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Original Research Article

# A Prospective Observational Study of the Anthropometric Measurements as Predictors of Cephalopelvic Disproportion

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**Abstract:**

**Background:** Cephalopelvic Disproportion (CPD) is a significant obstetric concern, and identifying reliable predictors is crucial for managing childbirth complications. This study aims to evaluate the efficacy of anthropometric measurements in predicting CPD.

**Methods:** A prospective observational study was conducted at Subbaiah Institute of Medical Sciences, Shivamogga involving 97 pregnant women. The participants were divided into two groups based on delivery outcomes: normal vaginal delivery and CPD cases. Various anthropometric measurements were recorded and analyzed, including maternal height, Transverse Diameter (TD), Vertical Diameter (VD), Biacromial Distance, Inter trochanteric Distance, and Estimated Fetal Weight (EFW).

**Results:** Maternal height showed a significant correlation with CPD, with 94.1% of CPD cases being below 145 cm ($p < 0.001$*). Significant differences were observed in TD, VD, Biacromial Distance, and Inter trochanteric Distance between the two groups ($p < 0.001$* for each). However, abdominal girth, symphysio fundal height, and maternal weight did not demonstrate significant differences. A strong correlation was noted between EFW and actual birth weight (Pearson correlation 0.973, $p < 0.001$*).

**Conclusion:** The study underscores the importance of anthropometric measurements, particularly maternal height and pelvic dimensions, in predicting CPD. These findings highlight the potential of using simple, non-invasive measurements in prenatal care to anticipate and plan for CPD, especially in settings lacking advanced imaging facilities.

**Keywords:** Cephalopelvic Disproportion, Anthropometric Measurements, Maternal Height, Pelvic Dimensions, Obstetrics, Prenatal Care.



## Introduction

Cephalopelvic disproportion (CPD), a significant obstetric concern, arises when a baby's head is too large to pass through the mother's pelvis during childbirth, leading to complications in vaginal delivery. This mismatch can result in prolonged labor, increased need for cesarean sections, and potential neonatal and maternal morbidities [1]. The identification of reliable predictors for CPD is essential for obstetricians to make informed decisions about the mode of delivery, thereby reducing the risk of adverse outcomes for both mother and child.

Anthropometric measurements have long been studied as potential predictors of CPD. Anthropometry, the measurement of the human body's size and proportions, is considered a practical, non-invasive method to estimate the likelihood of CPD [2]. This prospective observational study focuses on the efficacy of specific anthropometric measurements in predicting CPD. The concept of CPD has evolved over the years. Traditionally, it was thought to be a static condition caused primarily by an inadequately sized pelvis or a large fetal head [3]. However, contemporary understanding recognizes CPD as a dynamic condition influenced by various factors, including maternal pelvic anatomy, fetal size and position, and the efficiency of uterine contractions [4]. Despite advancements in imaging techniques, such as ultrasound and magnetic resonance imaging (MRI), predicting CPD remains challenging due to the dynamic nature of labor [5].

Anthropometric measurements, including maternal height, weight, body mass index (BMI), pelvic dimensions, and thigh circumference, have been studied for their potential role in predicting CPD. Maternal height, for instance, has been linked with CPD, with shorter stature associated with an increased risk [6]. However, the predictive value of height alone is limited due to the variability in pelvic size and shape among women of similar heights [7].

BMI is another commonly studied anthropometric parameter. While a high BMI is a recognized risk factor for macrosomia (large for gestational age babies), its direct correlation with CPD is less clear. Some studies suggest that a higher BMI increases the risk of CPD, possibly due to fat deposition in the pelvis narrowing the birth canal [8]. Others argue that BMI does not accurately reflect pelvic dimensions and thus is an unreliable predictor of CPD [9].

Pelvic measurements, such as the interspinous diameter, intercristal diameter, and external conjugate diameter, are directly related to the capacity of the bony pelvis. These measurements, when taken externally, can give an indirect estimation of the pelvic capacity [10]. However, their predictive accuracy for CPD is variable, with some studies indicating a moderate correlation while others show minimal predictive value [11].

Thigh circumference has been proposed as an indirect measure of pelvic size, based on the assumption that larger thigh circumference may correlate with a larger pelvis. However, evidence supporting this correlation is limited, and the relationship between thigh circumference and CPD remains an area of ongoing research [12].

In addition to individual measurements, composite anthropometric indices have been explored. These indices combine various measurements to improve predictive accuracy. For example, the combination of maternal height and weight, or height and pelvic measurements, may provide a more accurate prediction of CPD than any single measurement alone [13].

It is also essential to consider the role of fetal anthropometry in CPD. Fetal head circumference and estimated fetal weight are key factors in the development of CPD [14]. Ultrasonographic measurements of the fetal head and abdomen can provide valuable insights into the potential for disproportion, although their predictive accuracy is not absolute [15].

