**The Utility of Mid-Pelvic Dimensions Via Plain Radiography in Predicting Cesarean Delivery**


## ABSTRACT

**Introduction:** Studies on the role of pelvimetry in predicting the mode of delivery have yielded mixed results. The aim of this study is to determine utility of the mid-pelvic measurement in predicting the mode of delivery in a cohort of women attempting vaginal delivery.

**Study Design and Methods:** With thisprospective cohort study,we evaluated the use of x-ray in predicting the delivery outcome of women attempting to deliver vaginally. Women were recruited before labor at >36 weeks gestational age and X-ray pelvimetry was performed after delivery. The exposures of interest were mid pelvic measures including anteroposterior diameters, transverse diameters and circumferences. The outcome measures were whether the women delivered via vaginal route or had cesarean delivery. We estimated the distribution and calculated measures of central tendency and spread of each pelvic dimension. Area under the receiver-operating characteristics curve (AUC) was used to estimate the overall predictive ability for each pelvic dimension and the optimal cut-point was estimated using the method of Liu. Logistic regression analysis was used to identify independent predictors for mode of delivery. The Hosmer – Lemeshow goodness-of-fit test was used to estimate the overall fit while the AUC was used to estimate the overall prediction of the final model.

**Results:** A total of 426 women met the inclusion criteria. The mean gestational age at delivery was 40 (±6.0) weeks and the majority were black parturient (62.6%0. Aslight majority were nulliparous (52.1%). In all, 127 women (29.8%) were delivered by cesarean delivery. All the pelvic inlet and mid pelvic dimensions were approximately normally distributed. The AUC ranged from 0.62 to 0.86. While the pelvic inlet and mid pelvic diameters had equivalent AUC, the optimal cut-point of the mid pelvic anteroposterior diameter (10.8cm) had both higher sensitivity and specificity than the pelvic inlet anteroposterior diameter (10.2cm) (95% and 85% versus 90% and 80%, respectively). There was an inverse relationship between the mid pelvic anteroposterior diameter and mode of delivery by cesarean section, with a 100% risk among women with a diameter of 9cm or less. However, the multivariable model developed had an AUC of 0.90, indicating overall good and higher predictive ability than the mid-pelvic anteroposterior diameter alone.

**Conclusions:** In this large cohort study, the mid pelvic anteroposterior diameter best predicted mode of delivery by cesarean section with 96% sensitivity and 85% specificity for the optimal cut-point of 10.8cm. Mid pelvic anterior posterior diameter may be useful alone but produces best result when combined with other maternal factors in predicting the mode of delivery.

**Key words**: Pelvimetry, Vaginal Delivery, Cesarean Delivery



## Introduction

Pelvimetry is widely used if there is any suspicion of cephalopelvic disproportion (CPD)[1]. CPD has been implicated in almost 50% of cesarean deliveries[2]. Thus, the need to find a method that accurately predicts the occurrence of CPD became highly desired[3]. Although the descent of the fetal head has been the best indicatorof the appropriateness of pelvic capacity[4], other anthropometric measurements, such as maternal height, maternal shoe size, and maternal weight have all been investigated as predictors for pelvic capacity. If they are compared with the pelvimetric measurements, they do not seem reliable[5].

Since the adoption of X-ray pelvimetry, it provided an anatomic and quantitative assessment of the maternal pelvis[6]. It has been utilized to ascertain pelvic adequacy and to allow a trial of labor[7,8,9,10]. Thus, the usage of X-ray pelvimetry in assessing patients who may have problems with vaginal delivery is a well-established practice in many parts of the world[11].

The mid-pelvis is measured at the level of the ischial spines—the midplane, or plane of least pelvic dimensions (Figure 1). It is of particular importance following the engagement of the fetal head in obstructed labor[12]. The interspinous diameter of 10 cm or slightly greater, is usually the smallest pelvic diameter. The anteroposterior diameter through the level of the ischial spines normally measures at least11.5 cm.

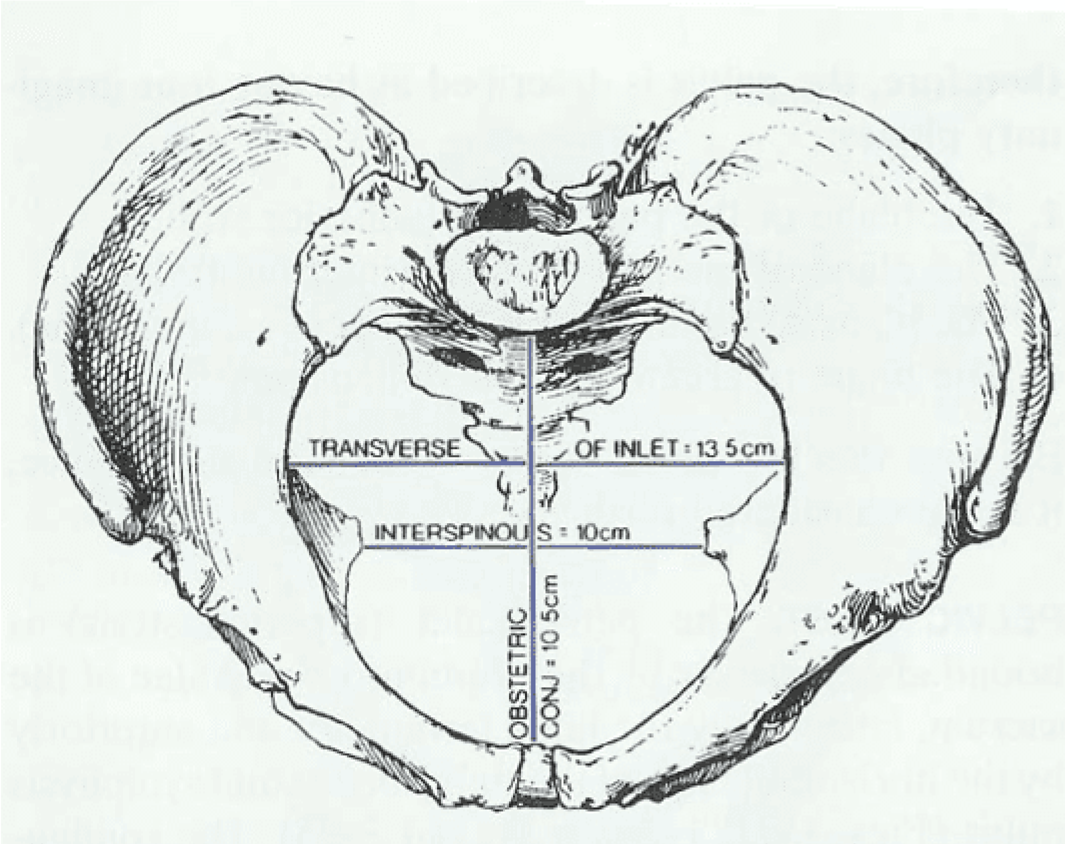


**Figure 1:** Transverse Diameter of the Mid-Pelvis. Bispinous diameter = 10cm between the tips of the Ischial spines[13].

