Check for updates

*Ultrasound Obstet Gynecol* 2023; **62**: 821–828
Published online in Wiley Online Library (wileyonlinelibrary.com). **DOI:** 10.1002/uog.26277.
This is an open access article under the terms of the Creative Commons Attribution License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.

# Accuracy of sonographic fetal weight estimation and prediction of birth-weight discordance in twin pregnancy: large single-center study

H. ROSEN[1,2], Y. GOLD-ZAMIR[1], M. LOPIAN[1], T. WEISSBACH[2,3], E. KASSIF[2,3] and B. WEISZ[2,3]

[1]*Department of Obstetrics and Gynecology, Mayanei Hayeshua Medical Center, Bnei Brak, Israel;* [2]*Sackler Faculty of Medicine, Tel Aviv University, Tel Aviv, Israel;* [3]*Institute of Obstetrical and Gynecological Imaging, Department of Obstetrics and Gynecology, Sheba Medical Center, Tel Hashomer, Israel*

**KEYWORDS:** birth weight; estimated fetal weight; intertwin discordance; twins; ultrasound

## CONTRIBUTION

*What are the novel findings of this work?*
We investigated the accuracy of sonographic fetal weight estimation and prediction of birth-weight (BW) discordance in twin pregnancy, with respect to previously unaddressed parameters. We found a strong correlation between estimated fetal weight (EFW) and BW of both twins when assessed within 1 week before delivery. Accuracy was diminished for the non-presenting cotwin, the smaller cotwin and for the presenting cotwin in cases of prelabor rupture of membranes. Accuracy was increased with advancing gestational age and was not affected by fetal gender, chorionicity, maternal body mass index or diabetes. Most EFWs were overestimated, particularly for the non-presenting cotwin. Evaluation of BW discordance indicated high specificity but moderate sensitivity.

*What are the clinical implications of this work?*
Incorporating various maternal and fetal characteristics may increase the precision of EFW formulae and prediction of BW discordance in twin pregnancy. Accurate estimation of BW discordance and fetal growth restriction is imperative for the management and delivery of mono- and dichorionic twin pregnancies. Sonographic estimation of discordance when the presenting cotwin is smaller is limited, and this should be considered when determining the optimal mode of delivery.

## ABSTRACT

***Objectives*** *To determine the accuracy of sonographic fetal weight estimation in predicting birth weight (BW) and BW discordance in twin gestations, and to evaluate maternal and fetal characteristics that may affect the accuracy of this assessment.*

***Methods*** *This was a retrospective cohort study of all twins delivered at a single tertiary medical center between 2010 and 2021. Twin gestations for which sonographic estimation of fetal weight was performed within the week preceding delivery were included. Statistical analysis was performed to evaluate the strength of the correlation between sonographic estimated fetal weight (EFW) and BW, and to determine the impact of maternal and fetal factors on the accuracy of sonographic estimation.*

***Results*** *The study included 2154 twin pregnancies. There was a strong correlation between sonographic EFW and corresponding BW for all twins (*$r = 0.922$*;* $P < 0.001$*). Strong correlations were observed for both the presenting and non-presenting cotwin (*$r = 0.921$ *and* $r = 0.922$*, respectively; both* $P < 0.001$*), as well as the larger and smaller cotwin (*$r = 0.928$ *and* $r = 0.934$*, respectively; both* $P < 0.001$*). The overall mean ± SD absolute error of sonographic EFW was 7.41 ± 6.81%. This error was greater for the non-presenting cotwin compared with the presenting cotwin (7.99 ± 6.12% vs 7.17 ± 5.64%;* $P < 0.001$*), and for the smaller cotwin compared with the larger cotwin (8.56 ± 7.50% vs 6.58 ± 5.47%;* $P < 0.001$*). Advanced gestational age at scanning was correlated inversely with the mean absolute error of sonographic EFW. Multivariate logistic regression indicated that an earlier gestational age at scanning, being the non-presenting cotwin and being the smaller cotwin were independent risk factors for sonographic EFW inaccuracy. Pregnancies in which the presenting twin was estimated to be the smaller cotwin had twice the rate of*

*Correspondence to:* Dr H. Rosen, Mayanei Hayeshua Medical Center, 17 Povarsky Street, Bnei Brak, Israel (e-mail: rosenhadar@gmail.com)

*Accepted: 16 May 2023*

© 2023 The Authors. *Ultrasound in Obstetrics & Gynecology* published by John Wiley & Sons Ltd on behalf of International Society of Ultrasound in Obstetrics and Gynecology.

*false-positive BW discordance compared with pregnancies in which the presenting twin was estimated to be the larger cotwin (36.0% vs 13.0% for BW discordance > 15%, 35.0% vs 17.0% for BW discordance > 20% and 37.7% vs 12.1% for BW discordance > 25%; all P < 0.001). The error in sonographic EFW discordance was not related to chorionicity, the position of the presenting fetus or gestational age at the time of fetal weight estimation.*

***Conclusions*** *Sonographic estimation of fetal weight within 7 days before delivery accurately predicts BW in twin pregnancy. Sonographic EFW accuracy is reduced for the non-presenting twin, the smaller cotwin and when delivery occurs at an earlier gestational age. Sonographic estimation of fetal weight discordance is less accurate when the presenting twin is the smaller cotwin.* © *2023 The Authors. Ultrasound in Obstetrics & Gynecology published by John Wiley & Sons Ltd on behalf of International Society of Ultrasound in Obstetrics and Gynecology.*

## INTRODUCTION

Twin gestation represents approximately 3% of births in the USA[1] and is associated with an increased risk of perinatal morbidity and mortality. This is due mainly to higher rates of fetal growth restriction and preterm labor[1,2]. Small-for-gestational age (SGA) is defined as an estimated fetal weight (EFW) below the 10$^{th}$ percentile and complicates up to 30% of twin gestations[3–5]. Contrary to singleton gestation, evaluation of growth in twins is performed not only by comparison with published growth charts, but also by comparing growth between cotwins. Intertwin EFW discordance is calculated as the difference in estimated weights of the cotwins divided by the estimated weight of the larger twin.

The mechanisms underlying intertwin discordance have yet to be elucidated. Proposed theories include individual constitutional factors, adaptive processes, genetic aberrations, discordance in placental function, or a combination of some or all of the above[6,7]. Regardless of its pathogenesis, intertwin discordance has been reported to be an independent risk factor for complications such as preterm labor, stillbirth and short-term adverse neonatal outcome in both mono- and dichorionic twins[3,8–13].