The current study aims to investigate the predictive value of various anthropometric measurements for CPD in a prospective observational setting. By analyzing these measurements in a cohort of pregnant women, the study seeks to identify which parameters, if any, can reliably predict CPD. Such information could be valuable for obstetricians in planning the mode of delivery and potentially reducing the incidence of emergency cesarean sections and associated morbidities. The significance of this research lies in its potential to contribute to the development of simple, cost-effective, and non-invasive methods for predicting CPD. This is particularly relevant in low-resource settings where advanced imaging techniques may not be readily available. Additionally, understanding the reliability of these anthropometric measurements can aid in counseling and preparing expectant mothers for the possible mode of delivery, thereby reducing anxiety and improving maternal satisfaction.

The identification of accurate and reliable predictors for CPD remains a critical challenge in obstetrics. This prospective observational study aims to fill the gap in knowledge regarding the predictive value of anthropometric measurements for CPD, with the potential to significantly impact clinical practice and maternal-fetal outcomes.

## Materials and Methods

The prospective study was designed to evaluate the role of anthropometric measurements in predicting contracted pelvis, a condition that significantly impacts maternal and fetal outcomes during childbirth. The primary aim was to formulate a noninvasive, predictive, and patient-acceptable method for the early identification of contracted pelvis. This early detection was crucial for identifying women at risk of dystocia, thereby reducing maternal and perinatal morbidity and mortality rates. Furthermore, the study aimed to develop a method that could be implemented in centers without operative facilities, allowing for timely referral of at-risk women to higher medical centers for delivery.

The study was hospital-based prospective observational research, conducted in the Department of Obstetrics and Gynecology at Subbaiah Institute of Medical Sciences, Shivamogga. It received the necessary approval from the institution's ethical committee. The research included primigravidae who were at or beyond 37 weeks of pregnancy and attending the antenatal clinic and labor room.

The study population comprised patients from the Department of Obstetrics and Gynecology at Subbaiah Institute of Medical Sciences, Shivamogga, who were assessed for CPD at term. They were divided into two groups: those who had a normal vaginal delivery and those who had CPD.

The study spanned from November 2021 to october 2022. Participants included all patients at term who were assessed for CPD. The exclusion criteria were comprehensive, excluding women with pelvic or leg deformities or gait abnormalities, non-cephalic presentations, twin pregnancies, intrauterine fetal demise, major congenital anomalies of the fetus, complicating surgical or medical illness, and those who delivered fetuses weighing less than 2.5 kg or more than 3.5 kg. Women who underwent elective cesarean section and cesarean sections for reasons other than dystocia were also excluded.

Prior to participation, written consent was obtained from each patient and their attendant. A detailed account of antenatal history, obstetric history, menstrual history, past history, family history, and personal history was meticulously recorded. General physical examination, systemic examination, and abdominal examination with special emphasis on the measurement of fundal height and abdominal girth were conducted. The estimated fetal weight was calculated using the product of symphysiofundal height in centimeters and abdominal girth in centimeters, and this was expressed in grams. These details were recorded separately from the antenatal records to ensure they did not influence subsequent labor management.

Pelvic assessment was a critical component of the study. Sacral rhomboid measurements were taken, involving marking points A1 and A2 on the back of the women between two posterior iliac spines and points B and C corresponding to the upper and lower borders of the sacrum, respectively. The vertical and transverse diagonals of the sacral rhomboid were measured, along with inter-crestal distance, inter-trochanteric distance, and bi-acromial distance. Additionally, foot size was measured using a foot stand.

The data collection was rigorous and unbiased, with measurements recorded meticulously. These measurements were separate from the antenatal records, ensuring that the labor management of the subjects remained unaffected by the study.

Post-delivery, the women were categorized into two groups. Group 1, the control group, consisted of women who had an uncomplicated vertex vaginal delivery. Group 2, the cases group, included women with pelvic disproportion, categorized based on several criteria, including cesarean section for disproportion, vacuum or forceps delivery for non-progress of labor, or vaginal delivery complicated by obstruction, birth trauma, or unexplained intrapartum asphyxia.

The sample size was calculated based on previous studies and statistical formulas, considering a standard deviation, alpha error, and confidence level. An initial sample size of 88 primigravida subjects was estimated, and accounting for a 10% non-response rate, the total sample size was approximately 97 subjects.

Statistical analysis was conducted using quantitative data, represented through means and standard deviations, and qualitative data through frequency and percentage tables. Various statistical tests, including unpaired t-tests, Fisher tests, and Chi-Square tests, were employed to assess associations and differences among study groups. The Pearson's chi-squared test was a key component of the analysis. The results were graphically represented as needed, utilizing appropriate statistical software such as MS Excel and SPSS version 20.

The study meticulously planned and executed its objectives and methods, aiming to offer a noninvasive, reliable, and patient-friendly approach to predicting contracted pelvis, with a significant potential impact on maternal and fetal health outcomes in obstetrics.