Precious studies found a strong positive correlation between mid-pelvic dimensions and the mode of delivery[13,14,15,16].There exist a lot of conflicts among clinicians on the relevance of pelvimetry in determining labor outcomes. Most clinicians are of the opinion that a trial of labor for every woman that has no clear indication for cesarean delivery should be the gold standard. As such the usage of both the conventional clinical pelvimetry being done during routine antenatal care visits in the third trimester and the deployment of imaging pelvimetry started losing popularity more so in the developed countries[17,18].

In clinical settings, women are generally allowed a trial of labor to test whether the pelvis is "adequate". However, the studies of radiographic pelvimetry had a limited number of patients, as such were subject to bias because of lack of blinding and used arbitrary cutoff points of "adequate" vs. "contracted" pelvis. Some "critical" limits identified range from 1—11.5cm in the anteroposterior diameter (APD), and some studies used the sum of the measurements[12,19,20]. Therefore, with this study, we sought to determine the utility of Simple measures of mid-pelvic dimensions using X-ray pelvimetry in predicting the mode of delivery in pregnant women attempting delivery.

## Materials and Methods

This is a secondary analysis of the data generated from a multi-centered prospective cohort study which was initially designed to assess feto-pelvic index. About 654 women were enrolled but 426 met the selection criteria which consisted of 221 nulliparous women and 205 women who were attempting a trial of labor after cesarean delivery (TOLAC) with only 1 previous cesarean delivery from 2001 – 2006 at University of Pennsylvania Health System: Pennsylvania Hospital and Hospital of University of Pennsylvania.

Nulliparous women and women attempting a trial of labor after cesarean delivery (TOLAC) were selected if they had a viable singleton intrauterine pregnancy at >36 weeks' gestation with cephalic presentations and were planning to attempt a vaginal delivery. All women with multiple gestations, breech presentation, major fetal malformations were excluded from the study.

X-ray pelvimetry was obtained after delivery with the Colcher-Sussman technique[22]. Pelvimetry was performed after the delivery to avoid exposure of the fetus to ionizing radiation for research purposes; these measurements are not impacted significantly by the antepartum vs postpartum state. With this method, a lateral view of the pelvis was obtained with the patient on her side with knees and thighs semi-flexed. X-ray pelvimetry consisted of the anteroposterior and transverse diameters of the inlet and mid pelvis with the Colcher-Sussman method. Blinding of pelvimetry reading was attempted, although in a small number of cases (<10%) surgical staples were used for closure. In these cases, a second reader reread these films and calculated pelvic diameters. There was a high degree of agreement between these 2 readings (intraclass correlation coefficient, 0.90)[22].



**Measuring the Antero-Posterior diameter of the Mid-Pelvis**

In the lateral view, the anteroposterior diameter (APD) of the mid-pelvis was measured from the third sacral vertebra (S3) to the pubic symphysis.

**Measuring the Transverse diameter of the Mid-Pelvis**

In the anteroposterior view, the transverse diameter (TD) of the mid-pelvis is measured at the level of the ischial spines.

**Measuring the Mean Circumference of the Mid-Pelvis**

The mean circumference of the mid pelvis was calculated from the APD and TD measurements with the following formula: (APD+TD) x P/2. Two independent radiologists who were blinded to the mode of delivery determined each measurement, and the average measurements were used. In cases in which the measurements differed by >5%, the radiologists met and discussed the case and agreed on the measurement.

## Data Analysis

The collected data were analyzed using STATA 12 statistical software. Both univariable and multivariable analyses were performed only with subjects with complete data for the covariates that were included in the multivariable models.The exposures were mid-pelvic measures including anteroposterior diameter, transverse diameter, and circumference. The outcome measure was the mode of delivery as either vaginal or cesarean. We estimated the distribution and calculated measures of central tendency and spread for the mid-pelvic pelvic dimension. The area under the receiver-operating characteristics curve (AUC) was used to estimate the overall predictive ability for the mid-pelvic dimension and the optimal cut point was estimated using this method of Liu.  Potential predictive factors considered were the mid-pelvic anteroposterior diameter, factors biologically plausibly associated with cesarean delivery, factors associated with cesarean delivery in prior studies, and baseline characteristics which differed between patients with vaginal and cesarean delivery. Logistic regression was used to identify independent predictors of cesarean delivery. The Hosmer-Lemeshow goodness-of-fit test was used to estimate the overall fit while the area under the receiver characteristics curve (AUC) was used to estimate the overall prediction of the final model.

**RESULTS**

Out of the 652 women in the cohort, a total of 426 women met the inclusion criteria the mean maternal age at delivery was 40 (±6.0 π) weeks and the majority were black (62.6%). A slight majority were nulliparous (52.1%). Of all the eligible women, 127 women (29.86%) were delivered by cesarean method

**Table 1:** Mean ±SDof Some Baseline Demographic Variables of Study Participants.

| Variables | N | Mean ± SD |
|---|---|---|
| Maternal Age (Years) | 426 | 23.90 ± 6.00 |
| Gestational Age at delivery (weeks) | 426 | 40.00 ± 1.10 |
| Estimated Fetal Weight (g) | 426 | 3195.70 ± 478.90 |

**Note: N =** Number of Study Participants;**SD** = Standard Deviation

Table 1 shows the mean and standard deviation values of baseline demographic variables of the study participants. The overall mean maternal age of study participants was 23.90±6.00 while their mean gestational age was 40.00±1.10. The estimated fetal weight in grams was 3195.70 ± 478.90.

**Table 2:** Student's t – Test to Compare Mean ± SD of Some Baseline Demographic Variables of Study Participants According to Mode of Delivery.

| | Mode of | Delivery | |
|---|---|---|---|
| Variables | **Vaginal** | **Cesarean** | **P-value** |
| | Mean± SD | Mean ± SD | |
| Maternal Age (years) | 23.20 ± 5.70 | 25.50 ± 6.50 | 0.0001* |
| Gestational Age at delivery (weeks) | 40.00 ± 1.20 | 40.20 ± 1.10 | 0.130 |
| Estimated Fetal Weight (g) | 3155.40± 477.20 | 3288.90 ± 471.70 | 0.009* |