Furthermore, the assessment of intertwin discordance is imperative when considering the mode of delivery in twin gestation, particularly when the non-presenting twin is estimated to be larger and when the non-presenting twin is non-vertex. As a result, sonographic evaluation of intertwin discordance has become an integral part of assessing the growth and wellbeing of twins[14]. However, data are sparse regarding the accuracy of sonographic fetal weight estimation and evaluation of discordance in twin gestation. The aims of this study were to assess the accuracy of sonographic estimation of fetal weight and prediction of birth-weight (BW) discordance in twin pregnancy, and to evaluate maternal and fetal factors that may influence the accuracy of this assessment.

## METHODS

This was a retrospective cohort study of all twin gestations delivered at a single tertiary medical center between January 2010 and December 2021. Exclusion criteria were: (i) pregnancy that ended prior to 24 weeks' gestation; (ii) pregnancy complicated by double or single intrauterine fetal demise; (iii) monoamniotic twin pregnancy; and (iv) cases in which sonographic estimation of fetal weight was performed more than 7 days prior to delivery. The study was approved by the institutional ethics committee at our center (SMC 5345-18).

### Fetal biometric measurements

All ultrasound biometric measurements were performed at our tertiary fetal ultrasound unit by either certified sonographers or fetal medicine specialists. The standardized fetal weight estimation method used in our unit is the Hadlock 4 regression formula, which incorporates biparietal diameter, head circumference, abdominal circumference and femur length[15]. The terms larger cotwin and smaller cotwin refer to the fetus with higher and lower EFW, respectively. SGA and large-for-gestational age (LGA) were defined as EFW < 10$^{th}$ percentile and EFW > 90$^{th}$ percentile, respectively.

### Definition of fetal weight estimation errors

Absolute fetal weight estimation error (%) was calculated using the formula: ((BW − sonographic EFW)/BW) × 100. Directional fetal weight estimation error (%) was given by the same formula, but considering the directional sign of the result: a positive result indicated that the BW was greater than the EFW and *vice versa*.

### Maternal parameters

Maternal height and prepregnancy weight were recorded. Prepregnancy body mass index (BMI) was calculated as the prepregnancy weight in kg divided by the squared height in m. We also calculated delivery BMI using the weight at delivery admission in kg divided by the squared height in m.

Diagnosis of maternal diabetes, either pregestational or gestational, was evaluated. In our institution, gestational diabetes is diagnosed when there is at least one abnormal value result in a 100-g glucose-tolerance test after 24 weeks' gestation, and women with pregestational diabetes are considered those with Type-1 or Type-2 diabetes mellitus diagnosed before pregnancy.

Demographic and clinical data were obtained from hospital computerized medical records.

### Statistical analysis

Statistical analysis was conducted using IBM SPSS version 25 (IBM Corp., Armonk, NY, USA). Normality of data was tested using the Shapiro–Wilk test or the

© 2023 The Authors. *Ultrasound in Obstetrics & Gynecology* published by John Wiley & Sons Ltd on behalf of International Society of Ultrasound in Obstetrics and Gynecology.


14690705, 2023, 6, Downloaded from https://obgyn.onlinelibrary.wiley.com/doi/10.1002/uog.26277 by Cochrane Israel, Wiley Online Library on [16/05/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Kolmogorov–Smirnov test. Data are presented as *n* (%) or mean ± SD, as appropriate. Bivariate correlation was evaluated using Pearson's correlation coefficient. Comparison of two unrelated continuous variables was conducted with Student's *t*-test or the Mann–Whitney *U*-test, as appropriate. Comparison of more than two variables was performed using ANOVA. The chi-square test and Fisher's exact test were used for comparison of categorical variables. When univariate evaluation determined significance, multivariate correlation analysis was performed. Significance was determined at $P < 0.05$.

## RESULTS

Overall, 2154 twin gestations were included in this study, of which 1740 (80.8%) were dichorionic and 414 (19.2%) were monochorionic. The mean ± SD gestational age at delivery was 35 + 3 ± 2 + 2 weeks. Background demographic characteristics for di- and monochorionic pregnancies are presented in Table 1.

**Table 1** Demographic, clinical and pregnancy characteristics of 2154 twin gestations, according to chorionicity

| *Characteristic* | *DC twins* (n = *1740*) | *MC twins* (n = *414*) | P |
|---|---|---|---|
| Maternal age (years) | 33.3 ± 5.4 | 31.5 ± 5.3 | 0.001 |
| Prepregnancy BMI (kg/m$^2$) | 23.7 ± 4.8 | 22.8 ± 4.9 | 0.004 |
| BMI at delivery (kg/m$^2$) | 29.8 ± 4.8 | 29.0 ± 4.9 | 0.001 |
| Spontaneous conception | 609 (35.0) | 332 (80.2) | < 0.001 |
| Gestational diabetes | 276 (15.9) | 48 (11.6) | 0.032 |
| Pregestational DM | 9 (0.5) | 5 (1.2) | 0.287 |
| GA at delivery (weeks) | 36 + 2 ± 2 + 2 | 34 + 5 ± 2 + 3 | < 0.001 |

Data are given as mean ± SD or *n* (%). BMI, body mass index; DC, dichorionic; DM, diabetes mellitus; GA, gestational age; MC, monochorionic.

### Correlation between sonographic EFW and BW

Sonographic estimation of fetal weight was performed within 7 days before delivery (median, 2 (range, 0–7) days). Sonographic EFW correlated significantly with BW for both the presenting and non-presenting cotwin ($r = 0.921$ ($P < 0.001$) and $r = 0.922$ ($P < 0.001$), respectively) (Figure 1). There was a significant correlation between sonographic EFW and BW for both the larger and smaller cotwin ($r = 0.928$ ($P < 0.001$) and $r = 0.934$ ($P < 0.001$), respectively). Chorionicity did not affect the strength of correlation between sonographic EFW and BW for the presenting and non-presenting cotwin (dichorionic: $r = 0.916$ ($P < 0.001$) and $r = 0.920$ ($P < 0.001$), respectively; monochorionic: $r = 0.922$ ($P < 0.001$) and $r = 0.915$ ($P < 0.001$), respectively), nor for that of the larger and smaller cotwin (dichorionic: $r = 0.916$ ($P < 0.001$) and $r = 0.920$ ($P < 0.001$), respectively; monochorionic: $r = 0.922$ ($P < 0.001$) and $r = 0.915$ ($P < 0.001$), respectively).