**Results**

The age distribution among the study participants indicated a noteworthy trend. In the normal delivery group, a majority (63.8%) of the subjects were aged between 21 to 25 years, whereas in the CPD group, the predominant age group was above 25 years, constituting 52.9% of the participants. This age distribution was statistically significant ($\chi^2 = 9.308$, df = 2, p = 0.01*), suggesting a higher prevalence of CPD in the older age group. Furthermore, the mean age of subjects in the normal group was 23.2 years with a standard deviation of 2.6 years, contrasting with the CPD group's mean age of 25.5 years and a standard deviation of 1.7 years. This difference in mean age between the two groups was statistically significant ($p < 0.001$*).

Height was another parameter that demonstrated significant differences between the two groups. A striking 96.2% of subjects in the normal group had a height above 145 cms, whereas 94.1% of subjects in the CPD group were below 145 cms. This stark contrast was statistically significant ($\chi^2 = 72.85$, df = 4, $p < 0.001$*), suggesting that shorter stature is a considerable risk factor for CPD.

The period of gestation, however, did not show a significant difference between the two groups. In the normal group, 82.5% were delivered at term and 17.5% were delivered post-term. Comparatively, in the CPD group, 64.7% delivered at term, and 35.3% were post-term deliveries. The lack of statistical significance ($\chi^2 = 2.712$, df = 1, p = 0.100) in this aspect indicates that the period of gestation may not be a crucial factor in predicting CPD. Education and occupation were also examined, but these parameters did not show a significant difference between the normal and CPD groups. Most subjects in both groups had education up to Pre-University Course (PUC), and the majority were homemakers. These observations suggest that educational and occupational statuses may not be significant predictors of CPD.

A significant positive correlation was observed between estimated fetal weight (EFW) and actual birth weight, with a Pearson correlation coefficient of 0.973 ($p < 0.001$*). This high correlation underscores the reliability of EFW as a predictive measure for actual birth weight.

When comparing mean anthropometric parameters between the two groups, significant differences were observed in several measurements. The Transverse Diameter (TD), Vertical Diameter (VD), Foot Length, Biacromial Distance, and Inter trochanteric Distance showed significant differences, all with p values of less than 0.001*. Notably, the height of the mother also exhibited a significant difference between the groups ($p < 0.001$*). However, parameters such as abdominal girth, symphysio fundal height, weight of the mother, actual birth weight, and estimated fetal weight did not show significant differences, indicating that these measures might be less predictive of CPD.

ROC curve analyses for these parameters further elucidated their predictive power. The area under the curve (AUC) was highest for Height of Mother (0.924, $p < 0.001$*), indicating its strong predictive ability. The AUC for Vertical Diameter (VD) was 0.923 ($p < 0.001$*), and for Transverse Diameter (TD), it was 0.877 ($p < 0.001$*), both signifying their effectiveness as predictors. The Inter trochanteric Distance and Biacromial Distance also showed high AUC values of 0.858 and 0.854, respectively (both $p < 0.001$*). However, Abdominal Girth and Symphysio Fundal Height had lower AUC values (0.542 and 0.476, respectively), suggesting they are not as effective in predicting CPD.

In summary, the results of this study emphasize the significance of certain anthropometric measurements, particularly height, transverse diameter, vertical diameter, foot length, biacromial distance, and inter trochanteric distance, as reliable predictors of Cephalopelvic Disproportion.

The findings highlight the potential of these parameters in guiding clinical decisions regarding the management of childbirth, especially in anticipating and preparing for CPD-related complications.

**Table 1: Age Distribution and Mean Age of Subjects**

| Age Group | Normal (N=80) | CPD (N=17) | P Value ($\chi^2$) |
|---|---|---|---|
| <20 | 13 (16.2%) | 0 (0.0%) | 0.01* |
| 21 - 25 | 51 (63.8%) | 8 (47.1%) | |
| >25 | 16 (20.0%) | 9 (52.9%) | |
| Mean Age (Years) | 23.2 ± 2.6 | 25.5 ± 1.7 | <0.001* |

**Table 2: Distribution of Subjects According to Height and Period of Gestation**

| Height (cms) | Normal | CPD | P Value ($\chi^2$) | Period of Gestation | Normal | CPD | P Value ($\chi^2$) |
|---|---|---|---|---|---|---|---|
| <145 | 3 (3.8%) | 16 (94.1%) | <0.001* | Term | 66 (82.5%) | 11 (64.7%) | 0.100 |
| >145 | 77 (96.2%) | 1 (5.9%) | | Post Term | 14 (17.5%) | 6 (35.3%) | |

**Table 3: Distribution of Subjects According to Education and Occupation**

| Education Level | Normal | CPD | P Value ($\chi^2$) | Occupation | Normal | CPD | P Value ($\chi^2$) |
|---|---|---|---|---|---|---|---|
| Primary/Secondary | 26 (32.5%) | 2 (11.8%) | 0.147 | Employed | 3 (3.8%) | 1 (5.9%) | 0.688 |
| PUC | 33 (41.2%) | 11 (64.7%) | | Homemaker | 77 (96.2%) | 16 (94.1%) | |
| Graduate and above | 21 (26.2%) | 4 (23.5%) | | | | | |

