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The Ability of Medical Students in the Prediction of Birth Weight

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ABSTRACT

Objective To assess the accuracy of clinical fetal weight estimation performed by medical students.

Design Cross-sectional comparative study.

Material and methods The study sample included 1880 pregnant women admitted for delivery in Thammasat hospital between March 1999 and February 2000. Estimated fetal weight (EFW) was performed clinically by last-year medical students and lecturers. The accuracy of clinical EFW was determined by errors using actual birth weight as the gold standard, consisted of percentage error, absolute percentage error and proportion of accurate estimation within 10% of actual birth weight. Comparison of the accuracy between examiners was assessed by paired *t* test, comparison of correlated variances, Wilcoxon signed-rank test, Student *t* test and χ^2 test.

Results The actual birth weight in the study population averaged 3077 ± 503 g (mean ± SD). In the entire population and in the middle range of birth weight group (2500-3999 g), students predicted birth weight within acceptable range. In the low birth weight (<2500 g) and high birth weight (≥4000 g) groups, students systematically over- and underestimated the actual birth weight respectively. The rate of estimates within 10% of birth weight in the entire population was 69%. When comparing with lecturers, there were no significant differences in mean percentage and absolute percentage errors between student's and lecturer's estimates in the entire population. In the low birth weight group (<2500 g), all mean errors of EFW by lecturers were significantly smaller than those of EFW by students and the proportion of estimates within 10% of birth weight was significantly higher for lecturers.

Conclusion Last-year medical students can fairly predict birth weight except in the low birth weight group. Lecturers should train medical students by obtaining feedback on their assessments and note the range of accuracy of their own weight predictions especially at the extremes of the scales (< 2500 g and ≥ 4000 g).

Key words : Estimated Fetal Weight

Fetal weight estimation is often beneficial in determining obstetrical interventions. Firstly, this prediction helps to assess fetal growth in utero that could lead to further investigations and management.[1] Secondly, it helps to assess the chance for neonatal survival in extremely preterm gestations and may guide

decisions regarding the maternal transportation to regional perinatal centers,[2] the most proper route of delivery,[3] the interventions undertaken to postpone preterm delivery[4] and perinatal counseling on the likelihood of infant survival.[5] Finally, it can lead to choosing mode of delivery for very large fetuses regarding prevention of shoulder dystocia[6] and for large fetuses with breech presentation regarding prevention of birth asphyxia.[7]

Estimated fetal weight (EFW) may be performed either clinically or sonographically. Ultrasound prediction may be more advantageous because it is objective, reproducible and able to look for associated factors such as amniotic fluid volume and placental grading.[8] However, ultrasound procedure needs skilled physicians and must be at the patient's expense. In most general hospitals, although both ultrasound machine and skilled physicians are available, but ultrasound cannot be routinely used to estimate fetal weight in the majority of cases because of the cost to patients. In regional hospitals, ultrasound machines usually are available, but there may be a lack of skilled physicians. Moreover, in some small rural hospitals, ultrasound may not be available. For extreme instances, some pregnant women may have never received antenatal care until they have labor pain, and if these women attempt to deliver at rural hospitals where either ultrasound or skilled physician is not available, clinical EFW at this situation must be extremely helpful.

Studies in recent years have shown that clinical EFW is as accurate as ultrasonic EFW[8-11] and some studies have shown that it is more accurate than ultrasonic estimation,[12-14] therefore; clinical EFW should have been pushed forward to use widely because of its benefits. However, clinical EFW is suggestive, poorly defined and has no standard measurable technique. The way to achieve accurate estimation by this method is the use of a physician's experience. Because of the great variations among physician's experience in real practice and because last-year medical students are persons who are going to become general practitioners in near future, the present study is intended to assess their ability in the prediction of birth weight by evaluating the accuracy of clinical EFW. The present study also compares the accuracy of clinical EFW performed by students to that of the more-experienced personnel.

Materials and methods

The study population consisted of 1880 pregnant women admitted for delivery between March 1999 and February 2000 in Thammasat University Hospital. Inclusion criteria were: 1) singleton pregnancy, 2) admission for planned delivery or in early labor and 3) gestational age beyond 28 weeks. Exclusion criteria were: 1) multifetal pregnancy, 2) dead fetus in utero and 3) fetal anomalies. Clinical fetal weight estimates were carried out by twenty last-year medical students and two lecturers representing less and more experienced examiners respectively. Students admitted in the protocol were randomly selected from all last-year students. The number of the study population was calculated by increasing number as adequate as the interobserver reliability from twenty medical students was acceptable, originally from pilot study of 500 samples (correlation coefficient = 0.7, $P < 0.05$ and interobserver reliability = 75 %). Clinical EFW of each sample was performed by one student and one lecturer using the abdominal palpation (Leopold's maneuver) after the admission nurse identified a case that met the inclusion criteria. No special training was undertaken nor was a standardized method used to clinically estimate the birth weight. Neither the antenatal records nor any discussion were available to the examiners before the clinical estimation. The student and the lecturer who obtained clinical EFW of each sample were selected at random. Both estimations were made blinded each other. Estimates obtained from both examiners were entered into the questionnaire, then other information was undertaken and recorded into the questionnaire. The actual birth weight was measured and recorded into the questionnaire immediately after delivery. Ballard score was also determined to confirm gestational age. Of 2000 pregnant women who met inclusion criteria, 120