* Statistically significant at $p$ – value < 0.05; **SD** = Standard Deviation

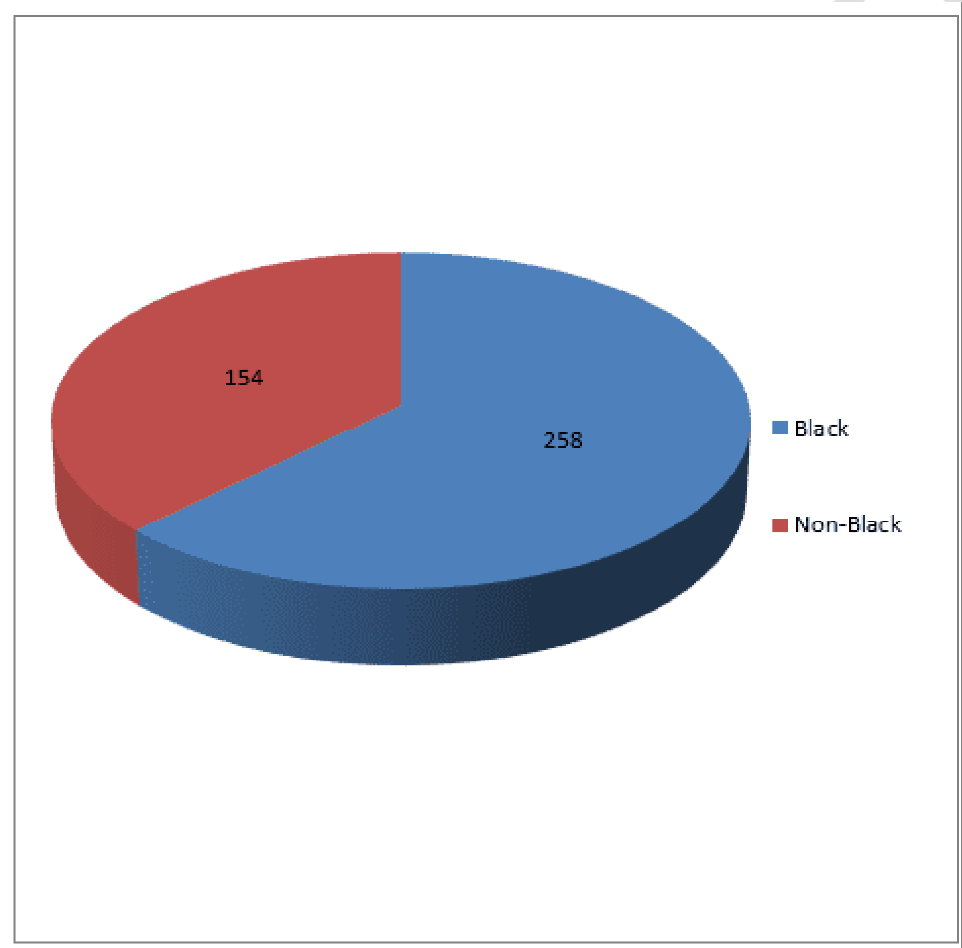


**Figure 2:** A 2D-Pie Chart Showing Percentage of Frequency Distribution of Race among the Study Participants.

**Table 3:** Chi-Squared Statistics Showing Distribution of Race of Study Participants according to Mode of Delivery.

| | Vaginal | Cesarean | Total |
|---|---|---|---|
| Maternal Race | **O** (E) | **O** (E) | |
| | [$\mathbf{X}^{2(df)}$]; *p-value* | [$\mathbf{X}^{2(df)}$]; *p-value* | |
| Black | **179 (**180.98) | **79 (**77.02) | 258 |
| | [0.02]; $p$ = 0.887 | [0.05]; $p$ = 0.823 | |
| Non-Black | **110 (**108.02) | **44 (**45.98) | 154 |
| | [0.04]; $p$ = 0.842 | [0.08]; $p$ = 0.777 | |
| Total | **289** | **123** | 412 |

Chi-Square **(With Yates' Correction for Continuity)** = 0.108 (1df); p = 0.742

Fisher Exact Probability Test (2 tailed), p = 0.738

N – Number of Subjects; O – Expected Counts; $\mathbf{X}^2$ – Chi- Square Test Statistics; df – Degree of Freedom; * Statistically significant at p ≤ 0.05.

Table 3 is a 2x2 contingency table showing the Chi-squared statistics test of association among the distribution of race based on mode of delivery. The Chi-squared test was not statistically significant (P = 0.742) and also none of the Chi-Square statistics for each cell count produced a statistically significant contribution to the chi-square distribution ($p > 0.05$).

**Table 4:** Percentage Frequency of Labor Type of Study Participants.

| Labor Type | N | Percentage |
|---|---|---|
| Spontaneous | 117 | 27.9% |
| Induced | 91 | 21.7% |
| Augmented | 211 | 50.4% |
| Total | 426 | 100% |

N = Number of Study Participants

Table 4 shows the distribution of labor type among the study participants with spontaneous labor type having a percentage of 117 (27.9%) while those with induced and augmented labor types had a percentage frequency of 91 (21.7%) and 211 (50.4%) respectively (See Figure 2).

Based on mode of delivery, 96 (32.4%) of those with spontaneous labor type had vaginal delivery and 21 (17.1%) had cesarean delivery while those with induced labor type had a frequency of 147 (49.7%) for vaginal delivery and 64 (32.0%) for cesarean delivery(See Figure 3).