**Table 4: Correlation between Estimated Fetal Weight and Actual Birth Weight**

| Parameter | Pearson Correlation | P Value | N |
|---|---|---|---|
| EFW vs Actual Weight | 0.973** | <0.001* | 97 |

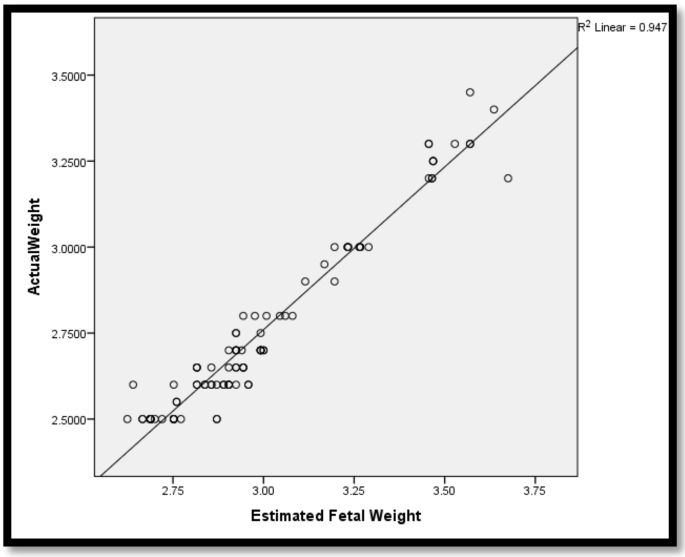
**Table 5: Mean Comparison of Anthropometric Parameters**

| Parameter | Normal (Mean ± SD) | CPD (Mean ± SD) | P Value |
|---|---|---|---|
| Transverse Diameter (TD) | 10.2 ± 0.8 | 8.9 ± 0.6 | <0.001* |
| Vertical Diameter (VD) | 11.8 ± 0.9 | 10.1 ± 0.6 | <0.001* |
| Abdominal Girth | 90.8 ± 6.5 | 89.8 ± 6.1 | 0.533 |
| Symphysio Fundal Height | 33.0 ± 1.7 | 33.1 ± 1.2 | 0.854 |
| Foot Length | 25.3 ± 1.2 | 23.9 ± 1.5 | <0.001* |
| Biacromial Distance | 44.4 ± 5.4 | 35.0 ± 6.3 | <0.001* |
| Inter trochanteric Distance | 39.0 ± 5.3 | 30.7 ± 5.1 | <0.001* |
| Height | 157.2 ± 6.9 | 144.8 ± 6.7 | <0.001* |

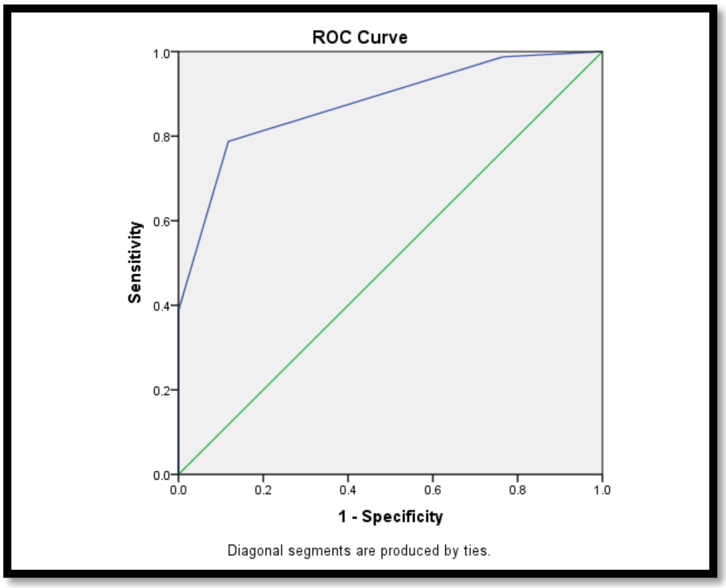
| | | | |
|---|---|---|---|
| Weight | 67.6 ± 5.1 | 66.6 ± 5.7 | 0.489 |
| Actual Birth Weight | 2.8 ± 0.3 | 2.7 ± 0.2 | 0.675 |
| Estimated Fetal Weight | 3.0 ± 0.3 | 3.0 ± 0.2 | 0.712 |