(6%) were excluded because either exclusion criteria were met by chance after delivery (i.e., anomaly that had not been antenatally recognized) or the questionnaire records were incomplete.

The accuracy of birth weight estimation was determined by calculation of the percentage error ([estimated birth weight - actual birth weight] x 100 / actual birth weight), the absolute percentage error (absolute value of the percentage error) and the ratio (by percentage) of estimates within 10 percent of the actual birth weight. The percentage error in this study expresses the deviation as a percentage of the actual birth weight and is comparable across samples, therefore; the mean percentage error represents the summation of the positive (overestimation) and negative (underestimation) deviations from the actual birth weight. Zero in the method represents very low or no measurement error. The mean absolute percentage error is the summation of the absolute deviations of the percentage error which expresses the size of the overall predictive error in terms of the actual birth weight. The data were divided into three strata of birth weight (< 2500 g, 2500 - 3999 g and ≥ 4000 g). Statistical analysis used paired *t* test, comparison of correlated variances (a modification of the standard *F* test), Wilcoxon signed-rank test, Student *t* test , and χ^2 test to adjust for comparison between groups, as appropriate, $P < 0.05$ was considered statistically significant.

Results

The actual birth weight in the study population averaged 3077 ± 503 g (mean ± SD) and ranged between 1060 and 4940 gram. The distribution of birth weights is shown in Figure 1. Among the 1880 parturients, the mean maternal age was 26.4 ± 5.1 years and ranged between 14 and 45 years. Median of gravidity was 2 and median of parity was 1. Gestational age at delivery averaged 38.6 ± 2.1 weeks and ranged between 29 and 43 weeks, consisted of preterm (28th - before 37th week) for 8.2 percent, term (37th- 42nd week) for 86.3 percent and postterm (after 42nd week) for 5.5 percent.

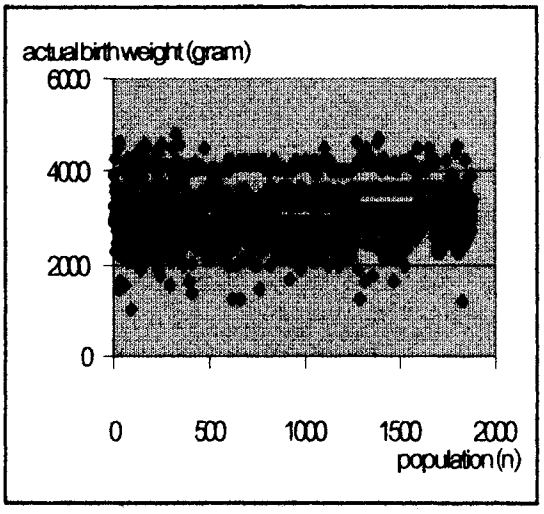

Fig. 1. Distribution of birth weights in the study population.

The accuracy of clinical EFW performed by last-year medical students and lecturers is shown in Table 1. In the entire (1880) study population, the mean percentage error of clinical EFW by both examiners was not significantly different from zero, meaning no measurement error. The rates of estimates within 10% of birth weight were 69% and 72% for EFW by students and lecturers respectively. There were no significant differences in mean absolute percentage error between both estimates (analyzed by the Wilcoxon signed-rank test because the absolute errors were not normally distributed). Paired t test was used to assess differences between both estimates in the mean percentage error to see how large the size of the measurement error was. It was found that the mean errors were not significantly different between both estimates. Comparison of correlated variances (a modification of the standard *F* test) was used to assess random error, it was found that there were no significant differences between both estimates. The last one, χ^2 test was used for comparison of ratios of estimates between two groups that were within 10% of the actual birth weight and it was found that there were no significant differences in the ratios of both estimates

When dividing by the birth weight strata (Table

1), in the low birth weight group (<2500 g), students and lecturers systematically overestimated the actual birth weight. The rates of estimates within 10% of birth weight were 41% and 50% for EFW by students and lecturers respectively. Mean percentage error and mean absolute percentage error of the estimation by lecturers were significantly smaller than those of the estimation by students. The proportion of estimates within 10% of the actual birth weight was significantly higher for the estimation by lecturers than for that of the students.