### Factors affecting accuracy of EFW

The overall mean ± SD absolute error of sonographic EFW was 7.41 ± 6.81%.

#### *Fetal factors*

Sonographic EFW error was analyzed according to the following fetal characteristics:

*Sonographic EFW error according to presentation status*. The mean absolute error for the non-presenting cotwin was higher compared with that for the presenting cotwin (7.99 ± 6.12% *vs* 7.17 ± 5.64%; $P < 0.001$). Likewise, non-presenting twins had higher rates (around 1.5-fold) of mean absolute error > 10%, > 15% and > 20% compared with their presenting counterparts (Table 2).

*Sonographic EFW error according to fetal size*. The mean absolute error for the smaller cotwin was higher

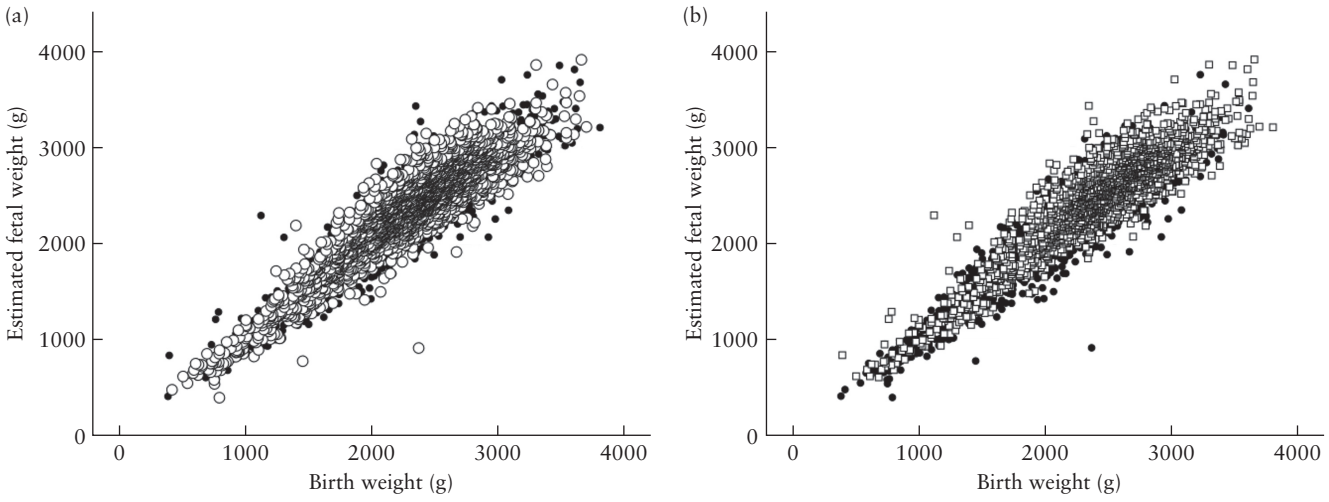


**Figure 1** Correlation between sonographic estimated fetal weight and birth weight of: (a) presenting (●) *vs* non-presenting (○) cotwin; and (b) smaller (●) *vs* larger (□) cotwin.

© 2023 The Authors. *Ultrasound in Obstetrics & Gynecology* published by John Wiley & Sons Ltd on behalf of International Society of Ultrasound in Obstetrics and Gynecology.


14690705, 2023, 6, Downloaded from https://obgyn.onlinelibrary.wiley.com/doi/10.1002/uog.26277 by Cochrane Israel, Wiley Online Library on [16/05/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

compared with that for the larger cotwin (8.56 ± 7.50% *vs* 6.58 ± 5.47%; $P < 0.001$). Higher rates of mean absolute error > 10% (1.4-fold), > 15% (2.3-fold) and > 20% (2.9-fold) were observed for the smaller cotwin compared with the larger cotwin (Table 2). Moreover, the mean absolute error for sonographic EFW in twins suspected of being SGA, appropriate-for-gestational age (AGA) and LGA did not differ significantly (7.94 ± 6.30% *vs* 7.47 ± 6.68% *vs* 7.58 ± 6.66%; $P = 0.084$).

*Sonographic EFW error according to both fetal presentation and size*. The mean absolute error of sonographic EFW was higher for the non-presenting twin compared with the presenting twin, both when the presenting twin was estimated to be the larger cotwin (8.11 ± 6.17% *vs* 6.85 ± 5.89%; $P < 0.001$) and when the presenting twin was estimated to be the smaller cotwin (7.61 ± 6.29% *vs* 7.09 ± 5.40%; $P = 0.024$). Results were similar when di- and monochorionic pregnancies were analyzed separately. Multivariate regression analysis indicated that being the non-presenting twin and being the smaller cotwin were independently and significantly associated with increased mean absolute error and higher rates of absolute error > 10%, > 15% and > 20% (all $P < 0.05$).

*Sonographic EFW error according to gestational age at estimation*. The mean absolute error of sonographic EFW for both the presenting and non-presenting twins was correlated inversely with gestational age at scanning ($r = -0.068$ ($P = 0.002$) and $r = -0.048$ ($P = 0.003$), respectively). This inverse correlation was evident when comparing the rates of absolute error > 10% and > 15%, which were significantly higher in those with severe prematurity (24 + 0 to 27 + 6 weeks) compared to those with moderate (28 + 0 to 31 + 6 weeks) and mild (32 + 0 to 35 + 6 weeks) prematurity (Table 3). Multivariate regression analysis indicated that earlier gestational age at scanning was an independent risk factor for sonographic EFW inaccuracy.

*Maternal factors*

Maternal height was inversely correlated with mean absolute error ($r = -0.044$; $P = 0.004$). However, BMI measured both before conception, as well as before delivery, was not correlated with mean absolute error. Mode of conception (spontaneous, ovulation induction or *in-vitro* fertilization) had no effect on mean absolute error, nor on the rate of absolute error > 15% and > 20%. Gestational and pregestational diabetes also had no effect on the mean absolute error of EFW.

