25]	25	99.14	18.18	99.43	29.19	0.76	98.58
9	Hadlock et al. [23]	25	99.43	25	99.43	43.83	0.75	98.87
10	Shinozuka et al. [28]	0	99.9	0	99.24	0	1	99.15
Median		25	98.90	11.80	99.4	17.61	0.75	98.30

PPV positive predictive value, *NPV* negative predictive value, *overall accuracy* (true positive + true negative)/total evaluations, + *LR* positive likelihood ratio, − *LR* negative likelihood ratio

Table 6 Accuracy measurements for all formulas according to systematic error, random error and proportion of estimates < 10%

Number	Formula	SE	RE	POE < 10%
1	Hadlock et al. [23]	11.58	14.39	43.96
2	Hadlock et al. [23]	6.61	5.65	74.05
3	Hadlock et al. [26]	5.48	4.93	79.81
4	Jordaan [25]	6.07	6.21	72.16
5	Hadlock et al. [23]	4.87	4.55	82.64
6	Hsieh et al. [27]	5.37	4.98	80.28
7	Shepard et al. [24]	9.02	6.99	58.67
8	Jordaan [25]	5.22	4.79	82.07
9	Hadlock et al. [23]	4.81	4.52	82.45
10	Shinozuka et al. [28]	4.92	4.63	82.73

SE systematic error, *RE* random error, *POE* < 10% proportion of estimates within 10% of actual birth weight

Overall, the proportion of sEFW within 10% of actual birthweight was highest for formula 10, based on AC, BPD and FL [28] (82.73%), nearly twice than that of formula 1 [23] (43.96%).

The Euclidean distance for all formulas is presented in Table 7. Formula 9, by Hadlock et al. [23], incorporating AC, FL, HC and BPD biometrical measurements, had the shortest Euclidean distance, corresponding to best prediction performance for macrosomia at birth.

Discussion

In this study, we aimed to evaluate the best performing formula for macrosomia prediction in pregnancies complicated by diabetes. Macrosomia was defined at three different cutoffs: 4000, 4250 and 4500 g, as accepted by different guidelines. We found considerable variation between the formulas in the different accuracy parameters, including the +LR, -LR, PPV, POE < 10%, SE and RE. We also found an inverse relation between specificity and sensitivity of the sEFW formulas for the three cutoffs we defined: the higher the birth weight cutoff, the higher is the specificity and the lower the sensitivity. Formula no. 9 (Hadlock et al. (1985) [23]) incorporating AC, BPD, HC and FL had the shortest Euclidean distance, reflecting the highest accuracy for macrosomia prediction in pregnancies complicated by diabetes.

Various studies have shown that two-dimensional ultrasound has a relatively low prediction rate for macrosomia [14, 15]. In pregnancies complicated by diabetes, in which the clinical significance is even higher compared to the non-diabetic pregnancies, the accuracy of sEFW of macrosomic fetuses may be even lower. Sonographic EFW formulas are constructed based on fetal biometrical measurements and their coefficients, usually from unselected population, mostly non-diabetic. Fetuses of pregnancies complicated by diabetes, especially the macrosomic ones, have different distribution of the fetal fat [12, 13] reflected by altered biometrical proportions and therefore may be subjected to even higher prediction weight error.

We found that higher birth weight of macrosomic babies in pregnancies complicated by diabetes was associated with a lower sensitivity of sEFW prior to delivery, and a higher specificity. This finding implies that the ability of the sEFW formulas to detect macrosomia is lower as the birth weight rises. This is not surprising. Previous studies found the accepted two-dimensional sEFW formulas to be less accurate in macrosomic fetuses. Faschingbauer et al. [29]. compared ten sEFW formulas for prediction of extreme macrosomia (≥ 4500 g). They concluded no single formula was accurate enough for the prediction of extreme macrosomia, with substantial mean percentage error in all formulas. Hoopmann et al. [30] compared the accuracy of 36 commonly used sEFW formulas in macrosomic fetuses.