In the middle range of birth weight group (2500-3999 g), students and lecturers estimated fetal weight without measurement error. The rates of estimates within 10% of birth weight were 73% and 75% for EFW by students and lecturers respectively. There were no significant differences between both estimates in all mean errors and in the proportion of estimates within 10% of the actual birth weight.

In the high birth weight group (≥4000 g), students and lecturers systematically underestimated the actual birth weight. The rates of estimates within 10% of birth weight were 61% and 63% for EFW by students and lecturers respectively. The mean percentage error and mean absolute percentage error were not significantly different between both estimates. The proportion of estimates within 10% of the actual birth weight was not significantly different between both estimates.

Table 1. The accuracy of clinical EFW obtained by medical students and lecturers

Birth weight strata (n)	Accuracy assessment	Medical students	Lecturers	Statistical difference, P
All	Percentage error	-0.67 ± 10.58*	-0.40 ± 8.14*	NS* *, NS* * *
(1880)	Absolute percentage error (mean ± SD)	7.94 ± 6.70	7.50 ± 6.71	NS* * * *
	Birth weight ± 10 % (%of estimates)	69.57	72.46	NS* * * * *
<2500 g	Percentage error (mean ± SD)	14.50 ± 19.00	9.15 ± 10.32	<0.001**,NS** *
(150)	Absolute percentage error (mean ± SD)	16.04 ± 10.75	12.54 ± 12.01	< 0.0015* * * *
	Birth weight ± 10 % (%of estimates)	41.74	50.15	< 0.03* * * * *
2500-3999 g	Percentage error (mean ± SD)	-0.60 ± 9.05*	-0.14 ± 8.70*	NS* *, NS* * *
(1556)	Absolute percentage error (mean ± SD)	7.80 ± 6.00	7.17 ± 5.94	NS* * * *
	Birth weight ± 10 % (%of estimates)	73.16	75.61	NS* * * * *
≥4000 g	Percentage error (mean ± SD)	-8.99 ± 7.15	-8.25 ± 6.04	NS* *, NS* * *
(174)	Absolute percentage error (mean ± SD)	9.35 ± 5.04	9.02 ± 4.47	NS* * * *
	Birth weight ± 10 % (%of estimates)	61.37	63.45	NS* * * * *

SD= standard deviation, NS= not significant,
* not significantly different from zero (Student *t* test) = meaning no measurement error,
* * Paired t test for comparison of means (= measurement errors),
* * * Comparison of correlated variances (SD) (= random errors),
* * * * Wilcoxon signed-rank test for comparison of absolute errors (= overall predictive error),
* * * * * χ^2 test for comparison of ratios of estimates between two groups that were within 10% of the actual birth weight

Discussion

Clinical EFW is a topic that has been discussed for five decades. The method of estimation has generally been known to be obtainable by simple external abdominal palpation. Some researchers proposed quantified external uterine measurement methods such as method of Johnson and Toshach (calculated by using longitudinal tape measurement { [McDonald's measurement / 3] -13= fetal weight })[15] , method of McSweeney (calculated by adding the two longitudinal uterine measurements to the two transverse uterine measurements allowing for excessive obesity and station of the presenting part),[16] by expecting that these methods may improve the accuracy of clinical EFW. However, later study by Niswander KR, et al showed that the data from these methods failed to prove that more precise measurement of fundal size would allow accurate prediction of birth weight and the largest errors occurred with infants of low birth weight, authors concluded that prediction of birth weight with simple external abdominal palpation had similar accuracy.[17] For the past two decades, ultrasound technology has become more prominent. There are formulae postulated by many authors obtaining fetal weight prediction by calculating from direct fetal parameter measurement. The accuracy of EFW by a variety of different formulae has been studied extensively,[18,19] however, no particular formula or biometric measurements had superior accuracy.[20,21] Moreover, many studies in recent years have shown that clinical EFW is as accurate as ultrasonic estimation[8-11] and some studies have shown that it is more accurate than ultrasonic estimation.[12-14] Therefore; clinical EFW, especially by simple external abdominal palpation, is still in clinical practice.

The present study intensively assesses the ability of last-year medical students to perform clinical EFW. The ability is represented by the accuracy of the estimation. We show the accuracy of clinical EFW resulted from different studies[8-11,13,22] in Table 2. Results of the present study are consistent with those of other studies and show that the estimations performed by students are similarly accurate.

Sherman DJ, et al [9] and Raman S, et al [12] also studied by dividing in three birth weight strata. Patterns of accuracy assessment obtained by examiners in the present study are as same as those of the previous studies, that are; overestimation in the low birth weight group, no measurement error in the middle range of birth weight group and underestimation in the high birth weight group.

