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ACCURACY OF ULTRASOUND VERSUS CLINICAL FETAL WEIGHT ESTIMATION AT TERM WITH ACTUAL BIRTH WEIGHT IN KENYATTA NATIONAL HOSPITAL

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Abstract

Purpose*:* The purpose of this study was to correlate fetal weight estimation by ultrasound and clinical methods with actual birth weight in KNH.

Methodology*:* This is a prospective comparative study. The design was suitable because it enabled comparison of the predictive value, sensitivity and specificity in estimating fetal weight which is known after birth. Study area was KNH Obstetric wards. The study population was all pregnant women admitted to obstetric wards for elective caesarean delivery and study period was February -March 2016. Data was analysed using SPSS version 20. Categorical variables were presented as proportions in tables and graphs, bars or pie charts). Continuous variable were summarized as means or medians and presented in table form.

Results*:* The findings show that the correlation between actual weight and Ultra Sound estimated weight was significant ($r=0.65$, $p<0.000$). The findings further showed that the proportion of Ultra Sound methods estimations within $\pm 10\%$ of the actual birth weight was 44% of the overall weights. Clinical methods estimations within $\pm 10\%$ of the actual birth weight were 47% of the overall weights. The mean difference between actual birth weights and ultra sound estimated weights were statistically insignificantThe findings revealed that the correlation between actual weight and clinical methods estimated weight was stronger ($r=0.79$, $p<0.000$) as compared to the correlation between actual weight and Ultra Sound estimated weight ($r=0.65$, $p<0.000$).

Unique contribution to theory, practice and policy: The finding of this study may influence further studies and decision on estimation of fetal weight. If clinical estimation is equal or same as ultrasound estimation then it can be recommended that all mothers undergo this instead of ultrasound for estimation of fetal weight. The results may be shared with the University of Nairobi, Kenyatta National Hospital and the Ministry of Health and any policy change resulting from this can be rolled down to counties.

Keywords: *fetal weight estimation, ultrasound, clinical methods, actual birth weight*

1.0 INTRODUCTION

1.1 Background of the Study

Fetal weight estimation is pivotal in decision making during intrapartum and postpartum care of both the mother and the newborn, this is especially so for the low (<2500g) and excessive (>4000g) fetal weight categories which are associated with an increased risk of complications. Fetal weight estimation therefore has a significance role in prevention of maternal and perinatal morbidity and mortality.

Maternal complications such as a cephalopelvic disproportion and its sequale; vesico-vaginal fistula, recto-vaginal fistula, perineal injuries, foot drop, uterine rupture and death can be prevented by antepartum and intrapartum fetal weight estimation. Perinatal morbidity and mortality is related to the fetal weight especially in the extremes of weights.About 80% of all maternal deaths globally can be directly attributed to pregnancy, with severe bleeding accounting for 25%, infections 15%, eclampsia12%, obstructed labour 8%, unsafe abortion 13%, other direct cause 8%. Foetal weight estimation would greatly predict cases of labour obstruction and necessary action taken beforehand.

More than half a million women die during pregnancy and childbirth every year worldwide. For every woman who dies another 30 suffers long-lasting injuries and illnesses (1). Maternal health is inextricably linked with the survival of the newborn: every year four million babies die in the first four weeks of life (the neonatal period), a similar number are stillborn. Three quarters of neonatal deaths occur within the first week and the highest risk of dying is within the first 24hours. Almost all (99%) neonatal deaths occur in low income or and middle income countries where facilities are lacking in equipment such as ultrasound machine and qualified personnel. (2) (3) Perinatal mortality rate i.e. the number of still births plus neonatal deaths during first 7 days per 1000 total births remain high in Kenya, KDHS 2008/9 is at 37/1000 live births. This is directly attributable to birth weight especially in the extremes of weight. (4)

Maternal mortality ratio (MMR) is the number of women who die as a result of child bearing during pregnancy, or within 42 days of delivery or termination of pregnancy in one year, per 100,000 live births. The global statistics indicate that there is increase in pregnancy related deaths. In Kenya, the estimates of deaths related to pregnancy and childbirth have increased over the decades. MMR estimates in Kenya have been high by global standards over the past decades with ratio of 590/100,000 in 1998. In 2003, there was a slight decline to 414/100,000. However, available data reveals that the ratio has again taken an upward trend. It is currently estimated at 488/100,000. (4). Accurate estimation of foetal weight would prevent some of these deaths.

Some studies in West Africa show a correlation between clinical orthopometric measurements and formulae with actual birth weight. It's not clear whether the studies have led to policy change thus a hiatus in translation of the research findings into policy on clinical estimation. This creates a necessity for a policy oriented study; though this study may lack the power to influence policy change it can guide further studies on the same.

1.2 Problem Statement

Limited resources in our country hinder accurate estimation of fetal weight by ultra sound. It is therefore important to validate use of clinical estimation of fetal weight. It is on this basis that this research was designed in an attempt to give credit to clinical method as predictor of fetal weight

1.3 Objectives of the Research

To determine and compare the accuracy of routine ultrasound fetal weight estimation at term with actual birth weight

To determine and compare the accuracy of clinical fetal weight estimation at term with actual birth weight

To determine and compare the correlations of ultrasound and clinical fetal weight estimation with actual birth weight

2.0 LITERATURE REVIEW

2.1 Empirical Review

Fetal weight estimation is pivotal in decision making in antepartum, intrapartum and postpartum care of both the mother and the newborn, (5) (6) (7)123. This is especially so for the low(<2500g) and excessive (>4000g) fetal weight categories which are associated with an increased risk of complications. (8)

The low birth weight category is associated with perinatal complications which are attributable to preterm delivery, IUGR or both. These include birth asphyxia, hypothermia, hypogylcaemia, neonatal sepsis and long term neurological sequelae among other complications. Perinatal mortality for the low birth weight tends to be much higher when compared to the normal birth weight. (3)

