Comparative Study of Four Methods of Clinical Estimation of Fetal Weight in the Late Third Trimester Admitted for Delivery: A Prospective Study

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ABSTRACT

Background: Clinical estimation of fetal weight is a basic skill an obstetrician should master. Although the use of ultrasound has gained much popularity in the recent decade, in low resource settings, most patients do not have the luxury to have an ultrasound done for their babies, more so a sonographic estimate. Four methods of clinical estimation – Dare's method, Johnson's formula, Modified Johnson's Formula and abdominal palpation were used in the study and compared with the actual weight of the baby.

Objective: To come up with the best/most reliable clinical method to use in estimating fetal weight among women in the late third trimester of pregnancy.

Methodology: The study used a prospective study design. All women beyond 34 weeks age of gestation admitted at the OB admitting section and ward were included. A total of 370 parturients were included. Senior residents on duty at the OB admitting section were asked to record their examination after the patient had given her consent. Those admitted at the wards were examined by the resident in charge and principal investigator after the patient consented to the study. The actual birthweight was used as the gold standard value. Paired Sample T-test was used to determine whether the estimates are comparable to the actual birthweight. Each formulae for estimating fetal weight were compared to the actual birthweight. Percentage error of each was computed and compared using the Wilcoxon Test and absolute percentage error were compared using T-test. One-way ANOVA test was used to determine inter-observer difference.

Results: The palpation method had the lowest mean absolute error, followed by Dare's Method. The Modified Johnson's Formula had the highest mean absolute error. Similarly, the palpation method had the highest number of estimates with difference less than 100 grams from the actual value. This is consistent with the absolute percent error which showed that the palpation method has most estimates (73.2%) having less than 5% error, followed by Dare's Method (49.5%), and Johnson's (38.6%). The Modified Johnson's Formula had the least number of estimates at less than 5%, at 10.8%. At 34 – 37 weeks age of gestation, the palpation method had the lowest mean percentage error (0.41±5.18) followed by Modified Johnson's formula (1.40±15.54). The Johnson's Formula yielded the highest percentage error at 13.29±18.56. At 37 weeks age of gestation and above, the Dare's Method had the lowest mean percentage error (0.91±8.51), followed by the Johnson's Formula (-1.14±9.62), then Palpation Method (-1.59±6.16).

Conclusion: Based on the data garnered, the clinician's estimate using the palpation method is by far the most accurate in any age of gestation, followed by Johnson's Method, with the Modified Johnson's Method with the least accurate estimate. At 34-37 weeks age of gestation, the palpation method had the closest estimate. At 37 weeks age of gestation and above, the Dare's Method is more superior.

Keywords: Estimated fetal weight, Dare's method, Johnson's formula, Modified Johnson's Formula and the Leopold's Maneuver

INTRODUCTION

Estimation of fetal weight is one of the required examinations done in a pregnant patient during consult, a basic skill an obstetrician should master. It is a parameter that affects the management during delivery, especially in patients with complicated pregnancies.[1,2] Timely obstetric intervention may be executed in cases of suspected large or small for gestational age babies. One concrete example would be in patients undergoing vaginal birth after cesarean section where obstetricians will think twice on proceeding with vaginal birth if their estimated fetal weight is big.

Although the use of ultrasound in the estimation of fetal weight has gained much popularity in the recent decade, clinical estimation of fetal weight is still an important skill for obstetricians. In low resource settings,[3] such as in developing countries like Philippines, most patients from the rural areas do not have the luxury to have an ultrasound done for their babies, more so a sonographic estimate of the fetal weight. Similarly,

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not all institutions have trained operators to estimate fetal weight sonographically. Hendrix and colleagues compared sonographic estimates with clinical estimates using palpation of fetal parts among term parturients. It was concluded that the clinical estimates were more accurate than those obtained sonographically, with 50% of the estimates within 10% of actual weight versus 32% in sonographically obtained estimates [4]. A similar study was done in Thailand and showed comparable results. The investigators used palpation method in clinically estimating fetal weights. They found out that there was no significant difference between the clinical and the sonographic method in estimating fetal weight. The accuracy rate was actually slightly higher with the clinical method but the difference was not statistically significant [5].