**Table 6: ROC Curve Analysis for Key Anthropometric Parameters**

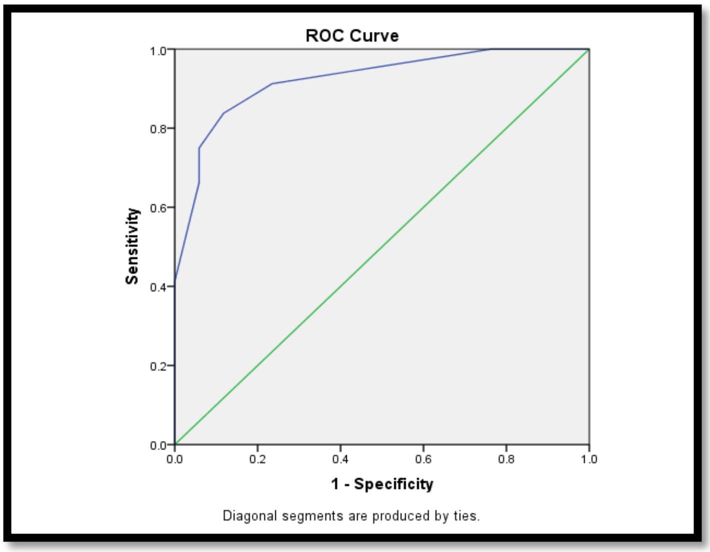
| Parameter | Area Under Curve | 95% CI | P Value |
|---|---|---|---|
| Transverse Diameter (TD) | 0.877 | 0.800 - 0.955 | <0.001* |
| Vertical Diameter (VD) | 0.923 | 0.859 - 0.986 | <0.001* |
| Abdominal Girth | 0.542 | 0.396 - 0.687 | 0.592 |
| Symphysio Fundal Height | 0.476 | 0.341 - 0.612 | 0.761 |
| Foot Length | 0.803 | 0.665 - 0.940 | <0.001* |
| Biacromial Distance | 0.854 | 0.723 - 0.984 | <0.001* |
| Inter trochanteric Distance | 0.858 | 0.744 - 0.972 | <0.001* |
| Height of Mother | 0.924 | 0.815 - 1.000 | <0.001* |