On the other hand, the delivery of an excessively large fetus is associated withan increased risk of perinatal morbidity and mortality and maternal morbidity. (6) (8) (9). Injuries such as shoulder dystocia, brachial plexus injuries, bony injuries and intrapartum asphyxia are some of the acute perinatal complications. Long term neurological complications are also not uncommon. Cephalo-pelvic disproportion incidences also increase with increasing fetal weight and so are operative vaginal deliveries. Pelvic floor injuries are also common and resulting in puerperal sepsis, VVF/RVF, foot drop. PPH is also common occurrence. (10)

Pre-partum fetal weight monitoring is therefore crucial and potentially useful in making decisions in obstetric care, any method which can reliably predict the fetal weight will contribute greatly in limiting the potential complications associated with the low and excessive fetal weight categories.(10) (11) (6)

Internationally similar studies have been conducted, Mehdizadeh et al in study conducted in 200 Iranian pregnant women and published in American Journal of Perinatology 2000, found same margins of error in both clinical and ultrasound fetal weight estimation and concluded that

clinical estimation is as accurate as ultrasound fetal weight estimation. In a similar prospective study in Southwest Nigeria, Akinola S.S. and his team concluded that clinical estimation is as accurate as ultrasound estimation except in low birth weight babies. In Kenya while clinical estimation and ultrasound estimation have been studied separately we did not find any study correlating the two.

The two main methods for predicting birth weight in current obstetrics are; a) clinical techniques based on abdominal palpation of fetal parts and calculations on fundal height, (12) b) imaging techniques such as ultrasonography and MRI. Although some researchers consider ultrasound estimates to be superior to clinical estimates, others in comparing both techniques concurrently, conclude that they confer similar levels of accuracy (12) (13) (14) (15)

Clinical Methods

Different clinical methods have been used for estimating the fetal weight, these include; tactile assessment of fetal size e.g.Leopold'smaneuver; clinical risk factors; maternal self assessment and prediction equations of birth weight. Research suggest that clinical fetal weight estimation is as accurate as ultrasound estimation. (15)

Tactile assessment of fetal size;

It is the oldest technique for assessing fetal weight through manual palpation by obstetrician all over the world. It is convenient and costless. However it is subjective and thus associated with significant predictive error. It is both patient and clinician dependent for its success(less accurate for obese gravidas than non-obese and significant inter observer variation in prediction of birth weight even among experienced clinicians) (16) (17)

Clinical risk factors:

This involves quantitative assessment of clinical risk factors and has been shown to be valuable in predicting fetal birth weight. In case of fetal macrosomia, the presence of risk factors such as maternal diabetes, abnormal glucose screening test, prolonged pregnancy, maternal obesity , pregnancy weight gain > 20kg, maternal age of > 35 years, maternal height >5ft 3in, multitparity, male fetal sex, and white race, should make the obstetrician suspicious of fetal macrosomia and assess accordingly. (6)

Maternal self-estimation:

Maternal self-estimation of fetal weighting multiparous women shows comparable accuracy to clinical palpation in some studies especially for large fetuses. (18) (19)

Birth weight prediction equations:

Various calculations and formulae based on measuring fundal height above symphysispubis have been developed. Ojwang et al used the product of symphsio-fundal height and abdominal girth at various levels (largest) in centimeters above the symphysis pubis (minus 450 to cater for placental weight) in obtaining fairly acceptable predictive value but with considerable variation from the mean. To further simplify this method Dare et al in 1988 used the product of symphsio-fundal height and abdominal girth at the level of umbilicus measured in centimeters and result

expressed in grams to estimate in -utero fetal weight and the estimates correlated well with birth weight. (20) (16)

Johnson's formula for estimating fetal weight in vertex position is as follows; foetal weight (g)=FH(cm)-n ×155. n =12 if vertex is above ischial spine or 11 if vertex is below ishial spine. If a patient weigh more than 91kg, 1cm is subtracted from the fundal height. For this study Dare's formula was used for its simplicity and can be used by all cadres of clinicians.

Imaging Techniques

Ultrasonography

Obstetric ultrasonography is a modern method of assessing the fetal weight, it involve the use of linear and planar measurement of fetal dimensions such as Femur Length (FL), Abdominal Circumference (AC), Head Circumference (HC), Biparietal Diameter (BPD). Sonographic predictions are based on algorithmsusing various combinations of fetal parameters (21) (6) (9) (5) (22)

Several technical limitations of the sonographic technique for estimating fetal weight are well known these include; maternal obesity, oligohydramnious, and anterior placentation. Other disadvantages of ultrasonography are that it's complicated and labour intensive and potentially being limited by suboptimal visualization of fetal parts. Sonographic machines are costly and require highly trained personnel. Although ultrasonography services are readily available in developed nations this is not the case in developing countries. (5) (23)

Magnetic resonance imaging

This has recently been used for estimating fetal volume and weight using high resolution magnetic resonance imaging machine combined with semi-automatic segmentation software. Its use may be recommended for clinical situation where accurate estimation is essential. Its strong disadvantage is that even where available it is expensive. (24)

The currently available techniques for estimating fetal weight have significant degree of inaccuracy and various studies have been done to compare the accuracy of different methods of estimation. Limiting the potential complications associated with birth of both small and excessively large fetuses requires that near accurate estimation of fetal weight occurs in advance of deliveries. (21) (12) (13). This study therefore aimed at comparing ultrasound estimation of fetal weight versus clinical estimation with the actual birth weight in our setting.