In a study done in Thailand wherein the Johnson's Formula was utilized, the author was able to conclude that 72% of the clinical estimates were within 10% of the actual birth weight.[6] Shittu and colleagues compared the estimated fetal weights of babies in Nigeria using sonography and clinical estimates and concluded that there was no significant difference with the two methods. The clinical estimate was actually more accurate than sonographic estimate in babies who have weights appropriate for gestational age (70% versus 68%).[7] A similar study was done in Iran and it showed the similar results, concluding that an ultrasound estimate of fetal weight offers no advantage over clinical estimate.[8]

Several formula described in literatures based primarily on measurement of fundic height still utilized in most institutions abroad may be applicable in our local setting. [1,6,7,9,10]

Four methods – Dare's method, Johnson's formula, Modified Johnson's Formula and abdominal palpation using Leopold's Maneuver were used in the study. The Dare's Method estimates the fetal weight by multiplying the fundic height with the abdominal girth.[1] Several studies have proven that the estimates using this method are comparable with the actual birthweight. [1, 7, 9, 10]

The Johnson's formula subtracts 13 (if the presenting part is floating), 12 (if the presenting part is at station 0), or 11 (if the presenting part is at station +1) from the obtained fundic height and multiplying the difference to 155.[6] The abdominal palpation using Leopold's Maneuver,[7] is currently being practiced in the institution. The estimated fetal weight is obtained by palpation method using a "titrated" palm of the examiner; the palms of the examiner are palpated over the maternal abdomen to palpate the area encasing the baby. This method is the most subjective of the three and most likely with the highest inter-observer variability.[6,7]

An unpublished study conducted at a tertiary hospital evaluated the accuracy of the palpation method in estimating fetal weight. The actual birthweight was used as a standard method. A total of 182 parturients were included in the study. The estimated birthweight obtained by the residents-in-training using the palpation method did not differ significantly from the actual birthweight. The study also compared the accuracy of estimating of the residents and found that there is no significant difference in the accuracy of clinical estimation of fetal weight between year levels of resident physician trainees.[11]

Another method of estimation of fetal weight was studied by Eckhart Bucthmann and Karabo Tlale.[12] The estimate was derived from the Johnson's Method, which was consequently validated. In this study, the modified Johnson's rule was estimated to be accurate (+/- 10% of the actual birthweight) in 60% of the population studied.

The study aimed to assess the fetal weight of term and near term pregnancies using the mentioned methods and to determine which among them is the most accurate. Ashrafganjooei and colleagues compared the estimated fetal weight by ultrasound, palpation method and maternal estimate and concluded that ultrasonography is not superior over palpation method, with specificity of 93.5% for ultrasound and 99.6% for the palpation method.[8] Belete and Gaym also compared two clinical estimates, the Johnson's Formula and palpation method.[3] They were able to conclude that the palpation method was more accurate than the Johnson's formula (65% versus 38%). They also found out that the palpation method is more accurate in average birthweight and that the Johnson's rule is more accurate for higher weight category (at 4000 grams).[3]

The study included all pregnant patients beyond thirty-four weeks age of gestation who are admitted at OB Admitting Section for delivery and those admitted at the ward for elective cesarean section. Exclusion criteria includes those who have uterine masses, maternal weight more than 90kg, polyhydramnios, intrauterine growth restriction, multiple gestation, and those whose presenting part is more than station +1.

OBJECTIVES

The main outcome of the study is to come up with the best/most reliable clinical method to use in estimating fetal weight among women in the late third trimester of pregnancy. Other outcomes that were observed in this study are:

i. Factors that may contribute to the discrepancy in estimating fetal weight
ii. Reliability of residents in training in estimating fetal weight

General objective:

The study aimed to identify the best clinical method in estimating the fetal weight beyond 34 weeks age of gestation in patients admitted at the Obstetrics and Gynecology Admitting Section and ward of a tertiary hospital for delivery, as performed by the residents in training. The researcher compared the sensitivity of the four methods of estimating fetal weight.

Specific Objectives:

1. To determine the demographics of patients included in the study.
2. To assess the fetal weight in term pregnancies using the four methods.
3. To identify the percentage error of each method.
4. To identify the best method in estimating the fetal weight beyond 34 weeks age of gestation.
5. To identify the best method in estimating the fetal weight beyond 37 weeks age of gestation.

METHODOLOGY

Study design

The study used prospective study design. Senior residents on duty at the OB admitting section were asked to record their examination after the patient had given her consent. The calculation of the clinical estimates was done by the lead investigator. The formula was not shared to the residents during were anonymized and in no way breach information of the patients included in the study.