Table 7 Ranking of formulas for LGA prediction

Ranking[a]	Number	Formula	Biometry	Euclidean distance
1	9	Hadlock et al. [23]	AC, FL, BPD and HC	6.60
2	5	Hadlock et al. [23]	AC, FL and HC	6.66
3	10	Shinozuka et al. [28]	AC, FL and BPD	6.76
4	8	Jordaan [25]	AC and BPD	7.08
5	6	Hsieh et al. [27]	AC and BPD	7.32
6	3	Hadlock et al. [26]	AC and BPD	7.37
7	4	Jordaan [25]	AC and HC	8.68
8	2	Hadlock et al. [23]	AC, FL and BPD	8.70
9	7	Shepard et al. [24]	AC and BPD	11.41
10	1	Hadlock et al. [23]	AC and FL	18.47

AC abdominal circumference, *FL* femur length, *BPD* biparietal diameter, *HC* head circumference

[a]Ranking of large for gestational age prediction accuracy by the Euclidean distance. Formulas are presented from the best formula (designated as "1") to the worst (designated as "10")

They calculated SE and RE, as well as POE < 5%, 10%, 20% and 30%. The authors concluded that none of the formulas reached an acceptable detection and false positive rate in screening for fetuses ≥ 4500 g that could lead to clinical recommendation.

We also found considerable variation between the formulas in the different accuracy parameters, including the +LR, − LR, PPV, POE < 10%, SE and RE. No single formula received high scores in all, or most, accuracy indices. Obviously, this suggests that no sEFW formula is ideal for macrosomia prediction. However, calculation of the Euclidean distance revealed shortest distance for the Hadlock formula (1985) [23]. This formula was the only formula in our study composed of four biometrical measurements (AC, FL, BPD, HC). In general, Euclidean distance was shorter for formulas incorporating more biometrical measurements, with the exception of formula 2 [23]. Formulas incorporating two biometrical measurements had longer Euclidean distance, reflecting less accuracy.

Limited number of studies evaluated sonographic weight prediction in pregnancies complicated by maternal diabetes. Most of them focused on comparison to non-diabetic pregnancies demonstrating similar accuracy [18, 19]. Valent et al. [31]. evaluated the accuracy and signed percent error between pregnancies with and without diabetes. Their cohort included women after 34 gestational weeks with sEFW evaluation within 2 weeks from delivery. Their results demonstrated higher delta weights among the diabetic pregnancies with similar percent error between groups. The overall sensitivity for macrosomia prediction was poor (62% for diabetic groups) with high specificity (99% for the diabetic group). Our study focused on the diabetic population only, with median sensitivity and specificity of 51.5% and 92.5% for all formulas, respectively. For our best formula [23], values were 46.4% and 94.6%, respectively. Unlike Valent et al.'s study, our study included only term pregnancies with sEFW within 1 week from delivery. Also, their results were based on smaller sample size group (316 diabetic pregnancies).

The strengths of our study lie in the large cohort evaluated, the various formulas combined by shared biometrical measurements and the three different thresholds from 4000 to 4500 g used. Also, all sEFW were performed in a single center, by either senior physicians who are ultrasound specialists, or by experienced ultrasound technicians and reviewed by a specialized physician.

However, it has several limitations. First, it is limited by its retrospective design. For that reason, we had no data on women's body mass index (BMI), demographic and ethnic origin, etc. Second, we examined only ten sEFW formulas. We chose these formulas since they are commonly used in practice. However, many other formulas exist, and one of these may be superior to the formulas we examined for recognition of macrosomia in diabetic women. Another important limitation of our study is the lack of detailed information on the different types of diabetes (pre-gestational and gestational) included in the cohort and the level of glycemic control.

We utilized different statistical methods for accuracy assessment and concluded that Hadlock's formula [23] was the best of all ten formulas included in our study, based on its shortest Euclidean distance. However, this statistical method is not necessarily more accurate than other methods, such as Cronbach's alpha.

The importance of identification of true macrosomia (≥ 4000 g) in pregnancies complicated by diabetes cannot be over emphasized. As new imaging technologies arise and three-dimensional ultrasound improves our ability to assess soft tissue volume, we expect to highly improve the accuracy of true macrosomia recognition [32]. However, these technologies are not commonly used yet, and two-dimensional ultrasound continues to be the accepted mode for sEFW. For that reason, recognition of the best performing two-dimensional sEFW formula for macrosomic fetuses is important.

Our study suggests that using the Hadlock formula [23] for weight estimation of suspected macrosomic fetuses in pregnancies complicated by diabetes may increase the accuracy of the fetal weight estimation and improve our ability to provide better consultation regarding the preferred mode and timing of delivery.

Author contribution AS: data collection and management, manuscript writing and editing, data analysis. LS: protocol development, manuscript editing. EH: protocol development, data management. A. Aviram: data collection and management, data analysis. RB: project development, data collection, manuscript editing. EA: project development, data collection. RG-B: project development, data collection, data analysis, manuscript editing.

Funding None.

Compliance with ethical standards

Conflict of interest None.

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