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2.2 Conceptual Framework

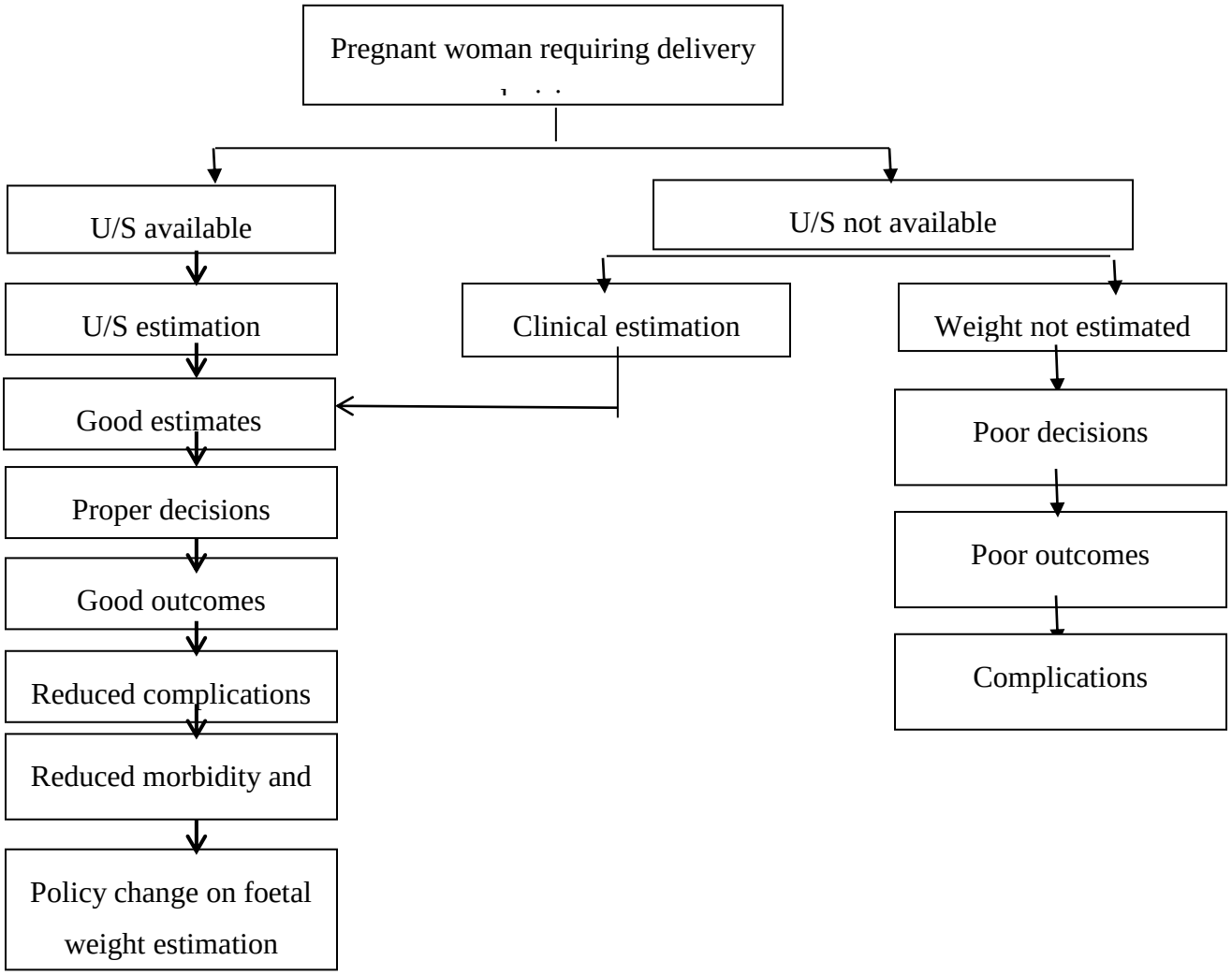

Figure 1: Conceptual Framework

3.0 RESEARCH METHODOLOGY

This is a prospective comparative hospital based study at KNH obstetric wards. All pregnant women admitted to obstetric wards at KNH were our target population. Pregnant women at term (37 completed weeks and above) admitted to obstetric wards for elective caesarean delivery KNH was purposely chosen for the study. Volunteer gravid mothers admitted to obstetric wards were consequently recruited till the sample size was achieved. The sample size was 96. A

questionnaire (time schedule), written in English were used to collect necessary information from the respondents. Clinical estimation was done using a flexible tape measure calibrated in centimeters. Ultrasonography was done by one selected senior registrar in the radiology, this ensured reduced inter observer error. The ultrasound estimation was done using LogiQ P6 Pro ultrasound machine in labour ward. After delivery midwife on duty weighed the newborn babies within 30 minutes of delivery employing standard Kubota Baby Scale. The weighing scale was calibrated daily for zero error. The actual birth weight were filled in the partograph and extracted by an assistant. These measurements and estimates were documented into a chart.

4.0 RESULTS AND DISCUSSIONS

4.1.1 Response Rate

The study recruited 102 participants but only 100 participants completed the study. Therefore this study had a completion rate of 98%.

4.1.2 Demographic Characteristics of ANC Mothers at KNH

The results in the table below provide the demographics characteristics of the participants in this study. The results show that 71% of the ANC mothers who participated in this study were of the age group of between 25 and 34 years. The second largest age group were between 35 and 44 years represented by 27% of the total sample while mothers of age group of between 18 and 24 years were the least at 2%.

The findings also show that slightly above 50% of the participants in this study had secondary level of education which was followed by those with tertiary level of education at 33%. Participants with primary level of education were the least at 15% as shown in Table 4.1 below.

The study also sought to find the marital status of the participants. The results show that majority (71%) of the participants were married. Those who indicated were divorced/separated were 18% and finally single mothers were 11% of the total participants. The results further show that 90% of the participants were Christians.

The study required the participants to indicate their residence. The results in Table 1 indicated that were from urban setting while 3% were from peri-urban setting. Since this study from conducted at KNH which is located in Nairobi metropolitan, this finding could imply that majority of the participant were from region this region. The findings further indicated that 37% of the respondents were unemployed, while 34% of the participants were self employed. The proportion of the respondents who were employed was 29%.