Informed consent of the patients was taken by the principal investigator, research assistant or senior resident on duty. Care was taken that the resident-in-charge will not be the one to secure the consent. If the patient is recruited at ward, the consent will be secured after admission, the day prior to her scheduled elective cesarean section. All patients consulting at the OB admitting section with fetus at 34 weeks age of gestation or more were oriented about the procedure. They were asked to give a verbal consent to join the study should they be admitted for delivery. Upon admission, a written consent was secured from her.

The actual birthweight was used as the gold standard value in the study. In compliance with the hospital policy, the researcher did not dictate the pediatrician when to take the birthweight. The study observed the Essential Newborn Care Policy and adhered to its guidelines.

A. Study population

1. Inclusion Criteria:

All women beyond 34 weeks age of gestation admitted at the OB Admitting Section for delivery and at ward 15 for elective cesarean section.

2. Exclusion criteria:

Patients with known

i. Uterine masses
ii. Multiple gestations
iii. Fetus with intrauterine growth restriction/demise
iv. Maternal weight of >90kg
v. Fetus at station more than +1
vi. Placenta previa
vii. Fetus with multiple congenital anomalies
viii. Problems in amniotic fluid

B. Study maneuver, conduct

All pregnant patients more than 34 weeks age of gestation admitted for delivery were invited to participate in this study. The principal investigator introduced and discussed the details, goal and expectations of the research to each patient. Once they have accepted and agreed to be a part of the investigation, they were asked to sign an informed consent.

For every patient recruited into the study, the lead investigator and research assistant/s completed an information data form and checklist documenting the following:

vi. Demographics: Name, age, address and contact details, height, weight, body mass index (BMI); age of gestation
vii. History: Past medical and surgical history;
viii. Obstetric examination: Fundic height, abdominal girth and estimated fetal weight by palmar method, fetal heart tones, and internal examination
ix. Birthweight

The history and physical examination were obtained from the notes of the resident-in-charge of the patient recruited into the study. The measurements (fundic height, abdominal girth, and estimated fetal weight) acquired by the most senior resident on duty were the ones recorded in the study.

The actual birthweight was taken from the record of the pediatrician. The study observed the essential newborn care and did not impose that the weight be taken immediately after delivery.

Computations of the birthweight were done by the lead investigator or research assistant if the lead investigator is the resident-in-charge. The computations of the estimated fetal weight were done after data collection.

Measurement of variables:

Senior residents (second to fourth year residents)

were oriented by the principal investigator on how to obtain/perform the clinical estimation of weights. A session was scheduled to reiterate to the residents the proper measurements for each method.

For the Johnson's method, obtaining the fundic height was done using soft tape measure. The landmark was from the midline of the upper border of the symphysis pubis to the highest point of the fundus, without bending the tape. The bladder should be empty and the measurement should be in centimeters. Station identification was done during internal examination. Station 0 is designated when the lowermost portion of the presenting part is at the level of the ischial spines. Levels above it in centimeters are designated with a negative value (-1, -2, etc) and levels below it are designated with positive values (+1, +2, etc) up to 5 centimeters from the ischial spines.[3,4] The same measurement of the fundic height obtained was used for the computation of the Modified Johnson's Formula. The birthweight is obtained using the Modified Johnson's Formula by subratcting 5 from the fundic height then multiplying the difference to 100.[3]

The birth weight estimation using the Dare's Formula is calculated by taking the product of the fundic height and abdominal girth in centimeters was used. It was taken with the patient in supine position, with legs flexed.[9] The resident should take the measurement at the level of the umbilicus and when the uterus is not contracted.

The abdominal palpation, or the Leopold's Method was the one most emphasized, especially to second year residents. This was performed during the Leopold's Maneuver, where the palm of the examiner is used to palpate the fetal parts to estimate the fetal weight. For uniformity, this study will use the term palpation method for estimates obtained using abdominal palpation method during Leopold's Maneuver. Each palm may be equivalent to 400-500 grams depending on the titrated estimate established by the resident based on experience.

RESULTS

The Study Population

There were 370 pregnant women who were included in the study with a mean age of 28 ± 5.35 years old, and their age of gestation ranges between 34 to 44 weeks during the time of examination. The mean gravidity among the participants would be 3 ± 1.89 pregnancies, and their average parity was 3 ± 1.90 live births around the time of examination.