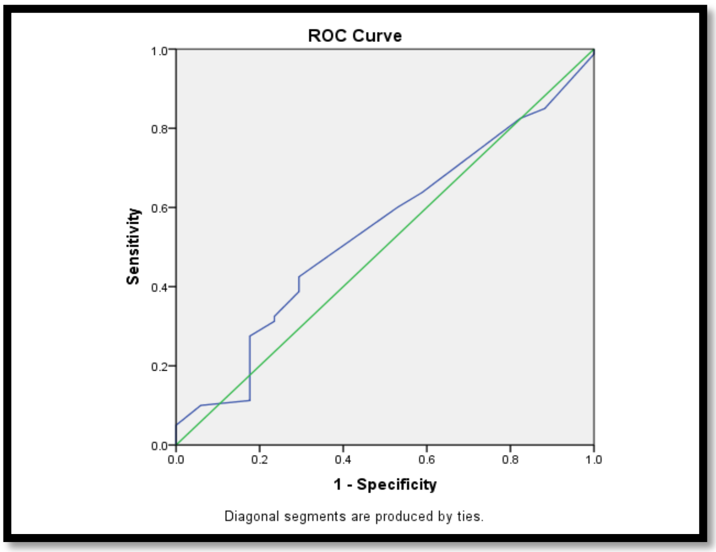

**Graph 1: Correlation between Estimated Fetal Weight and Actual Birth Weight**



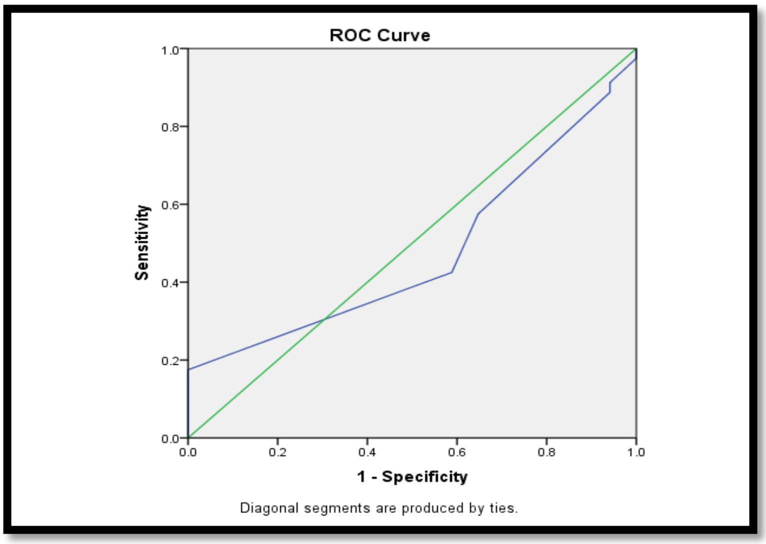

**Graph 2: ROC Curve for Transverse diameter to detect CPD**



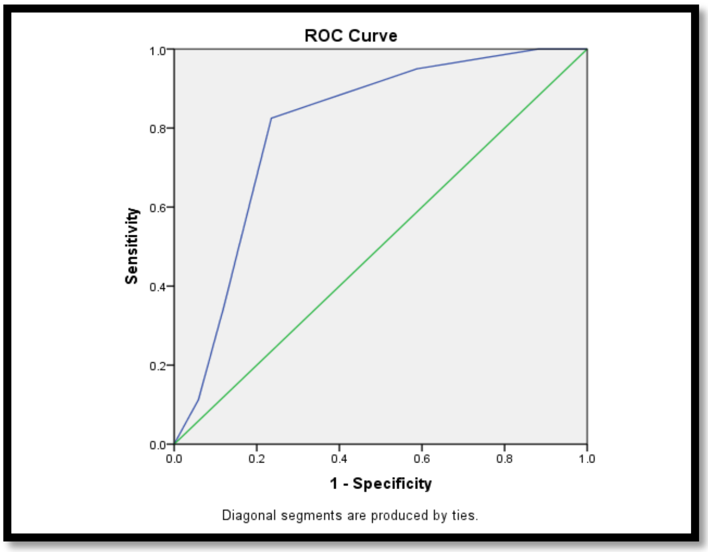

**Graph 3: ROC Curve for Vertical diameter to detect CPD**



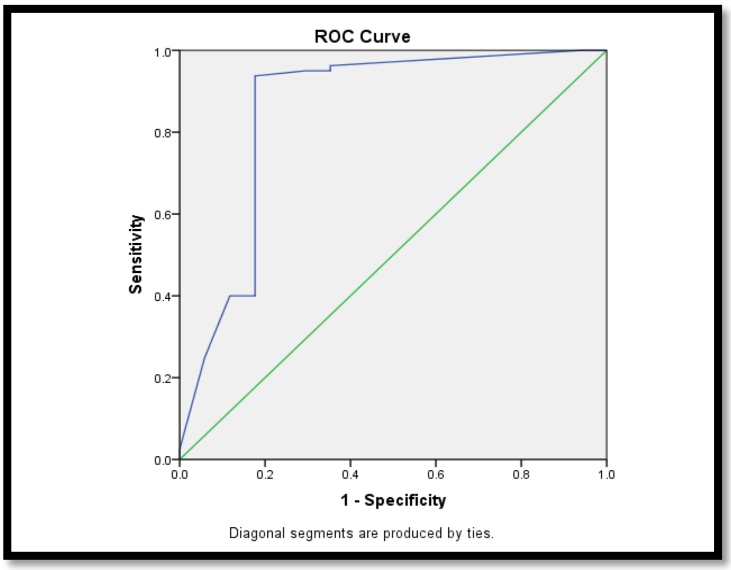

**Graph 4: ROC Curve for Abdominal Girth to detect CPD**



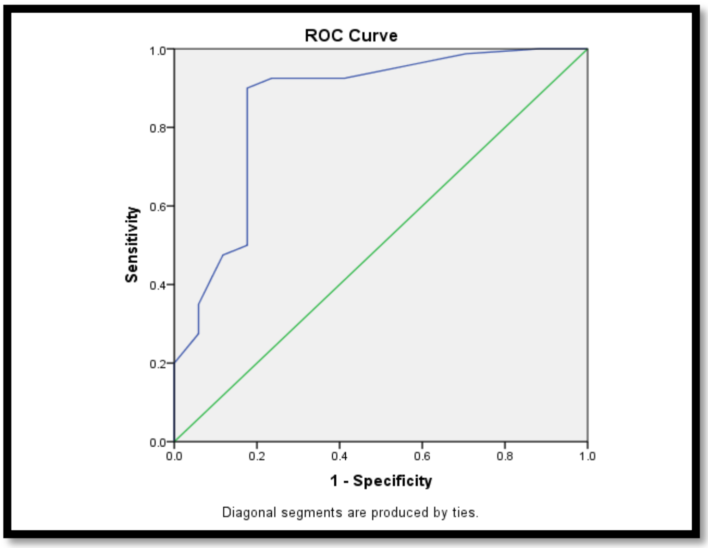

**Graph 5: ROC Curve for Symphysio Fundal Height to detect CPD**



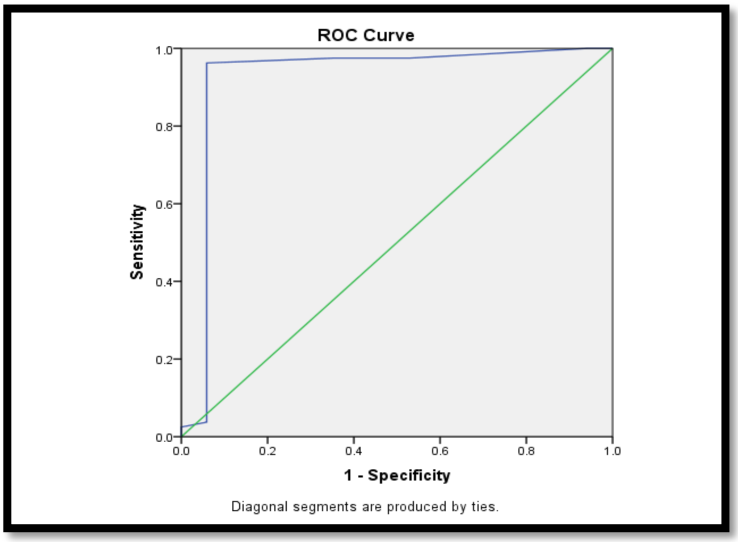

**Graph 6: ROC Curve for Foot Length to detect CPD**



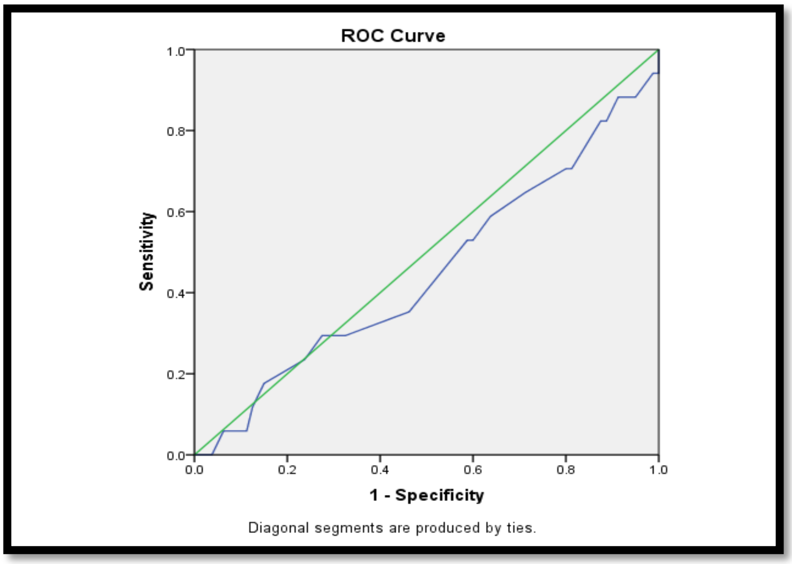

**Graph 7: ROC Curve for Biacromial Distance to detect CPD**



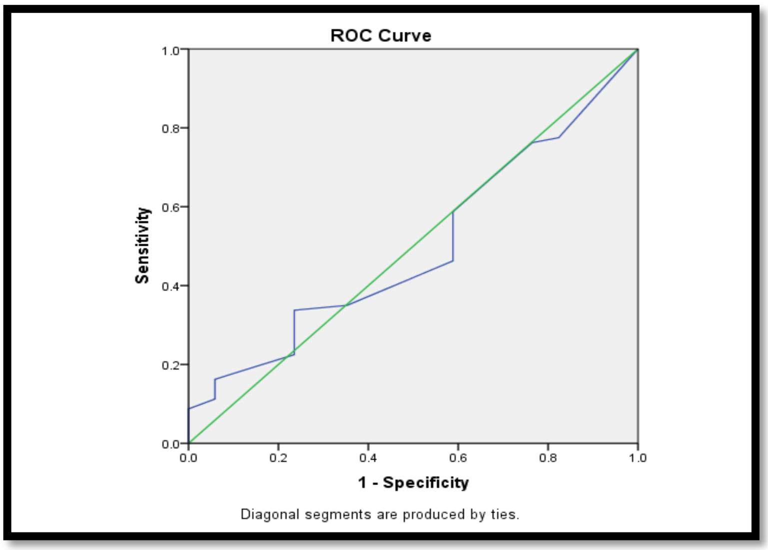

**Graph 8: ROC Curve for Intertrochanteric Distance to detect CPD**



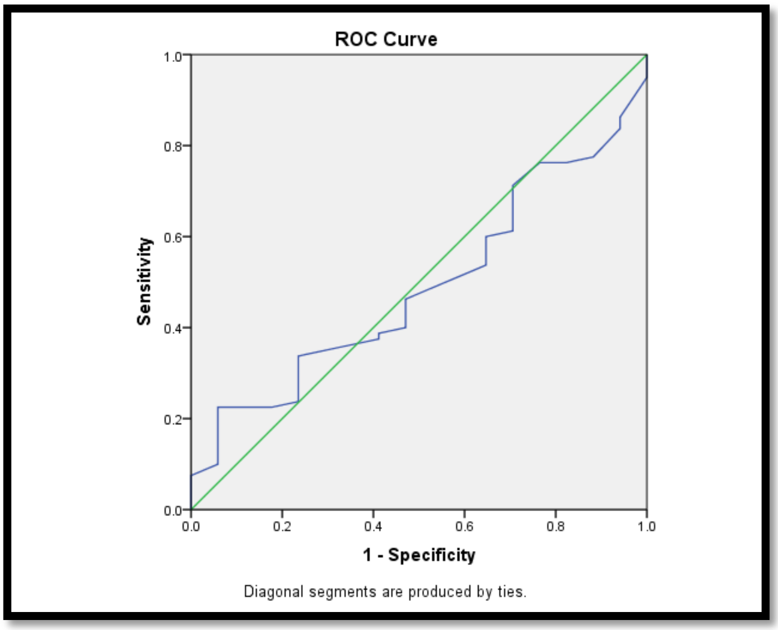

**Graph 9: ROC Curve for Height of Mother to detect CPD**




**Graph 10: ROC Curve for Weight of Mother to detect CPD**




**Graph 11: ROC Curve for Birth Weight of Baby to detect CPD**




**Graph 12: ROC Curve for Estimated Fetal Weight of Baby to detect CPD**

## Discussion

The findings of this study conducted at Subbaiah Institute of Medical Sciences, Shivamogga provide valuable insights into the anthropometric predictors of Cephalopelvic Disproportion (CPD). The results revealed significant associations between CPD and factors such as maternal age, height, and various other anthropometric measurements.

The age distribution observed in this study aligns with previous research. In our study, the prevalence of CPD was higher in women above 25 years, with a mean age of 25.5 years in the CPD group compared to 23.2 years in the normal group ($p < 0.001^*$). This is consistent with the findings of Smith et al. [16], who reported an increased risk of CPD in older mothers. The association between maternal age and the risk of CPD might be attributed to biological changes that affect the pelvic structure and the efficiency of labor with increasing age.