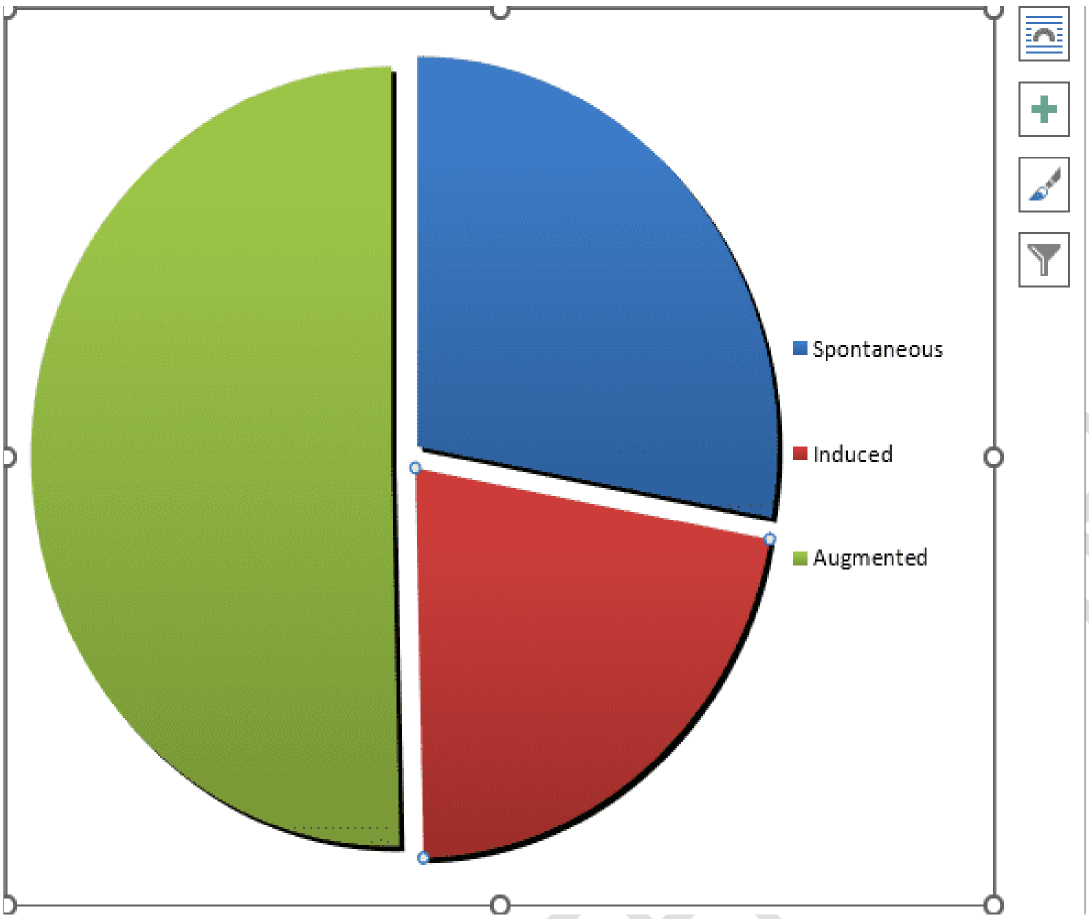


**Figure 3:** A 3D Pie Chart Showing Distribution of Labor Types among the Study Participants.

**Table 5:** Chi-Square Statistics Showing Distribution of Labor Type of Study Participants according to Mode of Delivery.

| Labor Type | Vaginal<br>**O** (E)<br>[$\mathbf{X}^{2(df)}$]; *p-value* | Cesarean<br>**O** (E)<br>[$\mathbf{X}^{2(df)}$]; *p-value* | Total |
|---|---|---|---|
| Spontaneous | **96** (82.65)<br>[2.15]; *p* = 0.341 | **21** (34.35)<br>[5.19]; *p* = 0.075 | **117** |
| Induced | **147** (149.06)<br>[0.03]; *p* = 0.985 | **64** (61.94)<br>[0.07]; *p* = 0.595 | **211** |
| Augmented | **53** (64.29)<br>[1.98]; *p* = 0.372 | **38** (26.71)<br>[4.77]; *p* = 0.092 | **91** |
| Total | **296** | **123** | **419** |

Chi-Square **(With Yates' Correction for Continuity)** = 13.02 (2df); p = 0.0014*

**N** – Number of Subjects; **O** – Expected Counts; **$X^2$**– Chi- Square Test Statistics; **df** – Degree of Freedom; * Statistically significant at $p \leq 0.05$.

Table 5 shows the Chi- Square statistics test of association among the distribution of labor type based on mode of delivery. The Chi-Square test was statistically significant ($p = 0.0014$). This Chi-Square is significant and none of the Chi-Square statistics for each cell count produced statistically significant contribution to the chi-square distribution ($p > 0.05$).

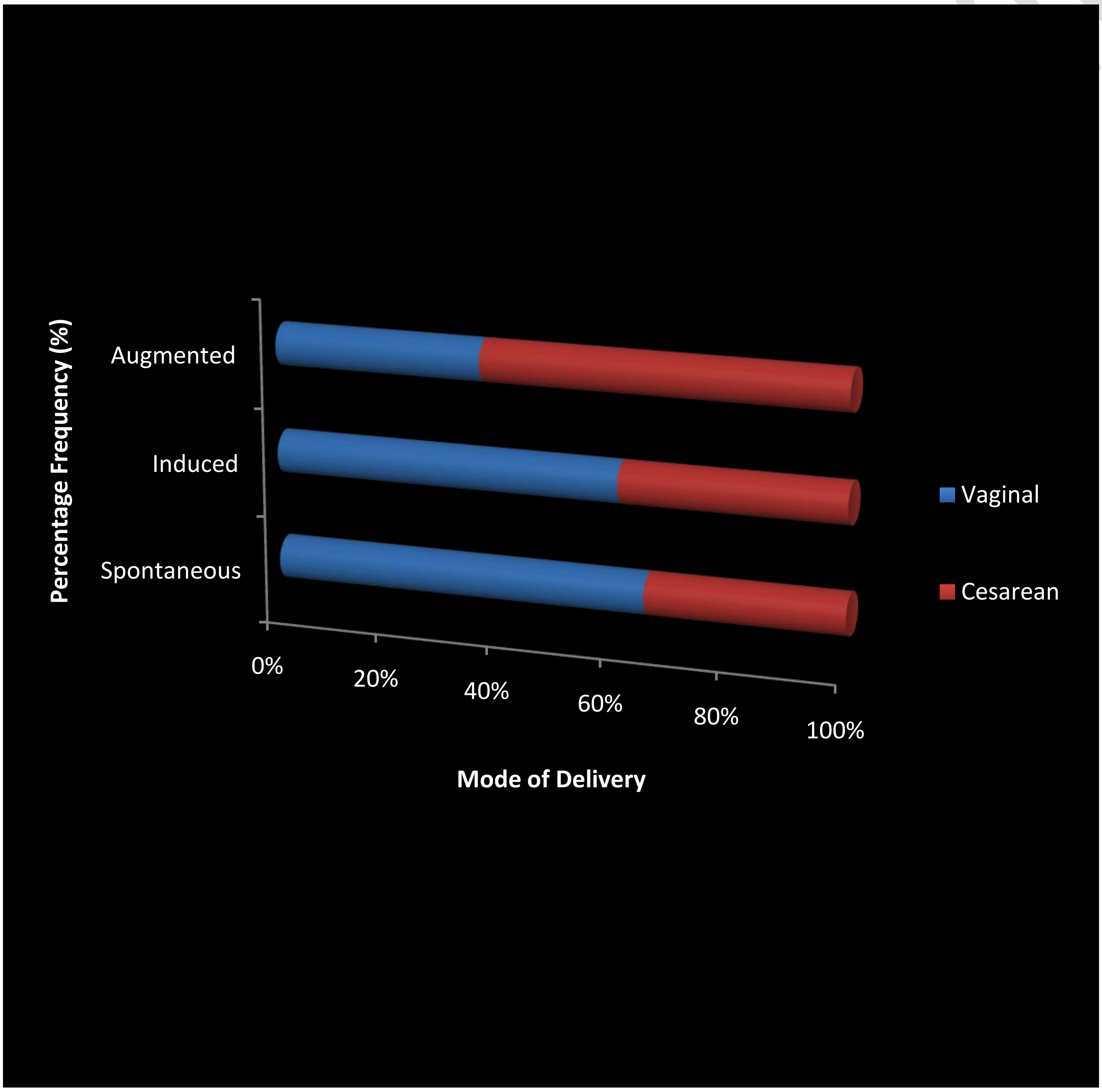


**Figure 4:** 3D Cylinder Bar Chart Showing the Distribution of Labor Types among Study Participants According to Mode of Delivery.