The mean weight of the participants during the time of examination was 60.93 ± 10.04 kilograms, mean height at 1.53±0.06 meters, and the body-mass index at 26.06 ± 3.97 kg/m^2. The average height of the uterine fundus is 30.28 ± 2.10 cm, and the mean abdominal girth would be 96.69 ± 6.26 cm around the time of examination. (Table 1)

Differences between the estimated fetal weight and actual weight

Fetal weight estimations obtained using the four methods were compared and analyzed (Table 2). The Modified Johnson's formula had the lowest standard deviation from the mean. A high standard deviation value was obtained for actual birthweight and was statistically significant at p>0.001

This just shows that there is a significant difference between the average fetal weight and the estimated

Table 1. Baseline Characteristics

Age	27.5 ± 5.3 (19 - 44)
Gravidity	3 ± 1.89 pregnancies
Parity	3 ± 1.96
BMI	26.06 ± 3.97 kg/m2
Abdominal Girth	96.69 ± 6.26 cm
Fundic Height	30.28 ± 2.10 cm

Table 3. Mean absolute error of the estimation methods

Estimation method	Mean absolute error ± standard deviation (%)	Range of absolute error (%)
Palpation method	3.96±4.67	0-46
Dare's method	7.44±8.77	0-52
Johnson's formula	8.94±10.16	0-82
Modified Johnson's formula	14.10±7.53	0-48

Percentage error=(EFW-ABW)/ABW x 100; Absolute percentage of error= |EFW-ABW|/ABW x 100

Table 2. Comparison of actual fetal weight and estimations by various methods

	Range	Mean	SD	t	p-value
Actual birth weight	1640-4235	2877.62	473.56	-	-
Palpation method	1800-4000	2829.62	407.07	5.36	.00**
Dare's method	2240-4360	2935.78	354.47	-4.21	.00**
Johnson's formula	2170-4340	2888.45	335.59	-0.64	.52
Modified Johnson's formula	2000-3500	2528.11	210.10	19.40	.00**

*Values expressed in grams; * - p>0.05, ** - p>0.01*

fetal weight using the palpation method, Dare's method and modified Johnson's formula. However, there is no difference between the mean actual birth weight and mean estimated weight using Johnson's formula. But, we must be reminded that the mean is affected by extreme values and does not give a clear picture of the accuracy of the different fetal weight estimation methods.

To provide a better comparison on the accuracy of the four methods, the absolute error of each was computed (Table 3). The palpation method had the lowest mean absolute error, followed by Dare's Method. The Modified Johnson's Formula had the highest mean absolute error, which was compatible with the observations.

This table just shows that the palpation method has the smallest average absolute error (m=3.96) in terms of fetal weight estimation compared with the other methods. This means that on the average, there is a 3.96% error in estimating fetal weight when using palpation method in contrast with the larger percent errors seen in other methods. The range also shows that the maximum absolute error observed in palpation method is only 46% compared with other methods of estimation.

Weight differences from actual birth weight were grouped and analyzed (Table 4 and Table 5). The palpation method had the highest number of estimates with difference less than 100 grams from the actual value. This is consistent with the absolute percent error which showed that the palpation method has most estimates having less than 5% error.

In this study, the overall accuracy of all four methods was as high as 80% in more than 70% of the cases. The most accurate method was the Palmar Method, with 73% of the cases at <5% absolute percentage error. This means that 73% of the estimates are within the 5% of the actual birthweight.

Estimates were further analyzed according to age of gestation. Table 6 summarizes the accuracy and differences based on age of gestation. At 34 – 37 weeks age of gestation, the palpation method had the lowest mean percentage error followed by Modified Johnson's formula. The Johnson's Formula yielded the highest percentage error. At 37 weeks age of gestation and above, the Dare's Method had the lowest mean percentage error, followed by the Johnson's Formula, then Palpation Method. The Modified Johnson's Formula had the highest mean percentage error at 37 weeks age of gestation and above.

Even with this, the palpation method has the highest percentage with estimates within 10% of the actual. It can also be observed that all clinical estimates are more accurate when the birthweight falls at 2000 to 3500 grams. At actual birthweights more than 4000 grams, the Dare's method was noted to be the most accurate, but this is not statistically significant. In terms of absolute percentage error, the palpation method and Modified Johnson's Method have significantly different mean absolute percentage error among neonates weighing 2,000 to 3,500 grams.