Estimating fetal weight in the setting of prelabor rupture of membranes (PROM) of the presenting fetus increased significantly the mean absolute error of sonographic EFW for the presenting twin (PROM *vs* no PROM, 7.35 ± 5.83% *vs* 6.83 ± 5.56%; $P = 0.035$), without a significant change in the mean absolute error of sonographic EFW for the non-presenting twin (PROM *vs* no PROM, 7.65 ± 5.78% *vs* 7.94 ± 6.24%; $P = 0.333$).

*Directional EFW error*

We further investigated factors affecting the direction of weight estimation error. Most (58.3%) twins were estimated to have a higher EFW compared with their BW. This was more common for the non-presenting twin compared with the presenting twin (63% *vs* 53%; $P < 0.001$).

The proportion of fetuses estimated to be larger than their BW by more than 10–25% was higher compared with the proportion estimated to be smaller than their BW by 10–25% (all $P < 0.001$). The rate of erroneous overestimation of fetal size (by more than 10%, 15% and 20%) was significantly higher (1.7- to 1.9-fold) for non-presenting fetuses and the rate of erroneous underestimation of fetal size (by more than 10% and 15%) was significantly higher (1.5- to 1.7-fold) for presenting fetuses (Table 4).

**Table 2** Comparison of mean absolute error in sonographic estimated fetal weight between presenting and non-presenting cotwins and between smaller and larger cotwins in 2154 twin pregnancies

| *Mean absolute error* | *Presenting twin* | *Non-presenting twin* | P | *Smaller twin* | *Larger twin* | P |
|---|---|---|---|---|---|---|
| > 10% | 546 (25.3) | 684 (31.8) | < 0.001 | 646 (30.0) | 452 (21.0) | < 0.001 |
| > 15% | 185 (8.6) | 283 (13.1) | < 0.001 | 335 (15.6) | 147 (6.8) | < 0.001 |
| > 20% | 64 (3.0) | 102 (4.7) | < 0.001 | 134 (6.2) | 46 (2.1) | < 0.001 |

Data are given as *n* (%).

**Table 3** Mean absolute error in sonographic estimated fetal weight in 2154 twin pregnancies (4308 fetuses), according to gestational age at delivery

| *Mean absolute error* | *24 + 0 to 27 + 6 weeks (n = 74)* | *28 + 0 to 31 + 6 weeks (n = 238)* | *32 + 0 to 35 + 6 weeks (n = 1140)* | *≥ 36 + 0 weeks (n = 2856)* | P |
|---|---|---|---|---|---|
| Mean ± SD | 9.8 ± 8.2 | 7.7 ± 6.3 | 7.5 ± 6.1 | 7.2 ± 5.8 | < 0.001 |
| > 10% | 31 (41.9) | 76 (31.9) | 353 (31.0) | 770 (27.0) | 0.015 |
| > 15% | 14 (18.9) | 29 (12.2) | 135 (11.8) | 290 (10.2) | 0.031 |
| > 20% | 6 (8.1) | 11 (4.6) | 50 (4.4) | 99 (3.5) | 0.101 |

Data are given as *n* (%), *n*-values corresponding to number of fetuses, unless specified otherwise.

© 2023 The Authors. *Ultrasound in Obstetrics & Gynecology* published by John Wiley & Sons Ltd on behalf of International Society of Ultrasound in Obstetrics and Gynecology.



14690705, 2023, 6, Downloaded from https://obgyn.onlinelibrary.wiley.com/doi/10.1002/uog.26277 by Cochrane Israel, Wiley Online Library on [16/05/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

When analyzing error according to EFW centile for the presenting fetus, the weight estimation error was −1.66 ± 9.17% for suspected SGA fetuses, compared with 1.80 ± 8.58% for suspected AGA fetuses and 9.77 ± 10.62% for suspected LGA fetuses ($P < 0.001$). For the non-presenting twin, the error was 1.85 ± 9.68% for SGA fetuses, compared with 4.25 ± 9.04% for AGA fetuses and 6.48 ± 8.59% for LGA fetuses ($P < 0.001$).

**Table 4** Magnitude of directional error of sonographic estimated fetal weight (EFW) in 2154 twin pregnancies, according to presenting order

| *Directional error* | *Presenting twin* | *Non-presenting twin* | P |
|---|---|---|---|
| EFW larger than BW | | | |
| By > 10% | 325 (15.1) | 538 (25.0) | < 0.001 |
| By > 15% | 130 (6.0) | 251 (11.7) | < 0.001 |
| By > 20% | 50 (2.3) | 94 (4.4) | 0.001 |
| EFW smaller than BW | | | |
| By > 10% | 221 (10.3) | 146 (6.8) | < 0.001 |
| By > 15% | 55 (2.6) | 32 (1.5) | 0.017 |
| By > 20% | 14 (0.6) | 8 (0.4) | 0.285 |

Data are given as *n* (%). BW, birth weight.

### *Fetal gender*

While fetal gender did not affect the mean absolute error of sonographic EFW, a significantly higher proportion of female fetuses were estimated to be larger than their BW compared with male fetuses (1394/2165 (64.4%) *vs* 1118/2143 (52.2%); $P < 0.001$). This was significant for both presenting (female *vs* male, 58.7% *vs* 47.5%; $P < 0.001$) and non-presenting (female *vs* male, 69.7% *vs* 57.1%; $P < 0.001$) twins.

## Prediction of BW discordance

Sonographic EFW discordance was correlated significantly with BW discordance ($r = 0.73$; $P < 0.001$). This correlation remained significant in pregnancies in which both twins were AGA, both were SGA or either the presenting or non-presenting twin was SGA (Figure 2). BW discordance > 15%, > 20% and > 25% was assigned