**Table 6:** Overall Percentage Frequency of Parity of Study Participants.

| Parity | N | Percentage |
|---|---|---|
| Nulliparous | 222 | 52.1% |
| Multiparous | 204 | 47.9% |
| Total | 426 | 100% |

**N** = Number of Study Participants.

Table 6 shows the distribution of parity among the study participants. Nulliparous had a percentage frequency of 52.1% while multiparous had a percentage frequency of 47.9%.

**Table 7:** Chi-Square Statistics Showing Distribution of Parity of Study Participants According to Mode of Delivery.

| | Vaginal | Cesarean | Total |
|---|---|---|---|
| Parity | **O** (E) | **O** (E) | |
| | [$\mathbf{X}^{2(df)}$]; *p-value* | [$\mathbf{X}^{2(df)}$]; *p-value* | |
| Nulliparous | **167** (155.82) | **55** (66.18) | **222** |
| | [0.8]; $p$ = 0.371 | [1.89]; $p$ = 0.169 | |
| Multiparous | **132** (143.18) | **72** (60.82) | **204** |
| | [0.87]; $p$ = 0.351 | [2.06]; $p$ = 0.151 | |
| Total | **299** | **127** | **426** |

Chi-Square **(With Yates' Correction for Continuity)** = 5.131 (1df); p = **0.024***

Fisher Exact Probability Test (2 tailed), p = **0.019***

N – Number of Subjects; O – Expected Counts; $X^2$ – Chi- Square Test Statistics; df – Degree of Freedom; * Statistically significant at $p \leq 0.05$.

Table 7 is a 2x2 contingency table showing the chi-square statistics test of association among the distribution of parity of study participants based on the mode of delivery. The chi-square test was statistically significant (p = 0.024). This Chi-Square is significant and none of the Chi-Square statistics for each cell count produced statistically significant contribution to the chi-square distribution (p > 0.05).



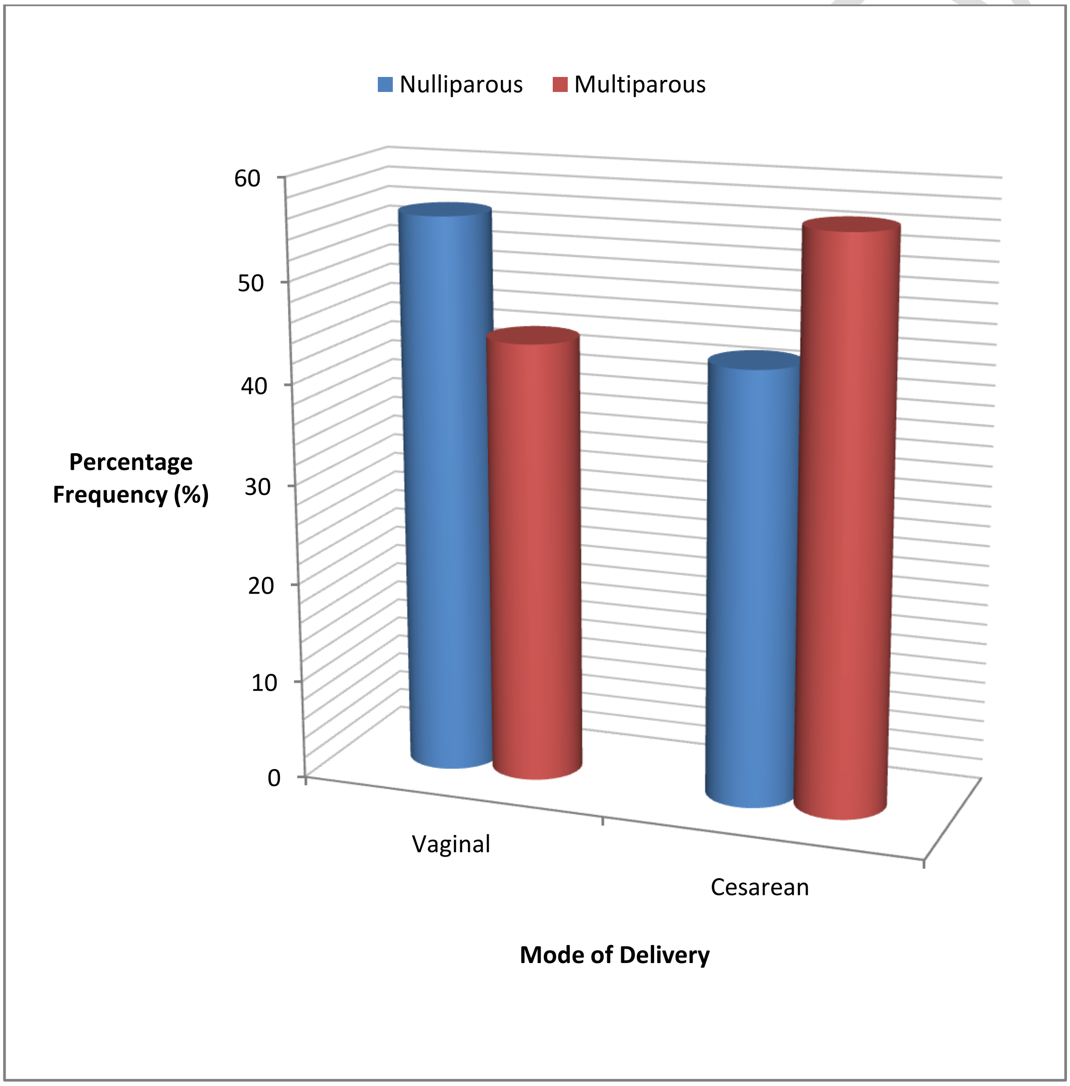


**Figure 5:** 2D – Column Chart Showing Percentage Frequency Distribution of Parity According to Mode of Delivery.

Based on mode of delivery, 167 (55.9%) of nulliparous women had vaginal delivery and 55 (43.3%) had cesarean delivery while the multiparous women recorded percentage frequencies of 132 (44.1%) and 72 (56.7%) had vaginal delivery and cesarean delivery respectively (See Figure 5).