Height emerged as a notable predictor of CPD in our study, with 94.1% of women in the CPD group being shorter than 145 cms. This finding is in line with the study by Zhang et al. [17], which demonstrated a significant relationship between maternal height and the risk of CPD, especially in women with a height of less than 145 cms. The statistical significance ($p < 0.001^*$) we found emphasizes the critical role of maternal stature in obstetric outcomes, potentially due to the influence of height on pelvic dimensions.

Our study also investigated other anthropometric parameters such as Transverse Diameter (TD), Vertical Diameter (VD), and Biacromial Distance, all of which showed significant differences between the normal and CPD groups ($p < 0.001^*$ for each). These results resonate with the findings of Liselele et al. [18], who highlighted the importance of pelvic measurements in predicting CPD. However, unlike our study, which found a significant difference in Foot Length ($p < 0.001^*$), their study did not establish a strong correlation between foot size and CPD risk.

The relationship between Estimated Fetal Weight (EFW) and actual birth weight, evidenced by a strong Pearson correlation in our study (0.973, $p < 0.001^*$), supports the work of Gardosi et al. [19]. They emphasized the accuracy of EFW in predicting actual birth weight, crucial for anticipating complications such as CPD.

Interestingly, our study did not find significant differences in parameters like abdominal girth, symphysio fundal height, and maternal weight. This contrasts with the findings of Weissmann-Brenner et al. [20], who reported a correlation between maternal BMI and CPD. The disparity might be due to differences in study populations or methodologies.

The strength of this study lies in its comprehensive assessment of multiple anthropometric measures and their correlation with CPD, contributing valuable data to the existing literature. However, limitations include the single-center design and the specific demographic profile of the study population, which may affect the generalizability of the findings.