From the above findings, the accuracy of clinical EFW obtained by last-year medical students in the present study seems to be similar to that of other personnel. We also compare between students and lecturers on purpose to assess effect of experience on the accuracy of clinical EFW (Table 1). It is found that there is no significant difference in the accuracy of clinical EFW between students and lecturers in the entire (1880) population. Our finding is consistent with results that had been previously discussed by other authors[23-26] that the accuracy of clinical EFW is generally not influenced by personnel's experience.

When dividing by birth weight strata, there are striking results in the low birth weight group (<2500 g). Even though both students and lecturers systematically overestimate the actual birth weight, the mean percentage error and the mean absolute percentage error of the estimation by more experienced examiners (lecturers) are significantly smaller than those of the estimation by less experienced examiners (students). The proportion of estimates within 10% of the actual birth weight is also significantly higher for the estimation by the lecturers (Table 1). These findings are discussed that experience of examiners has significant effect on the accuracy of clinical EFW in the low birth weight group.

Insler V, et al [23], Herrero RL, et al [26] and Ong HC, et al [27] concluded in their studies that experience of examiners did not influence the accuracy of clinical EFW. Differences of the study designs of the present and other studies[23,26,27] are shown in Table 3. It is suggested that 1) even various degrees of experience are used for comparison, 2) even statistics used for accuracy assessment have been changed and 3)even sample size has been increased to improve reliability,

experience does not generally affect the accuracy of clinical EFW. Why does experience of examiners generally not influence on the accuracy of clinical EFW? This may be explained by prior knowledge and expectations of the human observer. By knowing the mean birth weight, a relatively accurate estimate of birth weight may be obtained without even examining the patient, especially with the assumption of a term pregnancy and comparison of the uterine size to the average term uterus. It is the fact that most of study population (around 80%) are located in the middle range of birth weight group or that described above "the average term uterus". The result in this group reveals no measurement error, it also makes the same result in the entire population. However, data in the present study demonstrate that in the low range of birth weight group (< 2500 g), experience of examiners has significant effect on the accuracy of clinical EFW. This finding has never been demonstrated in earlier studies which focused only on the entire population.

The potential limitation of the present study is the difficulty of how to choose the appropriate number of examiners that interobserver variation could be minimized. The students must be chosen with some number according to the basis of behavioral sciences that cognitive learning by repeated doing and self assessment after each examination may affect their present ability assessment.[28] The authors decided to randomly choose 20 students to represent the whole last-year medical students, then reduced interobserver variability by increasing study population. This fundamental is supported by the formula for the standard error of mean, $\sigma/\sqrt{n}$, shows that the effect of random error can be reduced by increasing n (number of samples).[29]

Results from the present study would help lecturers to emphasize it in teaching medical students. They may have defects in the accuracy assessment in the low birth weight group. We suggest that this is important because last-year medical students are the becoming general practitioners who will work mostly in rural hospitals where clinical EFW is essential. Moreover, clinical EFW in the low birth weight group is very beneficial in determining obstetrical interventions. Lecturers should train medical students by obtaining feedback on their assessments and note the range of accuracy of their own weight predictions. Finally, we suggest that care must be taken in accepting estimates of fetal weight at the extremes of the scales (< 2500 g and ≥ 4000 g) for any levels of experience of examiners because measurement errors eventually occur (over- and underestimation respectively).

Table 2. Results comparing the accuracy of clinical EFW from different studies

References	Study population	Birth weight ranges	Mean absolute percentage error	Birth weight ±10 % (%of estimates)
Watson et al 1988[10]	100	2280-4650	8.2%	66%
Chauhan et al 1992[11]	106	2440-5225	9.0%	66%
Chauhan et al 1993[13]	200	2440-5225	9.1%	65%
Shamley et al 1994[22]	223	2028-4678	8.4%	66%
Sherman et al 1998[9]	1717	690-5320	7.9%	72%
Chauhan et al 1998[8]	1034	300-5240	Not available	55.3%
Present study	1880	1060-4940		
-students			7.9%	69.6%
-lecturers			7.5%	72.5%

Table 3. Studies comparing the accuracy of clinical EFW by experience of examiners

References	Study population	Degree of experience used for comparison	Statistics used to assess accuracy	Results
Insler et al 1967 [23]	100	4, 6, and 11 years training in obstetrics	Error as < 10,10-20,20-30, and > 30 % of actual birth weight	NS**
Ong et al 1972 [27]	506	Medical students, staff nurse, medical officers, and lecturers	Error as ± < 8, 8-16, 16-32, and > 32 ounces different between actual and estimated weight	NS**
Herrero et al 1999 [26]	471	Various years of physician experience in obstetrical practice	Error* and percentage of fetal weight estimates within 10% of actual weight	NS**
Present study	1880	Last year medical students and lecturers	Error* and proportion of estimates within 10% of the actual birth weight	NS** except in low birth weight group

*mean absolute percentage error,
**NS = not significant (no significant difference in the accuracy of clinical EFW between different examiner)

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