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Table 1: Demographic Characteristics of ANC Mothers at KNH

Variable	Category	Frequency	Percent (%)
Maternal age	18-24 years	2	2
	25-34 years	71	71
	35-44 years	27	27
	Total	**100**	**100**
Level of education	Primary	15	15
	Secondary	52	52
	Tertiary	33	33
	Total	**100**	**100**
Marital status	Single	11	11
	Married	71	71
	Divorced/separated	18	18
	Total	**100**	**100**
Religion	Christians	90	90
	Muslims	10	10
	Total	100	100
Residence	Urban	97	97
	Peri-Urban	3	3
	Total	**100**	**100**
Occupation	Employed	29	29
	Self employed	34	34
	Unemployed	37	37
	Total	**100**	**100**

Figure 1 below shows the Maternal Age Bracket

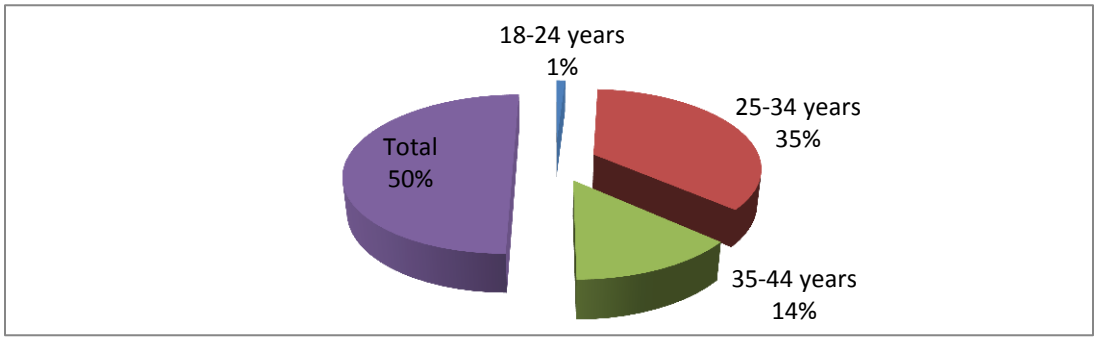

Figure 1: Maternal Age Bracket

Figure 2 below shows the marital status

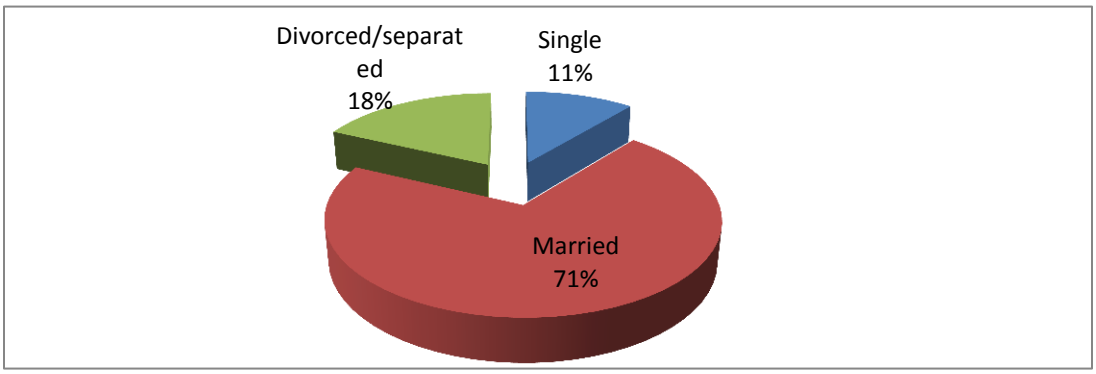

Figure 3 Marital Status

Figure 3 below shows occupation

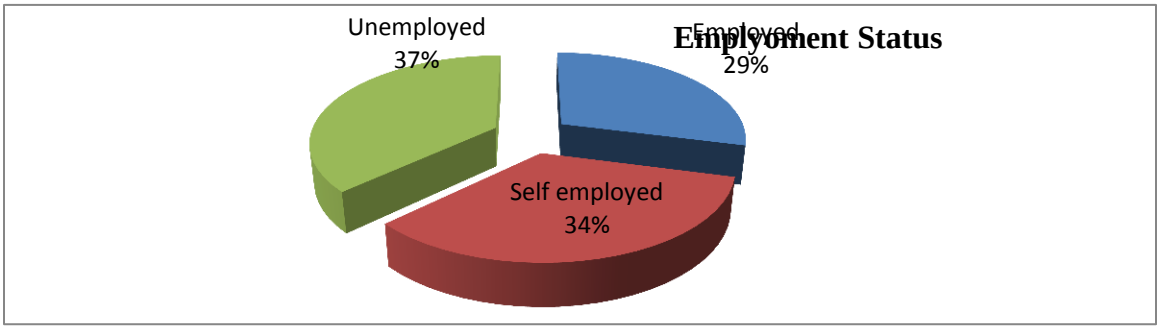

Figure 3 Occupation

4.2 Descriptive Statistics

4.2.1 Antenatal Profile and ANC Service Utilization in Mothers at KNH

The study sought to find out the antenatal profile and ANC service utilization in Mothers at KNH. The results are presented in the table below. The study sought to find whether the respondents attended anti-natal clinics. The findings show that 100% of the participants attended ANC.

The study also sought to find the frequency of participants ANC visits. The findings show that 60% of the respondents indicated to have visited ANC more than visits while 36% of the participants indicated to have made between 3 and 4 visits. Only 4% of the respondents indicated to have made between 1 and 2 visits. These findings imply that participants in this study comprised of individuals who frequently attend ANC services.

The study carried out an assessment to find out the family planning methods used by the participants before pregnancy. Half of the participants indicated they used natural methods, 40%

indicated they used pills while 7% and 2%of the participants used injections and implants methods respectively. Only one participant indicated to have used IUCD methods. Majority (91%) of the respondents indicated they had no complications during pregnancy.