**Table 8:** Minimum, Maximum, Mean and SD Values of Mid Pelvis Variables in Study Participants.

| Variables | Min. Value | Max. Value | Mean ±SD |
|---|---|---|---|
| Anterior Posterior Diameter (APD) | 8.0 | 14.0 | 11.3 ± 1.1 |
| Transverse Diameter (TD) | 7.0 | 14.3 | 10.3 ± 1.2 |
| Mid Pelvic Circumference (PIC) | 25.1 | 42.4 | 33.9 ± 2.9 |

**SD** = Standard Deviation; **Min**= Minimum; **Max** = Maximum

Table 8 shows the minimum, maximum, mean, and standard deviation values of Mid Pelvis measured variables. APD has a mean value of 11.3 ± 1.1, TD has 10.3 ± 1.2 and MPC has 33.9 ± 2.9.

**Table 9:** AUCValues for Predicting Cesarean Delivery in Study Participants Using Mid Pelvis Variables.

| Variables | AUC (95%CI) | OCP (cm) | Sensitivity (%) | Specificity (%) |
|---|---|---|---|---|
| Anterior Posterior Diameter (APD) | **0.86** (Min=0.82; Max=0.91) | 10.8 | 95 | 85 |

| | | | | |
|---|---|---|---|---|
| Transverse Diameter (TD) | **0.62** (Min=0.56; Max=0.68) | 9.6 | 43 | 80 |
| Mid Pelvic Circumference (PIC) | **0.83** (Min=0.78; Max=0.88) | 33.6 | 78 | 77 |

**AUC** = Area Under the Curve; **OCP** = Optimal Cut-off Point

Table 9 shows the area under the curve (AUC) values for predicting cesarean delivery in study participants. The highest AUC (0.86) was observed in APD of Mid-Pelvis (See Figure 6).

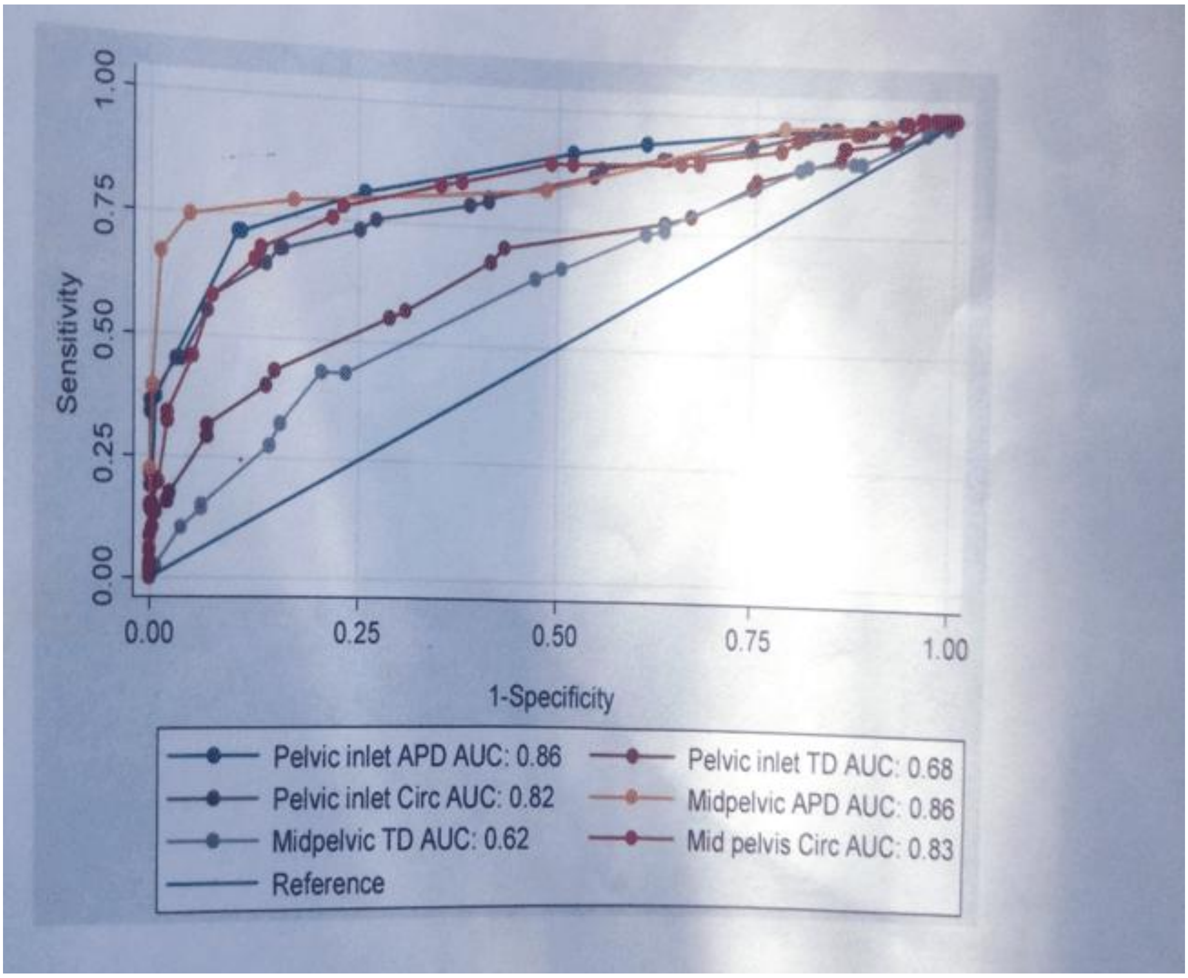

**Figure 6:** Receiver Operating Characteristics Curve of Pelvic Dimensions for Predicting Cesarean Delivery.

**Table 10:** Odds Ratio Values of Logistic Regression Model to Predict Delivery Mode Using Mid Pelvis APD, Labor Type, Prior Cesarean Section, Maternal Age and Race.

| Variables | OR | SE | Z | 95% CI |
|---|---|---|---|---|
| Mid Pelvis APD | 7.07 | 1.75 | 7.90 | 4.35 – 11.50 |
| Maternal Age | 1.12 | 0.005 | 2.80 | 1.03 – 1.21 |
| Maternal Race | 1.07 | 0.48 | 0.16 | 0.44 – 2.60 |
| Labor Type | 2.27 | 0.67 | 2.76 | 1.27 – 4.09 |
| Parity | 0.53 | 0.32 | -1.01 | 0.16 – 1.78 |
| Prior Cesarean Section | 3.84 | 2.63 | 1.97 | 1.00 – 14.69 |

Likelihood Ratio Chi-Square = 164.19 (6df); p = **0.0001***

-2 Log likelihood = -94.069, Pseudo $R^2$ = 0.466; p = **0.0001***

*Statistical Significance at p-value ≤ 0.05; **OR** = Odds Ratio; **SE** = Standard Error; **APD** = Anterior Posterior Diameter; **CI** = Confidence Interval; **Z** = Z – Scores

**Table 11:** Adjusted Odds Ratios (OR) of Logistic Regression Model to Predict Delivery Mode Using Mid Pelvis APD, Spontaneous Labor Onset, Maternal Age and Prior Cesarean Section.