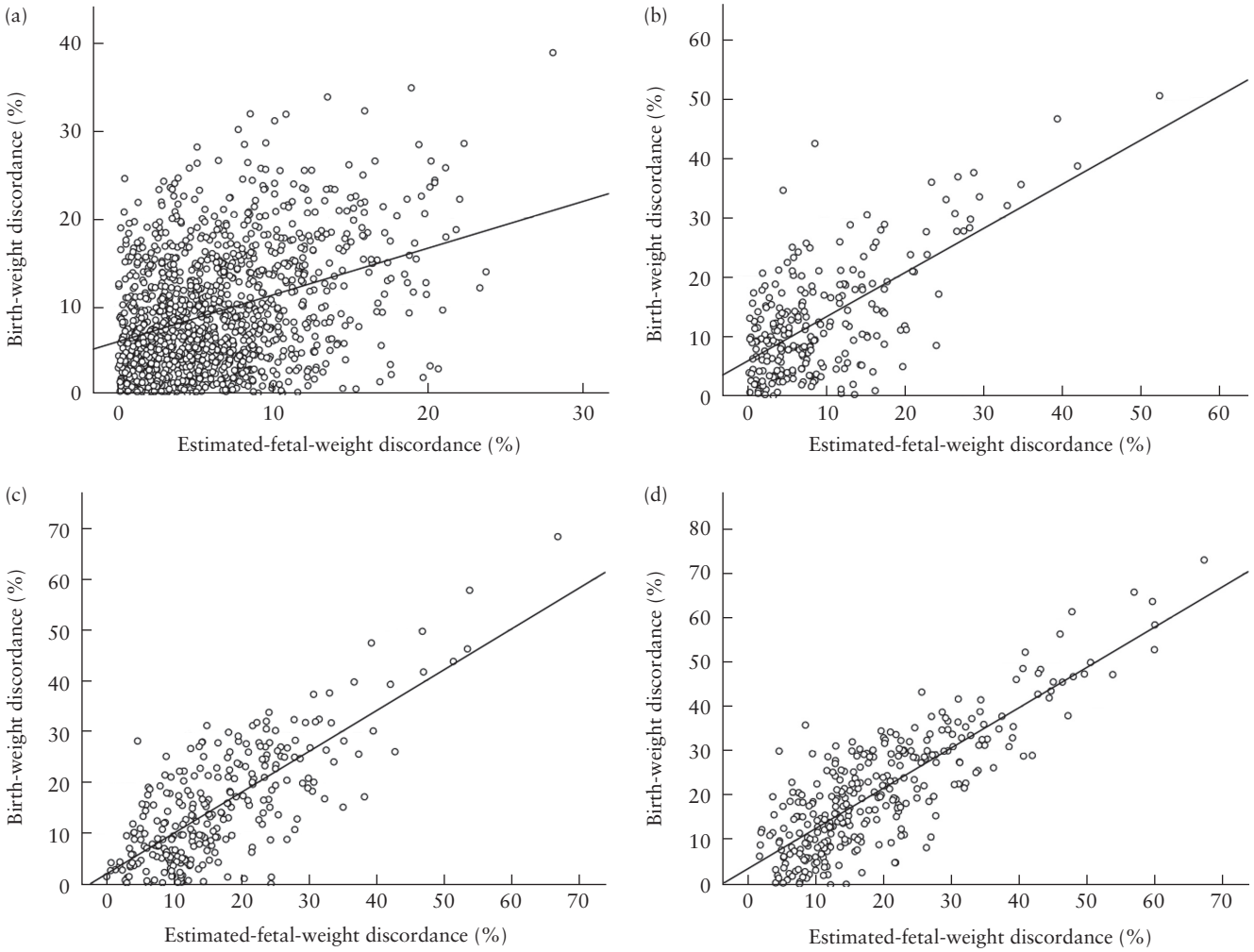


**Figure 2** Estimation of birth-weight discordance using ultrasound in appropriate-for-gestational-age (AGA) and small-for-gestational-age (SGA) twins: (a) both twins AGA ($R^2$ linear = 0.135); (b) both twins SGA ($R^2$ linear = 0.418); (c) presenting twin SGA and non-presenting twin AGA ($R^2$ linear = 0.566); and (d) presenting twin AGA and non-presenting twin SGA ($R^2$ linear = 0.682).

© 2023 The Authors. *Ultrasound in Obstetrics & Gynecology* published by John Wiley & Sons Ltd on behalf of International Society of Ultrasound in Obstetrics and Gynecology.


14690705, 2023, 6, Downloaded from https://obgyn.onlinelibrary.wiley.com/doi/10.1002/uog.26277 by Cochrane Israel, Wiley Online Library on [16/05/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

correctly in 76.7%, 75.7% and 78.6% (all $P < 0.001$) of ultrasound measurements. However, only 47.5%, 48.3% and 51.1% of newborns with BW discordance > 15%, > 20% and > 25%, respectively, were detected during the estimation of fetal weight, indicating higher specificity (93.5%, 96.6% and 98.4%, respectively), but lower sensitivity (47.5%, 48.3% and 51.1%, respectively) (Table 5).

Pregnancies in which the presenting twin was estimated to be the smaller cotwin had twice the rate of false-positive BW discordance compared with pregnancies in which the presenting twin was estimated to be the larger cotwin (36.0% *vs* 13.0% for BW discordance > 15%, 35.0% *vs* 17.0% for BW discordance > 20% and 37.7% *vs* 12.1% for BW discordance > 25%; all $P < 0.001$). Suspected EFW discordance > 20% ($n = 247$) was less accurate when the presenting twin was estimated to be smaller (65.0% *vs* 83.0%; odds ratio, 2.628 (95% CI, 1.449–4.764)). Thus, the prediction of BW discordance > 20% was less accurate when the presenting fetus was estimated to be the smaller cotwin. Nevertheless, the sensitivity for the diagnosis of BW discordance > 20% remained low, regardless of whether the smaller or larger fetus was the presenting one (50.8% *vs* 47.1%; $P = 0.518$) (Table 6).

When investigating factors that may affect the error in EFW discordance (BW discordance − EFW discordance), we found that the error was not related to chorionicity (dichorionic *vs* monochorionic, 5.8 ± 4.7% *vs* 5.5 ± 4.5%; $P = 0.151$). The position of the presenting fetus did not affect significantly the discordance prediction error (vertex *vs* non-vertex, 5.7 ± 4.7% *vs* 5.7 ± 4.7%; $P = 0.965$), nor did it affect the rate of false-positive (vertex *vs* non-vertex, 3.6% *vs* 2.7%; $P = 0.438$) or false-negative (vertex *vs* non-vertex, 51.9% *vs* 52.0%; $P = 1.0$) prediction of BW discordance > 20%. The error in EFW discordance was significantly smaller in gender-concordant pregnancies compared with gender-discordant pregnancies (5.5 ± 4.4% *vs* 6.1 ± 5.0%; $P = 0.002$). This difference persisted even after excluding monochorionic pregnancies (5.5 ± 4.5% *vs* 6.2 ± 5.0%; $P = 0.003$).