Table 2 Antenatal Profile and ANC Service Utilization in Mothers at KNH

		Frequency	Percent (%)
ANC attendance	Yes	100	100
	No	0	0
Frequency of ANC visits	1-2 visits	4	4
	3-4 visits	36	36
	>4 visits	60	60
	Total	**100**	**100**
Family planning methods before pregnancy	Natural	50	50
	Injections	7	7
	Pills	40	40
	Implants	2	2
	IUCD	1	1
	Total	**100**	**100**
Any complications during pregnancy	Yes	9	9
	No	91	91
	Total	**100**	**100**

Figure 4 below shows Proportion with Complications during Pregnancy

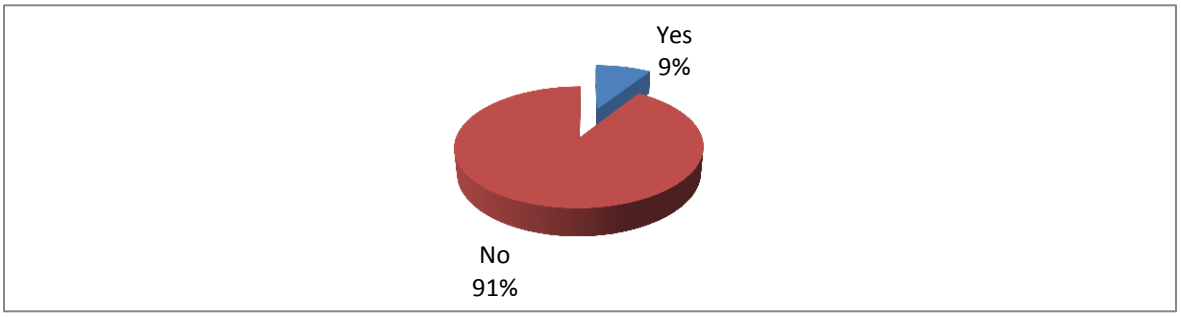

Figure 4: Showing Proportion with Complications during Pregnancy

Figure 5 below show results for family planning methods before pregnancy

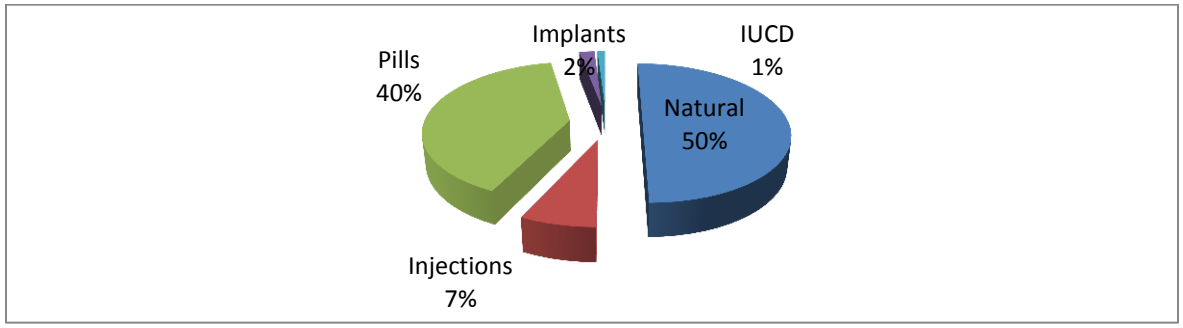

Figure 5: Showing Family Planning Methods before Pregnancy

Figure 6 below shows frequency of ANC visits

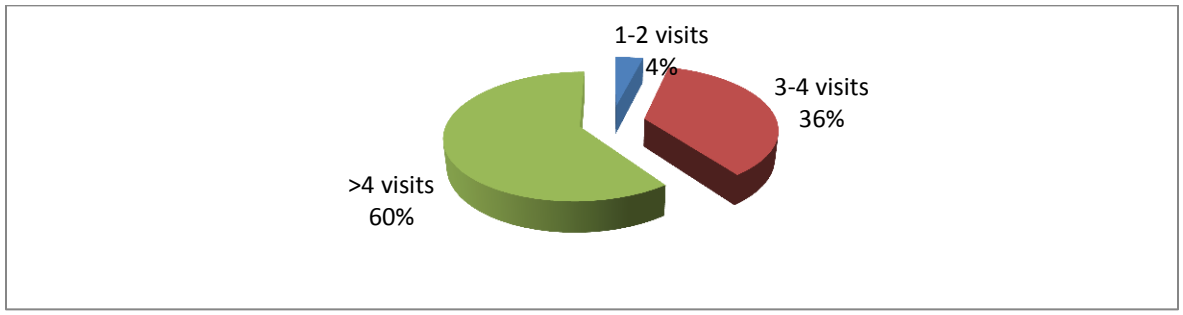

Figure 6: Frequency of ANC visits

4.2.2 Category of Birth Weights

The study enrolled 102 participated in this study but 100 participated successfully completed the assessment. The results show that 84 participants had babies of between 2.5 and 3.9 kg while 9 babies weighed more than 4.0 kg and only 7 babies weighed less than 2.5 kg. This finding imply that majority of the participants had babies of normal weight.

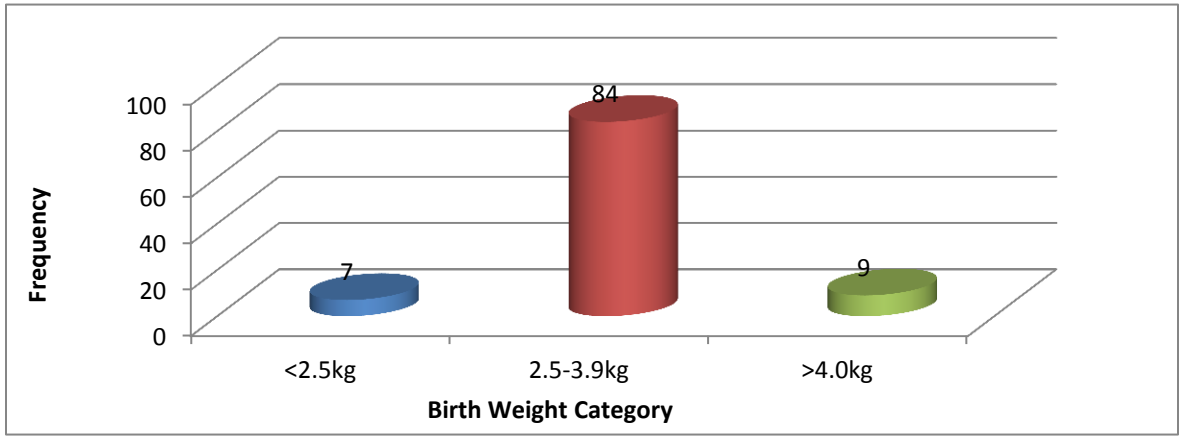

Figure 7: Foetal Birth Weight Category

4.3 Inferential Statistics

4.3.1 Paired Sample Correlations

A paired correlation analysis was conducted to show the relationship between actual weight of the foetal and the weight estimated using clinical methods and Ultra sound methods. The findings show that the correlation between actual weight and clinical methods estimated weight was stronger ($r=0.79$, $p<0.000$) as compared to the correlation between actual weight and Ultra Sound estimated weight ($r=0.65$, $p<0.000$).