| Variables | Adjusted OR | 95% CI | p-value |
|---|---|---|---|
| Mid Pelvis APD | 7.51 | 4.63 – 12.19 | **0.0001*** |
| Spontaneous Labor Onset | 0.28 | 0.11 – 0.67 | **0.004*** |

| | | | |
|---|---|---|---|
| Maternal Age | 1.12 | 1.05 – 1.21 | **0.001*** |
| Prior Cesarean Section | 2.15 | 0.87 – 14.69 | 0.098 |

Homer – Lemeshow Chi - Square = 9.54 (8df); p = 0.299

*Statistical Significance at p-value ≤ 0.05; **OR** = Odds Ratio; **SE** = Standard Error; **APD** = Anterior Posterior Diameter; **CI** = Confidence Interval

Table 11 on the other hand, shows the adjusted Odds Ratios (AOR) of variables that showed some level of statistical significance from the general logistic model. Mid-pelvis APD maintained the highest value with a slight increase in OR from 7.07 (OR value) to 7.51 (AOR value) with a confidence interval of 4.65 – 12.19, and this was statistically significant (p = 0.0001).

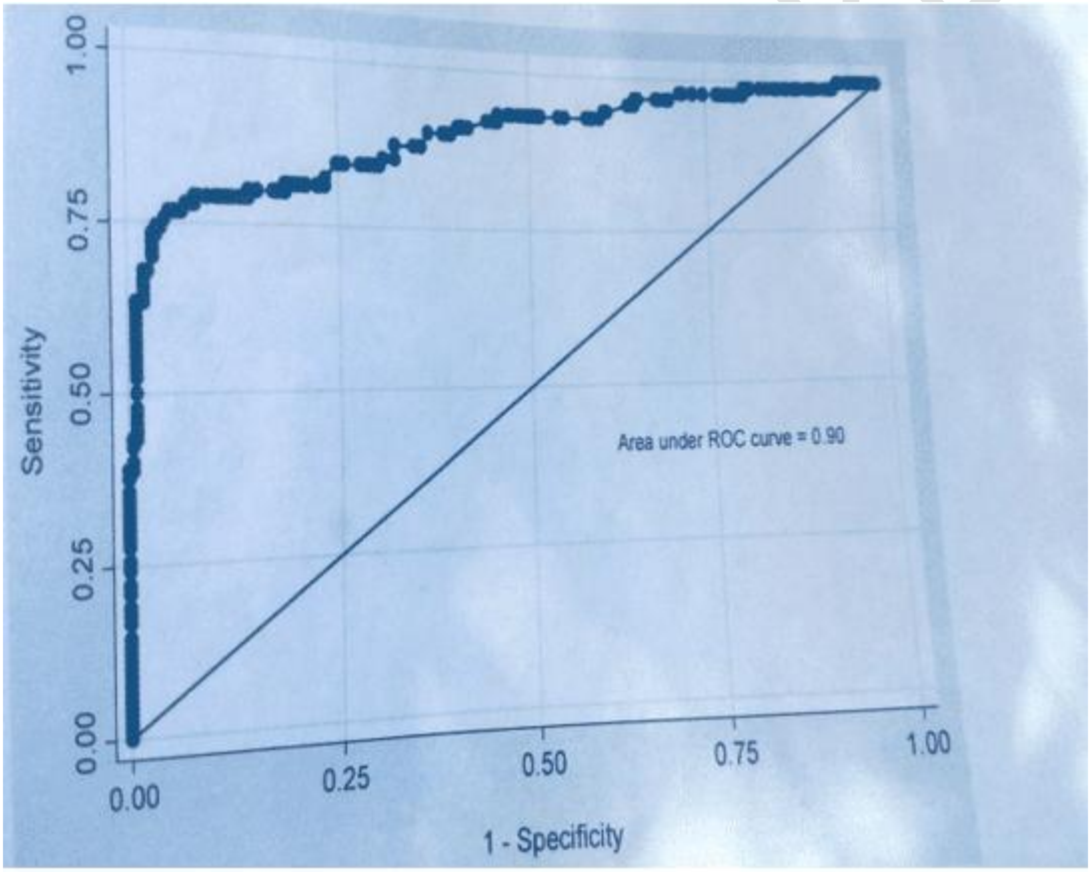


**Figure 7:** Receiver-Operating Characteristics Curve of Multivariable Prediction Model for Cesarean Delivery.

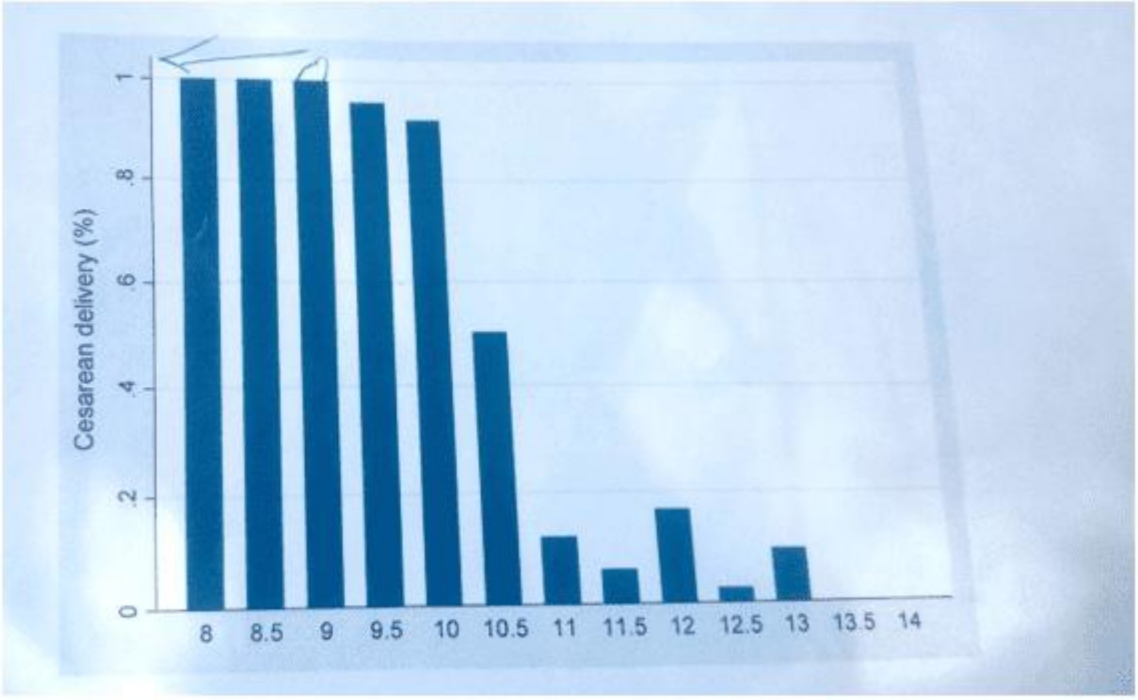


**Figure 8:** Relationship between mid-pelvic anteroposterior diameter and risk of cesarean delivery.

**DISCUSSIONS**

Prediction of labor outcomes especially in the potential fetal pelvic disproportion and determining the mode of delivery has been challenging tasks for obstetricians[1]. Pelvimetry is widely used if there is any suspicion of cephalopelvic disproportion (CPD) in normal presentations[1]. CPD and cervical dystocia were cited as the indication in almost 50% of cesarean deliveries[2]. Thus, this substantiates the fact that there isan increasing need for a method to accurately predict the presence of cephalopelvic disproportion and then select the most appropriate route of delivery[3].