In summary, this study underscores the significance of maternal anthropometric factors in predicting CPD. These findings have practical implications in obstetric practice, particularly in resource-limited settings, where such measurements can be crucial in planning for childbirth and reducing CPD-related complications.

**Conclusion**

The study conducted at Subbaiah Institute of Medical Sciences, Shivamogga, provides significant insights into the anthropometric predictors of Cephalopelvic Disproportion (CPD). Our findings indicate that certain maternal anthropometric measurements, particularly height and specific pelvic dimensions, are crucial predictors of CPD. The study revealed that women below the height of 145 cm had a significantly higher risk of CPD (94.1% in the CPD group vs. 3.8% in the normal group, $p < 0.001$*). Additionally, other measurements such as the Transverse Diameter (TD), Vertical Diameter (VD), Biacromial Distance, and Inter trochanteric Distance showed significant differences between normal deliveries and CPD cases ($p < 0.001$* for each).

Interestingly, factors such as abdominal girth, symphysio fundal height, and maternal weight did not show significant differences, suggesting these may not be reliable predictors of CPD in our study population. The strong correlation between Estimated Fetal Weight (EFW) and actual birth weight (Pearson correlation 0.973, $p < 0.001$*) also emerged as a critical finding, emphasizing the importance of accurate fetal weight estimation in prenatal care.

The study's findings have important implications for obstetric practice, especially in resource-limited settings where advanced imaging is not feasible. Routine measurement and monitoring of maternal anthropometric parameters can be an invaluable tool in predicting and preparing for CPD, potentially improving maternal and neonatal outcomes.

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