Table 8 shows that body mass index does not have significant effect on estimation of fetal weights. However, a trend can be observed. Clinical estimates are closer to the actual birthweights in underweight mothers. As the BMI increases, the mean percentage error also becomes higher, but was not statistically significant.

A one-way between subjects ANOVA was conducted to compare the effect of residency year level on the absolute percent error in estimating fetal weight via palpation method among pregnant women. There was a significant difference that was observed at the $p<.05$ level for the said condition [$F(2, 367) = 11.02$, $p = 0.00$]. Post hoc comparisons using the Scheffe test indicated that the mean score for the seniors (2.43 ± 2.31) was significantly different from the absolute percent errors noted from the junior (4.50 ± 4.74) and sophomore obstetric residents (4.94 ± 5.74).

Overall sensitivity of the estimates was calculated using estimates within 10% of the actual birth weight as the true positive value. The palpation method was noted to have the highest sensitivity, as high as 92%, which was statistically significant at $p>0.01$. In all methods, there is tendency for underestimation at 37 weeks age of gestation and above. In obtaining the correlation coefficient for each, the palpation method has the highest correlation coefficient at 0.93 (the closer the coefficient to 1, the

Table 4. Distribution of cases based on weight differences from actual birth weight

	Palpation method	Dare's method	Johnson's	Modified Johnson's
<100 gms	225	136	33	119
100-199 gms	81	101	35	82
200-299 gms	30	57	50	58
300-399 gms	18	29	65	46
400-499 gms	5	18	56	22
500 gms or more	11	29	131	43

Table 5. Distribution of cases based on absolute percent errors

	Palpation method	Dare's method	Johnson's	Modified Johnson's
<5%	271(73.2%)	183 (49.5%)	143 (38.6%)	40 (10.8%)
5-10%	69(19%)	116 (31.3%)	120 (32.4%)	73 (19.7%)
11-20%	27 (7%)	42 (11.3%)	75 (20.3%)	190 (51.3%)
21-30%	2 (0.5%)	18 (4.8%)	17 (4.5%)	57 (15.4%)
>30%	1 (0.3)	11 (2.9%)	15 (4.05%)	10 (2.7%)

closer it is to the actual birth weight). This meant that the estimates taken using abdominal palpation were the closest to the actual.

Comparing the four methods according to the actual birth weight showed that in general, there is an overestimation in birthweights less than 2000 grams and was statistically significant at p = 0.01. (Table 7) Although not statistically significant, it can be observed that there is a tendency to underestimate in birthweights more than 3500 grams.

A one-way between subjects ANOVA was also conducted to compare the effect of residency year level on the absolute percent errors in estimating fetal weight using the Dare's, Johnson's and modified Johnson's method among pregnant women. There was no significant difference that was observed at the p<.05 level for the said conditions. Post hoc comparisons using the Scheffe test indicated that the mean score for the seniors was not significantly different from the absolute percent errors noted from both those of the junior and sophomore obstetric residents.

Table 6. Accuracy and differences between methods of estimation

	Palpation method	Dare's method	Johnson's	Modified Johnson's
Overall				
Mean percentage error	-1.16±6.02*	3.26±11.04*	1.90±13.40*	-10.44±12.12*
Mean absolute PE	3.96±4.67*	7.44±8.77*	8.94±10.16*	14.10±7.53*
	340	299	263	
Estimates within ±10%	(91.89%)	(80.81%)	(71.08%)	113 (30.54%)
Correlation coefficient	0.93*	0.83*	0.73*	0.75*
34-37 weeks AOG (n=78)				
Mean percentage error	0.41±5.18*	12.05±14.53*	13.29±18.56*	1.40±15.54*
Mean absolute PE	3.77±3.55	13.41±13.27*	15.86±16.4*	11.94±9.95*
Estimates within ±10%	72 (92.31%)	46 (58.97%)*	38 (48.72%)*	36 (46.15%)*
>37 weeks AOG (n=292)				
Mean percentage error	-1.59±6.16*	0.91±8.51*	-1.14±9.62*	-13.6±8.64*
Mean absolute PE	4.02±4.93	5.85±6.24*	7.09±6.60*	14.68±6.65*
Estimates within ±10%	268 (91.78%)	253 (86.64%)*	225 (77.05%)*	77 (26.37%)*