The shortcomings of clinical pelvimetry, especially in the assessment of pelvic inlet, have given way to the use of imaging techniques[16]. In fact, the use of imaging to prevent and control the risks during delivery has profoundly changed obstetric prognoses[24]. Since its introduction in the 1940s, obstetricians have used X-ray pelvimetry as a method to predict successful vaginal delivery in cases of suspected cephalopelvic disproportion and breech presentations[25,26,27]. Improvements in technique and increased experience of pelvimetry have made it possible to accurately predict the outcome of labor in a high proportion of cases[28]. In fact, X-ray pelvimetry has been the standard for many years to provide an anatomic and quantitative assessment of the maternal pelvis[6]. With the introduction of standard and reproducible techniques, there was enthusiasm that mensuration of the pelvic diameters and areas could enable the clinician to predict the likelihood of vaginal delivery[28]. Thus, the usage of X-ray pelvimetry in assessing patients who may have problems with vaginal delivery is a well-established practice in many parts of the world[29,30,31].

The reliability of the pelvimetric measurements has been investigated with different imaging techniques. The present findings are in broad agreement with those of previous studies. In this study, we found the mean gestational age at delivery to be 40(±6.0) weeks and the majority of the parturient were black (62.6%). A slight majority were nulliparous (52.1%). In all, 127 women (29.8%) were delivered by cesarean delivery. The entire pelvic inlet and mid-pelvic dimensions were approximately normally distributed. The AUC ranged from 0.62 to 0.68. While the pelvic inlet and mid-pelvic anteroposterior diameters had equivalent AUC, the optimal cut point of the mid-pelvic anteroposterior diameter (10.8cm) had both higher sensitivity and specificity than the pelvic inlet anteroposterior diameter (10.2cm) (95% and 85% versus 90% and 80%, respectively). There was an inverse relationship between the mid-pelvic anteroposterior diameter and cesarean risk, with a 100% risk among women with a diameter of 9cm or less (Figure 7).

Independent predictors for labor outcome considered in the final model were mid-pelvic anteroposterior diameter, maternal age, spontaneous labor onset, and prior cesarean delivery (Table 9). The AUC was 0.90, indicating overall good and higher predictive ability of the multivariable model than the mid-pelvic anteroposterior diameter alone (AUC: 0.86) (Figure 6). The mid-pelvic anteroposterior diameter was most predictive of cesarean delivery in the model (adjusted OR 7.52; 95% CI 4.63 – 12.19), with every one-centimeter decrease in the mid-pelvic anteroposterior diameter associated with over 7-fold increase in the risk for cesarean delivery (0.28; 95% CI 0.11 – 0.67).

Our findings are similar to what have been found previously in subjects with anteroposterior diameter or circumference ≤10$^{th}$ percentile who were at greater risk of CD (risk ratio for anteroposterior diameter, 4.8; 95% confidence interval, 3.9 – 5.8). The area under the receiver operator characteristics curves for anteroposterior diameter, circumference 0.88[13].

In the present study, the risk factors for cesarean delivery in a multivariable regression analysis were maternal age, Spontaneous labor onset, prior cesarean delivery, and anteroposterior diameter of the mid-pelvis. This is much like the findings where the maternal pelvic size, fetal pelvic index, fetal head circumference, and maternal age were significantly associated with a risk of cesarean section. In their receiver operator characteristic analysis, the area under the curve was 0.686 with a p-value of 0.001 and a 96% confidence interval of 0.595 – 0.778. The optimal fetal pelvic index cut-off value according to the receiver-operating characteristic (ROC) was -0.65[20].

They found the mean mid-pelvic circumference to be also significantly larger (P< 0.001) in the vaginal delivery group (36.85 ± 1.46cm) than in the cesarean section group (34.7 ± 0.89cm).In their ROC analysis, the area under the curve (AUC) value for the pelvic inlet as found to be 0.736 (p< 0.001, 95% CI 0.656 – 0.816), and in the subgroups with fetal HC ≤340 and >340mm, AUCs were 0.634 (p < 0.11, 95% CI 0.493 – 0.775) and 0.836 (p < 0.001, 95% CI 0.751 – 0.921), respectively[20]. This is much Similar but lower than our present finding of the AUC of the pelvic inlet and mid-pelvic anteroposterior diameters with the optimal cut point sensitivity and specificity of (90% and 80% versus 95% and 85%, respectively) Their findings implied that labor arrest was associated with the linear relationship between the maternal pelvic dimensions and fetal size.

In other studies[17], higher FPI scores were associated with greater odds of CD and that a unit increase in FPI score increased the odds of CD by 15% (adjusted odds ratio, 1.15; 95% CI, 1.09 – 1.21) for nulliparous women, and 15% for women who attempted TOLAC (adjusted odds ratio, 1.15; 95% CI, 1.10 – 1.20) after adjustment for maternal age, race, medical risk factors, and labor method was much similar but lower to our finding that the mid-pelvic anteroposterior diameter was most predictive of cesarean delivery in the model (adjusted OR 7.52; 95% CI 4.63 – 12.19), with every one-centimeter decrease in the mid pelvic anteroposterior diameter is associated with over 7-fold increase in the risk for cesarean delivery (0.28; 95% CI 0.11 – 0.67).

Other previous studies established that an outlet index of 31.89 ± 2.05cm, and the pelvic diameters; transverse inlet of 12.56 ± 0.08cm, sagittal outlet of 10.54 ± 1.00cm, interspinous diameters of 10.46 ± 0.89cm, and intertuberous diameter (transverse outlet) 10.89 ± 1.02cm are useful cut-off points for vaginal delivery in their population[33]. This is like our transverse inlet finding of 12.7 ± 1.3 at the 13.0cm cut-off point.

Therefore, in this large cohort study, the mid pelvic anteroposterior diameter best predicted mode of delivery by cesarean section with 96% sensitivity and 85% specificity for the optimal cut-point of 10.8cm. Mid pelvic anterior posterior diameter may be useful alone but produces best result when combined with other maternal factors in predicting the mode of delivery.



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