None of the maternal parameters analyzed in this study impacted the accuracy of BW discordance, nor did gestational age at the time of fetal weight estimation.

## DISCUSSION

This study evaluated the accuracy of sonographic EFW in predicting BW and BW discordance in twin pregnancy. Our main findings were: a strong correlation between sonographic EFW and BW for both twins; most fetal weights were overestimated, particularly for the non-presenting twin; the mean absolute error of sonographic EFW was higher for the non-presenting twin and the smaller twin; gestational age at evaluation correlated inversely with the mean absolute error of sonographic EFW; PROM increased the mean absolute error of sonographic EFW for the presenting twin; fetal gender, chorionicity, maternal BMI and maternal diabetes did not affect the mean absolute error of sonographic EFW; and evaluation of BW discordance showed high specificity, but moderate sensitivity, with poorer specificity for a smaller presenting cotwin.

Previous studies have questioned the predictive value of measuring growth in twins, regarding sonographic EFW as less accurate in twin pregnancy compared with

**Table 5** Diagnostic accuracy of different cut-offs for sonographic estimation of birth-weight discordance (BWD) in twin pregnancy

| *Estimated BWD* | *Sensitivity* | *Specificity* | *LR+* | *LR−* | *Diagnostic OR** |
|---|---|---|---|---|---|
| > 10% | 0.55 (0.53–0.57) | 0.82 (0.80–0.84) | 3.18 (2.77–3.65) | 0.54 (0.50–0.57) | 5.87 (4.79–7.19) |
| > 15% | 0.47 (0.45–0.49) | 0.93 (0.92–0.94) | 7.26 (5.91–8.97) | 0.56 (0.53–0.59) | 12.94 (9.95–16.86) |
| > 20% | 0.48 (0.45–0.51) | 0.97 (0.95–0.97) | 14.23 (10.89–18.70) | 0.53 (0.50–0.57) | 26.85 (18.97–37.35) |
| > 25% | 0.51 (0.46–0.54) | 0.98 (0.97–0.99) | 31.84 (21.99–46.71) | 0.49 (0.45–0.54) | 64.98 (40.36–102.26) |

Values in parentheses are 95% CI. *Diagnostic odds ratio (OR) = (sensitivity × specificity)/((1 − sensitivity) × (1 − specificity)) = positive likelihood ratio (LR+)/negative likelihood ratio (LR−).

**Table 6** Accuracy of sonographic estimation of birth-weight discordance (BWD), according to fetal size and *in-utero* location

| *Weight discordance* | *Presenting fetus estimated to be larger* (n = *1082*) | *Presenting fetus estimated to be smaller* (n = *1072*) | P |
|---|---|---|---|
| EFWD (%) | 10.30 ± 10.06 | 9.30 ± 8.28 | 0.004 |
| BWD (%) | 13.98 ± 10.97 | 10.30 ± 8.39 | < 0.001 |
| EFWD > 15% | 230 (21.3) | 186 (17.4) | 0.022 |
| Falsely estimated | 30/230 (13.0) | 67/186 (36.0) | < 0.001 |
| EFWD > 20% | 147 (13.6) | 100 (9.3) | 0.002 |
| Falsely estimated | 25/147 (17.0) | 35/100 (35.0) | 0.001 |
| BWD > 20% | 259 (23.9) | 128 (11.9) | < 0.001 |
| Correctly estimated* | 122/259 (47.1) (43.4–50.1) | 65/128 (50.8) (43.9–57.0) | 0.518 |
| BWD ≤ 20% | 823 (76.1) | 944 (88.1) | < 0.001 |
| Correctly estimated† | 795/823 (96.6) (95.8–97.9) | 909/944 (96.3) (95.4–97.1) | 0.960 |

Data are given as mean ± SD, *n* (%), *n*/*N* (%) or *n*/*N* (%) (95% CI). *Sensitivity of estimated-fetal-weight discordance (EFWD) > 20%. †Specificity of EFWD > 20%.

© 2023 The Authors. *Ultrasound in Obstetrics & Gynecology* published by John Wiley & Sons Ltd on behalf of International Society of Ultrasound in Obstetrics and Gynecology.



14690705, 2023, 6, Downloaded from https://obgyn.onlinelibrary.wiley.com/doi/10.1002/uog.26277 by Cochrane Israel, Wiley Online Library on [16/05/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

singleton[16,17]. A study comparing the performance of sonographic EFW in 278 twins and 834 singletons performed within 3 days before delivery found that EFW had a higher mean absolute error and lower accuracy in twins compared with singletons[16].

### Accuracy of estimating fetal weight and discordance

Our data demonstrate a strong correlation between EFW measured on ultrasound within 1 week before birth and BW in twin pregnancy. We report a significant correlation between sonographic EFW discordance and BW discordance, with sonographic EFW discordance showing high accuracy and specificity but low sensitivity.

Whilst our findings are consistent with those of previous studies demonstrating that sonographic EFW is a reliable predictor of twin BW discordance at levels of 15%, 20% and 25%[18,19], others have demonstrated that underestimation of the BW of the larger twin compromises the accuracy of this assessment[20]. This contrasts with our data, which show that, in most cases, twin weights were overestimated, and this was more significant for the non-presenting twin.

A 2021 Cochrane review concluded that sonographic EFW was unreliable for the diagnosis of BW discordance in twins, as it detected BW discordance of 20% and 25% only half of the time[21]. The diagnosis of BW discordance has been associated with high specificity but low sensitivity, affirming our results[17]. These findings are supported by a meta-analysis of 20 studies including 5826 twin pregnancies, which found EFW discordance $\geq 20\%$ had a sensitivity of 65.4% and specificity of 90.8% for predicting BW discordance $\geq 20\%$[22].

Our data suggest that misdiagnosis of BW discordance $> 20\%$ might be attributed to higher mean absolute error of sonographic EFW for non-presenting and smaller cotwins.

### Timing of evaluation

This study confirms earlier findings[14] that the accuracy of sonographic EFW in twins improves with advancing gestational age, and that a shorter interval between EFW evaluation and delivery improves the predictive accuracy for each of the fetal sonographic parameters[23]. In our cohort, sonographic EFW performed at a median of 2 (range, 0–7) days prior to delivery was strongly correlated with BW.