These findings imply that clinical methods have a smaller error margins compared to ultra sound methods. These finding are in consistent with Ashrafganjooei, Naderi, Eshrati, and Babapoor (2010) who found out that Clinicians' estimates of birth weight in term pregnancy were as accurate as routine ultrasound estimation in the week before delivery.

The study failed to confirm the findings of Ugwu et al., (2014) who concluded that the ultrasound method was generally a better predictor of the actual birth weight than the clinical method.

Table 3: Paired Sample Correlations Results

		N	Correlation	Sig.
Pair 1	Actual weight & Clinical Method	100	0.79	0.00
Pair 1	Actual weight & Ultra sound	100	0.65	0.00

Comparison between Accuracy of Clinical and Ultrasound Estimated Fetal Weights

The study carried an assessment to find the accuracy of clinical methods and ultra sound methods. The study assessed the overall accuracy, accuracy in weights below 2.5kg category. The study also assessed the accuracy of the two methods in estimating fetal weights in babies between 2.5 and 3.9 kg weight category and finally in more than 4kg category.

The mean for actual birth weights was 3.30 ± 0.90 (2.4-4.8). Seven babies had the weight of below 2.5kg, 84 babies had a weight of 2.5-3.9kg while 9 babies had weight of above 4 kg. For all the participants both clinical method and ultra sound method overestimated the actual weight as shown by the mean error in Table 4.4. The overestimation by ultra sound methods was significantly higher than the clinical methods in all the birth weight categories. The results further show that the proportion of clinical methods estimations within $\pm10\%$ was higher than that of ultra sounds estimations for all the birth weight categories.

For babies with the birth weight of between 2.5 and 3.9 kg both clinical method and ultra sound method overestimated the weights. Similarly overestimation by clinical method was lower than that of ultra sound methods. The results also show that the mean error for ultra sound method was higher than that of clinical in babies with less than 2.5kg and those with more than 4kg but the difference was statistically insignificant.

The above findings demonstrate that a clinical method is more accurate in foetal estimation compared to ultra sound technique but statistically the difference was insignificant. These findings conquers with Njoku, et al., (2014) who found out that the accuracy within 10% of actual birth weights was 69.5% and 72% for both clinical estimation of fetal weight and ultrasound, respectively, and the difference was not statistically significant.

These finding are in consistent with Ashrafganjooei, Naderi, Eshrati, and Babapoor (2010) who found out that Clinicians' estimates of birth weight in term pregnancy were as accurate as routine ultrasound estimation in the week before delivery.

Table 4: Comparison between Accuracy of Clinical and Ultrasound

Birth Weight Category	Clinical	Ultrasound	P Value
Overall (%)			
Mean percent error	3.30±15.1	3.30±28.1	<0.001
Mean absolute error	3.30±0.16	3.30±0.28	<0.001
Estimates within ±10% of actual birth weight**	47(47%)	44(44%)	<0.001
<2.5 kg (%)			
Mean percent error	2.43±4.17	2.43±9.33	0.036
Mean absolute % error	2.43±0.04	2.43±0.09	0.036
Estimates within ±10% of actual birth weight**	3(42.9%)	2(28.6%)	0.611
2.5-3.5 kg (%)			
Mean percent error	3.27±4.11	3.27±11.35	<0.001
Mean absolute % error	3.27±0.04	3.27±0.11	<0.001
Estimates within ±10% of actual birth weight**	67(79.8%)	24 (28.6%)	<0.001
> 4.0 kg (%)			
Mean percent error	4.15±1.60	4.15±7.30	0.03
Mean absolute % error	4.15±0.16	4.15±0.73	0.03
Estimates within ±10% of actual birth weight**	9 (90%)	8 (80%)	0.104

*T-test; † chi square;** refers to n(%) and not mean (SD)

Scatter Plots

The scatter plot for actual weight and ultra sound estimated weight is shown in the figure below. The result show that is this technique has R squared of 0.48. These results imply that this technique is accurate enough in estimated birth weights.

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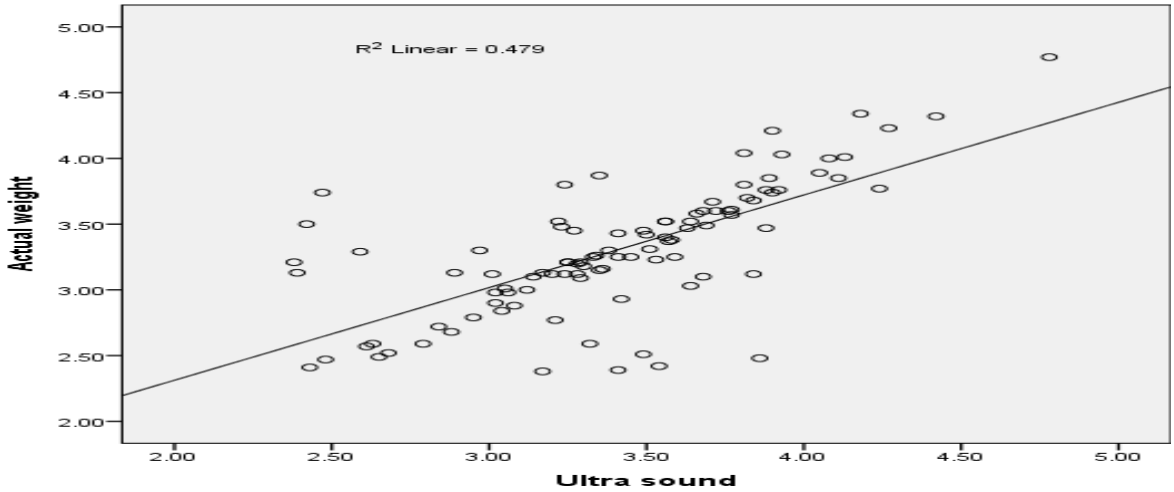

Figure 8 Scatter Plot Showing ABW and Ultra Sound Estimated Weight

The result furthers show that clinical method had R squared of 0.51. These results imply that this technique slightly more accurate in estimated birth weights than the ultra sound technique.