*Values expressed as n(%); * - p>0.05, ** - p>0.01*

Table 7. Accuracy and differences between methods of estimation based on actual weight

	Palpation method	Dare's method	Johnson's	Modified Johnson's
Overall				
Mean percentage error	4.81±12.09*	35.75±10.41*	38.75±14.13*	25.5±9.55*
Mean absolute PE	7.06±10.85	35.75±10.41*	38.75±14.13*	25.5±9.55
Estimates within ±10%	14 (87.50%)	0	0	0
Between 2000 to 3500 grams (n=323)				
Mean percentage error	-0.83±5.05*	2.62±8.23*	1.05±10.67*	-10.97±8.97*
Mean absolute PE	3.43±3.79*	6.05±6.16	7.46±7.69	12.63±6.41*
	303	277	242	113
Estimates within ±10%	(93.81%)	(85.76%)	(74.92%)	(34.98%)
Greater than 3500 grams (n=25)				
Mean percentage error	-7.08±5.64	-6.96±6.13	-7.52±6.40	-22.72±4.72
Mean absolute PE	7.32±5.31	7.20±5.83	7.84±5.99	22.72±4.72
Estimates within ±10%	20 (80%)	17 (68%)	19 (76%)	0
Greater than 4000 grams (n=6)				
Mean percentage error	-10.33±6.22	-6.00±9.72	-11.17±9.39	-26.83±6.27
Mean absolute PE	10.33±6.22	8.00±7.8	13.17±5.46	26.83±6.27
Estimates within ±10%	3 (50%)	5 (83.33%)	2 (33.33%)	0

**Values significant at p>0.01*

Table 8. Accuracy and differences between methods of estimation based on body mass index

	Palpation method	Dare's method	Johnson's	Modified Johnson's
Underweight (n=4)				
Mean percentage error	-1.75±1.71	4.00±3.27	5.25±3.86	-8.25±6.19
Mean absolute PE	1.75±1.71	4.00±3.27	5.25±3.86	8.25±6.19
Estimates within ±10%	4 (100%)	4 (100%)	4 (100%)	3 (75%)
Normal (n=147)				
Mean percentage error	-1.25±6.13	2.45±11.12	1.61±13.46	-9.82±12.4
Mean absolute PE	3.97±4.82	7.48±8.57	9.09±10.03	13.86±7.57
	138	117	105	51 (34.69%)
Estimates within ±10%	(93.88%)	(79.59%)	(71.43%)	
Overweight (n=129)				
Mean percentage error	-1.13±5.53	3.24±11.52	1.85±14.29	-11.13±12.16
Mean absolute PE	3.66±4.29	7.43±9.37	8.92±11.29	14.45±7.90
Estimates within ±10%	119 (92.25%)	101 (78.29%)	94 (72.87%)	32 (24.81%)
Obese (n=44)				
Mean percentage error	-2.18±6.08	5.16±11.70	1.32±12.87	-11.86±12.71
Mean absolute PE	4.59±4.51	7.93±9.99	9.14±9.06	15.86±6.94
Estimates within ±10%	38 (86.36%)	34 (77.27%)	29 (65.91%)	9 (20.45%)

DISCUSSION

Estimated fetal weight is a part of the routine care given by the Obstetricians for patients. As shown in previous studies, clinical estimation of fetal weight does not differ much from those taken ultrasonographically. The question now is: which clinical estimate has the nearest value to the actual?

In this study, the palpation method was noted to be the most accurate estimate compared to the other three methods. This coincided with the study done by Belete and Gaym in Ethiop in 2004.[3] Compared with the Johnson's rule, the estimate obtained by abdominal palpation was closer to the actual birthweight. It was also noted by the authors that in higher weight category, the Johnson's formula was noted to be more accurate, as was also observed in this study.