### Fetal factors

#### *Larger* vs *smaller twin*

Sonographic EFW correlation with BW was comparable for twins of smaller and larger birth weights. We also showed that the assessment of non-presenting twins and smaller twins was associated independently with a higher absolute percentage error in EFW and a higher absolute error rate of $> 10\%$, $> 15\%$ and $> 20\%$. This finding contradicts one study that reported that discordancy is often underappreciated, due mainly to underestimation of the weight of the larger twin[20].

#### *Presenting* vs *non-presenting twin*

The correlation between sonographic EFW and BW was similar for presenting and non-presenting twins. While the mean absolute error for the non-presenting twin was significantly higher compared with that of the presenting twin, this small difference has limited clinical significance. Few studies have addressed the impact of fetal order on the accuracy of BW-discordance prediction. A study evaluating various estimation formulae found consistent underestimation of BW for the non-presenting twin[20].

We demonstrated that the accuracy of BW discordance improves when the larger cotwin is the presenting fetus, due to higher specificity. However, regardless of whether the larger twin is presenting or non-presenting, sensitivity remained low at around 50%. Considering directional errors, fetal weight overestimation was almost two-fold higher for the non-presenting twin compared to the presenting one. In contrast, the rate of underestimation was higher for the presenting twin. These directional errors may have clinical relevance. Some practitioners advocate for Cesarean delivery in pregnancies with varying degrees of discordance when the non-presenting twin is estimated to be larger. Our data suggest considering the possibility of discordancy overestimation in these cases.

#### *Chorionicity*

Very few studies have stratified their analysis by chorionicity[24–26], due either to lack of data or exclusion of monochorionic twins. We found that chorionicity did not affect the prediction accuracy for BW or BW discordance.

#### *Fetal position*

The position of the presenting fetus did not significantly affect the discordance prediction error (vertex *vs* non-vertex, $5.7 \pm 4.7\%$ *vs* $5.7 \pm 4.7\%$; $P = 0.965$), nor the rate of false-positive or false-negative prediction of BW discordance $> 20\%$.

#### *Fetal gender*

Fetal weight was overestimated in a higher proportion of female fetuses compared with males. This finding differs from that of a previous study of 283 twin pregnancies, in which the accuracy of BW prediction was not affected by fetal gender[27]. A Cochrane review addressing the sensitivity and specificity of sonographic EFW in pregnancies with gender-concordant *vs* gender-discordant twins lacked sufficient data for analysis of this parameter[21].

### Maternal factors

A previous study evaluating the impact of several maternal and fetal variables on sonographic prediction of intertwin BW discordance showed no influence of these factors on predictive accuracy[28]. Two studies indicated

© 2023 The Authors. *Ultrasound in Obstetrics & Gynecology* published by John Wiley & Sons Ltd on behalf of International Society of Ultrasound in Obstetrics and Gynecology.



14690705, 2023, 6, Downloaded from https://obgyn.onlinelibrary.wiley.com/doi/10.1002/uog.26277 by Cochrane Israel, Wiley Online Library on [16/05/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

that obesity had a negative impact on discordance diagnosis: one showed that maternal obesity decreased sonographic EFW accuracy, particularly for the non-presenting twin[29], whilst another demonstrated that high maternal BMI increased the error rate of BW-discordance evaluation in twins[30]. In contrast, this study found that neither maternal weight nor BMI affected the accuracy of EFW. Indeed, none of the maternal parameters analyzed in this study impacted the accuracy of BW discordance.

### Strengths and limitations

This study's primary strength is that it contains the largest cohort of twin pregnancies for which sonographic EFW, BW and BW discordance are reported. We report on three types of error: absolute error, directional error and error in weight discordance. Furthermore, we evaluated the influence of maternal and fetal factors that have not been addressed previously.

The main limitations of this study are those inherent to the retrospective nature of our work and the non-reporting of fetal gender at the time of sonographic EFW evaluation.

### Conclusions

Sonographic EFW performed within 1 week before delivery in twin gestation is correlated strongly with BW. A robust relationship exists between sonographic EFW discordance and BW discordance. Whilst the diagnosis of BW discordance showed high specificity, it demonstrated limited sensitivity. Furthermore, sonographic evaluation of fetal weight is more reliable for the larger twin as well as for the presenting twin. Directional errors suggest that, in cases in which the non-presenting twin is estimated to be larger, specificity is lower, and thus there is a tendency to overestimate intertwin discordance. This may be of particular importance when considering the optimal mode of delivery and the safety of interventions such as total breech extraction in cases of non-vertex second twin.