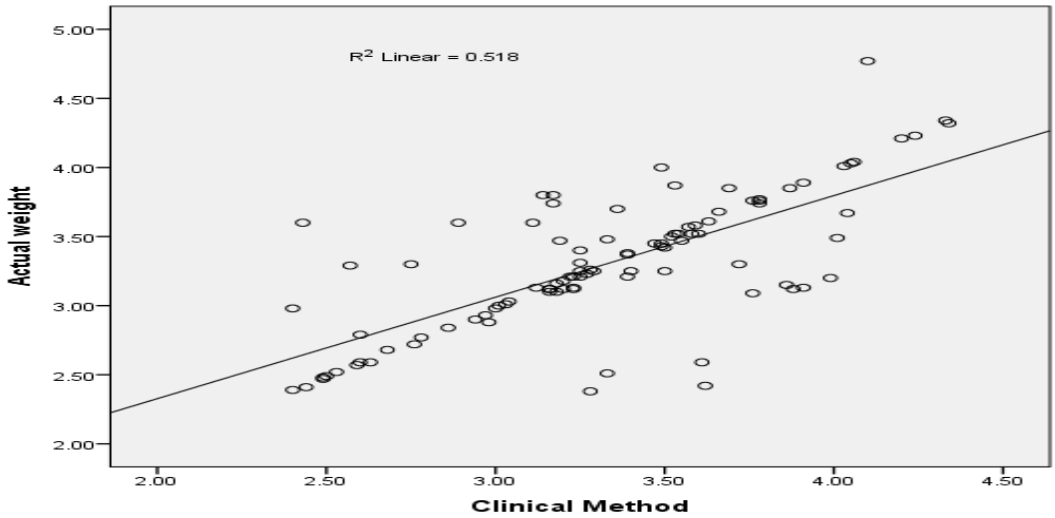

Figure 9: Scatter Plot Showing ABW and Clinically Estimated Weight

Distribution of Percentage Errors

The study conducted an assessment of errors of both ultra sound technique and clinical methods. The results are presented in figures below.