At 34-37 weeks age of gestation, the palpation method had the least percentage error. The estimates taken with this method had the closest value to the actual birth weight compared to Dare's, Johnson's and Modified Johnson's Formula. There was also a tendency among the residents to overestimate, as was observed by Shittu and colleages.[7] At 37 weeks and beyond, the Johnson's method had the lowest percentage error, followed by Dare's Method. This coincided with the findings in the study done in Thailand where 72% of the estimated weight predictions within the average 10% of the actual birth weight using Johnson's Formula.[6] Similarly, the Dare's Method was noted to be accurate, with approximately 86% of the estimates are within 10% of the actual birthweight, especially in term pregnancies.[9]

The estimates taken using abdominal palpation method was noted to be the most accurate among the four methods, with accuracy rate of 95% in 72% of the cases and sensitivity of 92.2%. This is the highest rate compared to other studies done.[3,4,5,7,8,11] The Modified Johnson's Formula was noted to be the least accurate, in contrast to the results obtained by Tlale and colleagues done on South Africa during its validation as a formula in estimating fetal weight,[12] 38% of the estimates taken were within 10% of the actual weight in contrast to 68% taken in their validation study. Although the formula was noted to be repeatable during the validation, the authors explained that it should be done at term pregnancies and during the first stage of labor.

The Johnson's Method has been an indispensable tool in clinically estimating fetal weight. There has been contention to its applicability to Asian women, since the estimates obtained were larger than the actual birthweight.[12] Using this formula, approximately 70% were within the 10% of the actual weight. This is consistent in other studies that compared clinical estimates with sonographic estimates.[1-7] This method also tends to overestimate in birthweights less than 2000 grams and underestimate in birthweights more than 3500 grams, which was consistent in a study done by Numprasert.[6] At 37 weeks age of gestation, estimates within 10% were noted to be 77%. Overall, the sensitivity of the Johnson's method was 71%, with correlation coefficient at 0.73,

which was statistically significant at p = 0.05.

Clinically estimating fetal weight using fundic height and abdominal girth is an objective method.[2,6] The Dare's Method can be a reliable tool, with 80.8% of the estimates falling within 10% of the actual birthweight. The correlation coefficient is also relatively high, at 083, and was statistically significant at p = 0.05. In a recent study, it was compared with sonographic estimates and the result was there was no significant difference between the sonographic and clinical estimate using Dare's Method.[6] Of the four methods studied, only Dare's Method had comparable estimates in birthweights more than 4000 grams, but this may still be inconclusive because of the small sample.

Clinical estimates may be affected by maternal build at the time of the examination. Ananlysis done using Wilcoxon test to correlate body mass index (BMI) with clinical estimates. In contrast to the result in a study done in Thailand, where there is poor correlation with estimates in patients with higher BMI,[5] BMI does not have a significant effect on estimation of fetal weights. However, it can be observed that estimates are closer to the actual birthweights in underweight mothers. As the BMI increases, the mean percentage error also becomes higher, but was not statistically significant.

Experience of the clinicians also plays a role in estimating fetal weight.[13] Estimates taken by senior residents using palpation method were closer to actual birthweight compared to junior residents.

Fourth year residents have closer estimates compared to third and second year residents during abdominal palpation. This proves the subjectivity of the palpation method in estimating fetal weight. The other three methods however did not show any difference in the estimates between year levels. This shows that even unexperienced clinicians may use the three methods (Dare's, Johnson's and Modified Johnson's) and have estimates comparable to skilled obstetricians. The study therefore recommend that the Johnson's method and Dare's be utilized by junior residents. While on training, they should practice estimating using abdominal palpation.

CONCLUSION

Equipped with different methods in estimating fetal weight, obstetricians are now able to predict fetal weights and foresee possible complications that may be encountered during delivery. In low resource settings, clinical methods may be used to estimate fetal weights in absence of congenital anomalies and abnormalities in the placenta.

The clinician's estimate using the palpation method is by far the most accurate in any age of gestation, followed by Johnson's Method, and the Modified Johnson's Method with the least accurate estimate. At 34-37 weeks age of gestation, the palpation method had the closest estimate. At 37 weeks age of gestation and above, the Dare's Method is more superior.

Experience affects clinical estimate when using abdominal palpation, the values obtained by senior residents were noted to be closer to actual compared to second and third year residents. The Johnson's Method, Dare's Method and the Modified Johnson's Method however are not affected by experience. Although it can be observed that estimates are closer in patients with lower BMI, this was not statistically significant.

Disclosure of conflict of interest

The investigators are not affiliated with organizations or committees that could affect the results and conclusions of the study. They also have no competing financial interests that could reasonably be viewed as a conflict of interest.

Recruitment and obtaining of informed consent was done by the principal investigator. If the principal investigator is the resident-in-charge of the patient, the informed consent was secured by a research assistant.

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