## REFERENCES


1. Hiersch L, Barrett J, Aviram A, Mei-Dan E, Yoon EW, Zaltz A, Kingdom J, Melamed N. Patterns of discordant growth and adverse neonatal outcomes in twins. *Am J Obstet Gynecol* 2021; **225**: 187.e1–14.
2. Kalafat E, Khalil A. Assessment of fetal growth in twins: Which method to use? *Best Pract Res Clin Obstet Gynaecol* 2022; **84**: 104–114.
3. Ashwal E, Hiersch L, Berger H, Aviram A, Zaltz A, Kingdom J, Barrett J, Melamed N. Pathologic Basis for the Definition of Discordant Growth in Dichorionic Twins. *Fetal Diagn Ther* 2021; **48**: 279–287.
4. Fox NS, Rebarber A, Klauser CK, Roman AS, Saltzman DH. Intrauterine growth restriction in twin pregnancies: incidence and associated risk factors. *Am J Perinatol* 2011; **28**: 267–272.
5. Cleary-Goldman J, D'Alton ME. Growth abnormalities and multiple gestations. *Semin Perinatol* 2008; **32**: 206–212.
6. SMFM Research Committee; Grantz KL, Kawakita T, Lu YL, Newman R, Berghella V, Caughey A. SMFM Special Statement: State of the science on multifetal gestations: unique considerations and importance. *Am J Obstet Gynecol* 2019; **221**: B2–12.
7. Melamed N, Hiersch L. Fetal Growth in Twin Pregnancies and the Choice of Growth Chart. *Matern Fetal Med* 2022; **4**: 234–237.
8. Hartley RS, Hitti J, Emanuel I. Size-discordant twin pairs have higher perinatal mortality rates than nondiscordant pairs. *Am J Obstet Gynecol* 2002; **187**: 1173–1178.
9. Ananth CV, Demissie K, Hanley ML. Birth weight discordancy and adverse perinatal outcomes among twin gestations in the United States: The effect of placental abruption. *Am J Obstet Gynecol* 2003; **188**: 954–960.
10. Blickstein I, Keith LG. Neonatal mortality rates among growth-discordant twins, classified according to the birth weight of the smaller twin. *Am J Obstet Gynecol* 2004; **190**: 170–174.
11. Kent EM, Breathnach FM, Gillan JE, McAuliffe FM, Geary MP, Daly S, Higgins JR, Hunter A, Morrison JJ, Burke G, Higgins S, Carroll S, Dicker P, Manning F, Tully E, Malone FD. Placental pathology, birthweight discordance, and growth restriction in twin pregnancy: results of the ESPRiT Study. *Am J Obstet Gynecol* 2012; **207**: 220.e1–5.
12. Branum A. The effect of birth weight discordance on twin neonatal mortality. *Obstet Gynecol* 2003; **101**: 570–574.
13. D'Antonio F, Thilaganathan B, Laoreti A, Khalil A; Southwest Thames Obstetric Research Collaborative (STORK). Birth-weight discordance and neonatal morbidity in twin pregnancy: analysis of STORK multiple pregnancy cohort. *Ultrasound Obstet Gynecol* 2018; **52**: 586–592.
14. Khalil A, Rodgers M, Baschat A, Bhide A, Gratacos E, Hecher K, Kilby MD, Lewi L, Nicolaides KH, Oepkes D, Raine-Fenning N, Reed K, Salomon LJ, Sotiriadis A, Thilaganathan B, Ville Y. ISUOG Practice Guidelines: role of ultrasound in twin pregnancy. *Ultrasound Obstet Gynecol* 2016; **47**: 247–263.
15. Nahum GG, Stanislaw H. Ultrasonographic prediction of term birth weight: How accurate is it? *Am J Obstet Gynecol* 2003; **188**: 566–574.
16. Danon D, Melamed N, Bardin R, Meizner I. Accuracy of ultrasonographic fetal weight estimation in twin pregnancies. *Obstet Gynecol* 2008; **112**: 759–764.
17. Chang YL, Chang TC, Chang SD, Cheng PJ, Chao AS, Hsieh PC, Soong YK. Sonographic prediction of significant intertwin birth weight discordance. *Eur J Obstet Gynecol Reprod Biol* 2006; **127**: 35–40.
18. Harper LM, Roehl KA, Tuuli MG, Odibo AO, Cahill AG. Sonographic Accuracy of Estimated Fetal Weight in Twins. *J Ultrasound Med* 2013; **32**: 625–630.
19. Reberdao MA, Martins L, Torgal M, Viana R, Seminova T, Casal E, Hermida M, Blickstein I. The source of error in the estimation of intertwin birth weight discordance. *J Perinat Med* 2010; **38**: 671–674.
20. Banks CL, Nelson SM, Owen P. First and third trimester ultrasound in the prediction of birthweight discordance in dichorionic twins. *Eur J Obstet Gynecol Reprod Biol* 2008; **138**: 34–38.
21. Jahanfar S, Ho JJ, Jaafar SH, Abraha I, Noura M, Ross CR, Pammi M. Ultrasound for diagnosis of birth weight discordance in twin pregnancies. *Cochrane Database Syst Rev* 2021; **3**: CD012553.
22. Leombroni M, Liberati M, Fanfani F, Pagani G, Familiari A, Buca D, Manzoli L, Scambia G, Rizzo G, D'Antonio F. Diagnostic accuracy of ultrasound in predicting birth-weight discordance in twin pregnancy: systematic review and meta-analysis. *Ultrasound Obstet Gynecol* 2017; **50**: 442–450.
23. Lei T, Zheng J, Papageorghiou AT, Feng JL, Lin MF, Zhang F, Xie HN. Ultrasound in the prediction of birthweight discordance in dichorionic twins. *Acta Obstet Gynecol Scand* 2021; **100**: 908–916.
24. D'Antonio F, Khalil A, Dias T, Thilaganathan B; Southwest Thames Obstetric Research Collaborative (STORK). Weight discordance and perinatal mortality in twins: analysis of the Southwest Thames Obstetric Research Collaborative (STORK) multiple pregnancy cohort: Weight discordance and perinatal mortality in twins. *Ultrasound Obstet Gynecol* 2013; **41**: 643–648.
25. D'Antonio F, Khalil A, Thilaganathan B, on behalf of the Southwest Thames Obstetric Research Collaborative (STORK). Second-trimester discordance and adverse perinatal outcome in twins: the STORK multiple pregnancy cohort. *BJOG* 2014; **121**: 422–429.
26. Jahanfar S, Lim K, Oviedo-Joekes E. Optimal threshold for birth weight discordance: Does knowledge of chorionicity matter? *J Perinatol* 2016; **36**: 704–712.
27. Diaz-Garcia C, Bernard JP, Ville Y, Salomon LJ. Validity of sonographic prediction of fetal weight and weight discordance in twin pregnancies. *Prenat Diagn* 2010; **30**: 361–367.
28. Gernt P. Sonographic prediction of twin birth weight discordance. *Obstet Gynecol* 2001; **97**: 53–56.
29. Gandhi M, Ferrara L, Belogolovkin V, Moshier E, Rebaber A. Effect of increased body mass index on the accuracy of estimated fetal weight by sonography in twins. *J Ultrasound Med* 2009; **28**: 301–308.
30. Al-Obaidly S, Parrish J, Murphy KE, Glanc P, Maxwell C. The Accuracy of Estimating Fetal Weight and Inter-Twin Weight Discordance by Ultrasound in Twin Pregnancies in Women With Increased Body Mass Index. *J Obstet Gynaecol Can* 2015; **37**: 696–701.


© 2023 The Authors. *Ultrasound in Obstetrics & Gynecology* published by John Wiley & Sons Ltd on behalf of International Society of Ultrasound in Obstetrics and Gynecology.



14690705, 2023, 6, Downloaded from https://obgyn.onlinelibrary.wiley.com/doi/10.1002/uog.26277 by Cochrane Israel, Wiley Online Library on [16/05/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License