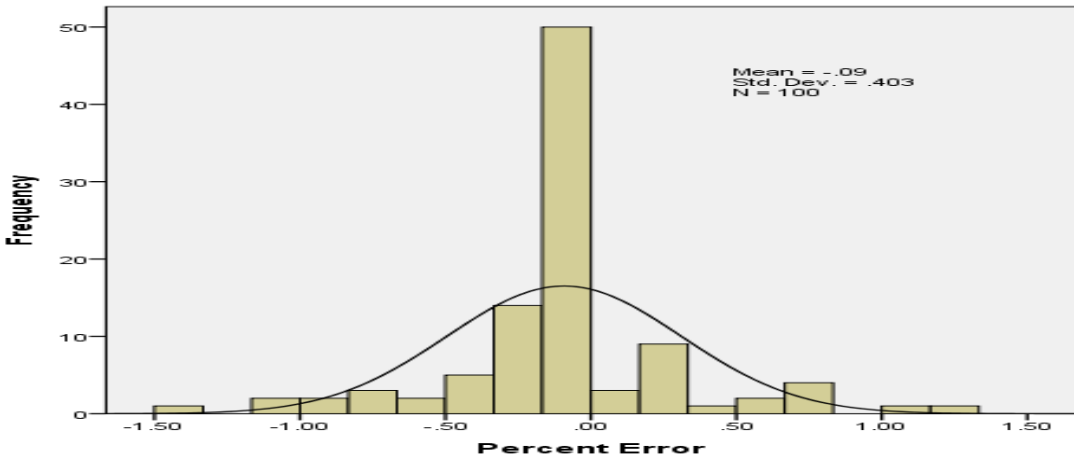

Figure 10: Histogram Showing Ultra Sound Percentage Error

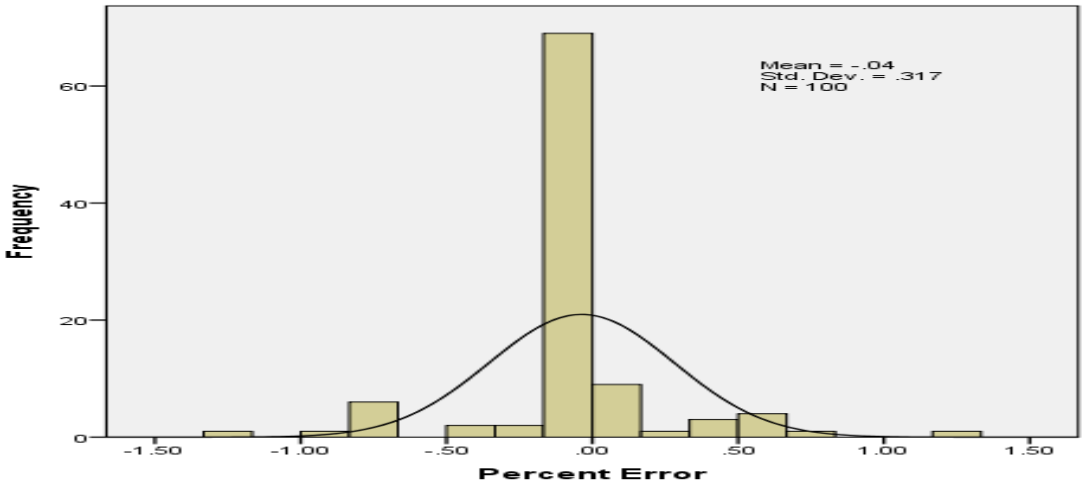

Figure 11: Histogram Showing Clinical Method Percentage Error

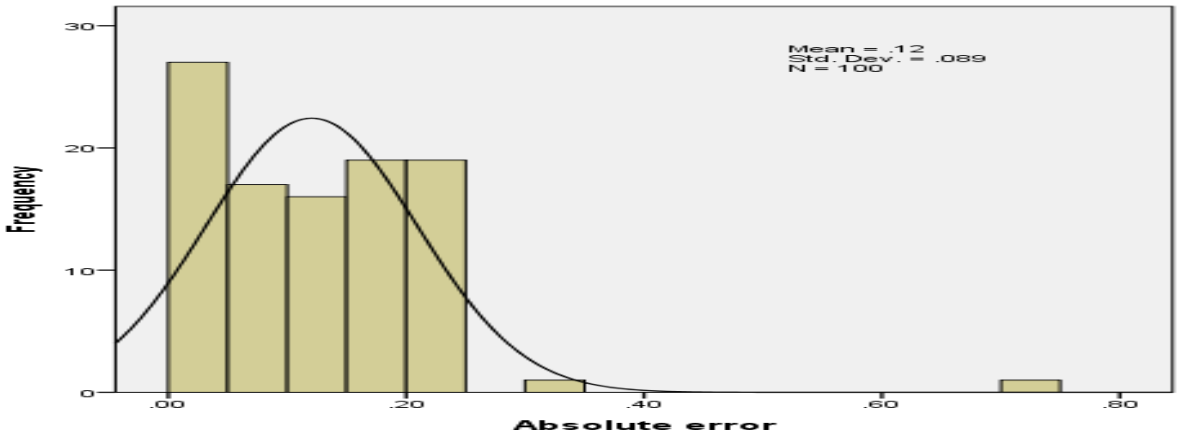

Figure 12: Histogram Showing Ultra Sound Absolute Error

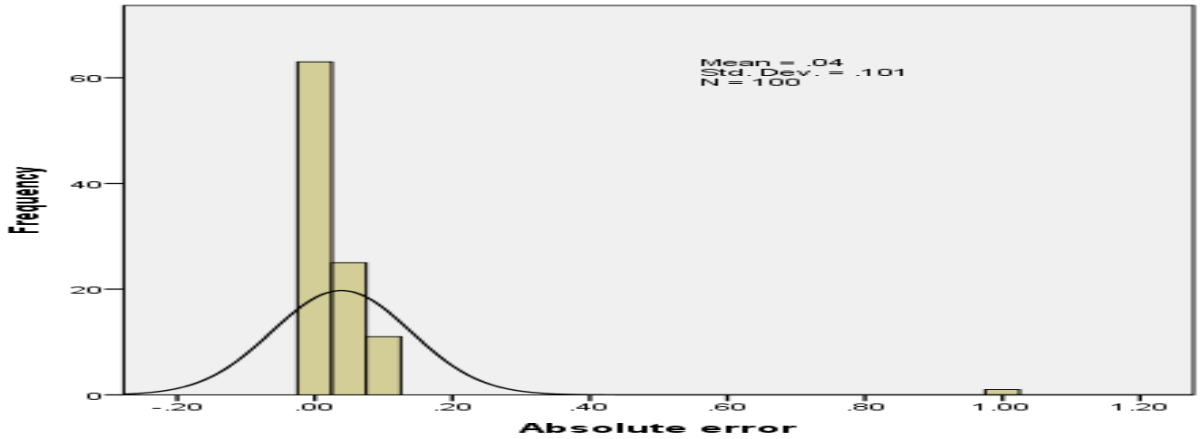

Figure 13: Histogram Showing Clinical Method Absolute Error

The results above show that the standard deviation of errors of ultra sound technique was higher than that of clinical methods. These findings imply that clinical method had small deviation in errors compared to ultra sound method.

5.0 DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.1 Discussion

This study established that the mean percentage error and absolute error for clinical methods were lower than the ultra sound technique. The finding imply that clinical methods were as good as ultra sound methods in estimating fetal birth weights since the mean difference was statistically insignificant. However, clinical methods estimations within $\pm$10% were slightly higher than that of ultra sounds estimations for all the birth weight categories.

Similar findings have been reported by Njoku, et al., (2014) who found out that the accuracy within 10% of actual birth weights was 69.5% and 72% for both clinical estimation of fetal

weight and ultrasound, respectively, and the difference was not statistically significant. Ashrafganjooei, Naderi, Eshrati, and Babapoor (2010) also found out that Clinicians' estimates of birth weight in term pregnancy were as accurate as routine ultrasound estimation in the week before delivery.

The finding of this study contradicts Ugwu et al., (2014) who concluded that the ultrasound method was generally a better predictor of the actual birth weight than the clinical method. This study used similar methods the current study adopted but the sample size was large compared to the one used in this study.

The limitations of this study include the use of only one sonographic model for the ultrasound estimation of the fetal weight and the subjectivity of clinical estimation of fetal weight; however, the rigorous quality measures employed in the study's method would have reduced their effects. Also, each of the two % error measures used in this study has its limitations, but their combination with the proportion of estimates within 10% of the birth weight in this study would have strengthened the study findings–this is because the latter measure appears to be the most appropriate and consistent measure of accuracy.

5.2 Conclusion

The study concludes that clinical methods of estimating birth weight are as accurate as ultra sound methods. Therefore, practitioners should adopt the use of clinical methods in estimating birth weight.

5.3 Recommendations

Based on the findings of this study, the study recommends that practitioners in obstetrics and gynecology should adopt the use of clinical methods since it is as good as ultra sound methods in estimating fetal birth weights.

5.4 Areas for Further Studies

This study recommends that further research should be carried out in this field using a sample derived from various hospitals for comparison purposes.

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