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Age, Anthropometric Measurements and Mode of Delivery among Primigravidae Women at Addis Ababa Governmental Hospitals, Ethiopia

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Abstract

Background: In developing countries, a significant number of maternal deaths are attributable to the complications of obstructed labor. Identifying women at risk for Cephalopelvic Disproportion (CPD) prepares physicians for on time treatment and enables them to minimize maternal-fetal trauma that accompanies this midwifery emergency. The study aims to identify diagnostic accuracy of maternal age and anthropometric measurements to predict CPD among Primigravidae women visiting Addis Ababa Governmental Hospital.

Methods: Hospital based prospective cohort study was carried out at Governmental Hospitals in Addis Ababa. The sample size was 384 mothers. Five hospitals were selected from Addis Ababa governmental hospitals by using simple random sampling (lottery method). Data was entered into EPI data version 3.3 and analyzed using SPSS version 23 statistical package.

Results: The current study shows as the most predictive variable is maternal height with Positive Predictive Value percentage of 64.9, sensitivity of 85.4% and specificity of 96.4% followed by Michaelis rhomboid transverse diameter with Positive Predictive Value of 14.8%, sensitivity of 51.3%, and specificity of 89.4%.

Conclusions: Age and maternal anthropometric measurements can predict CPD to some extent. Combining some of maternal anthropometric measurements with each other enhances the predictive value to a relatively modest degree. In this study when height is combined with other anthropometric measurements it doesn't show increment in predictive value.

Keywords: Cephalopelvic disproportion; Vaginal delivery; Dystocia; Fetal morbidity

Introduction

Cephalopelvic Disproportion (CPD) is a mismatch between the maternal birth canal (the pelvis), and the fetal head [1]. It is diagnosed when there is evidence of either (a) a prolonged first stage (>12 hours) in spite of effective uterine activity or (b) failure of the head to descend or evidence of severe molding or fetal distress in late first stage with secondary arrest or prolonged second stage [2]. Dystocia occurs in 25-30% of nulliparous women and is regarded as the cause for two thirds of cesarean sections in these women [3,4]. If not diagnosed and treated, this condition can lead to maternal/fetal morbidity and even the mother's mortality [5-7].

In developing countries, a significant number of maternal deaths are attributable to the complications of obstructed labor leading to birth canal trauma, postpartum hemorrhage, and genital infections, etc. Patients with CPD delay in the decision to seek care or delay in arrival to an appropriate medical care facility is common in rural hospitals. Detection of mothers at a higher risk of CPD is therefore important for higher precaution, close attention or preparation of cesarean section or timely labor induction in daytime when more manpower and experienced physicians are available. This is particularly crucial in settings where cesarean section is not feasible, so that women at high risk for CPD may be referred to a hospital equipped with an operating theatre before the onset of labor [8,9].

Women who experience CPD often undergo surgical interventions such as emergency caesarean, and vacuum and forceps deliveries which cause considerable physical problems for mothers, in addition to stress and an economic burden on the family and community [8]. Identifying women at risk for CPD prepares physicians for on time treatment and enables them to minimize maternal-fetal trauma that accompanies this midwifery emergency [9]. Therefore, one of the main objectives of pregnancy care is the identification of high risk women for CPD. In this direction, numerous investigators have attempted to find indexes to identify high risk women during pregnancy. A number of researchers have regarded factors such as mother's age, height, weight before pregnancy, body mass index (BMI), weight gain during pregnancy, fundal height, birth weight, and foot length of the mother as risk factors. These factors, however, are controversial [10,11].

Methods

The study was conducted at Addis Ababa, the capital city of Ethiopia. There are ten government hospitals in the city. The study was conducted in six hospitals: Gandhi memorial hospital, Zewditu memorial hospital, St. Paul General Specialized hospital, Yikatit [12] hospital, and Tikur Anbesa Specialized hospital.

Data collection instruments and method

Data collection tools were: Check list, weight scale, non-elastic tape meter and Standiometer. These instruments are sponsored by department of nutrition of Ethiopian Public Health Research Institute. Data were collected from client card and through different anthropometric measurements and filled on check list. Check list was coded by using clients' card number. The data include socio-demographic characteristics such as age, level of education and occupation of mothers. Information for gestational age, mode of delivery and information for socio-demographic was collected from antenatal follow up chart. Every data was collected before delivery and data which doesn't fulfill the inclusion criteria was rejected. Mothers who undergo cesarean section due to: non-vertex presentation, obvious congenital abnormalities of fetus, abruptio placenta, preeclampsia, eclampsia, placenta previa and women's who had hip fractures, asymmetrical pelvis, multiple pregnancy, polyhydroamnions, preterm delivery, birth weight (less than 2500 g and above 4000 g), elective cesarean section, instrumental delivery, gestational age above 42 weeks and repeat caesarean section were excluded from the study.

Height and foot length measurement

Height was measured in the standing position following standards of measuring height by using standardized standiometer (mothers stood next to a wall with their feet and knees together, knees straight, heels, legs, hip, shoulders, back of the head parallel to the wall, their body completely flat and stretched, hands hanging on both sides, and looking straight ahead. The horizontal plate of the standiometer was placed over the mother's head and standing height was measured) and foot length is measured by wooden centimeter from heel to the tip of longest toe.

Bi-acromial, head circumference, middle upper arm circumference and Michaelis diameter

The distance between the two acromial ends was taken by using standardized non elastic tape meter. Michael's sacral transverse diameter (distance between two depressions of superior posterior spines at two horizontal ends of the sacral bone) and vertical diameter of Michael's sacral (distance between L5 and carina ani) was measured using a centimeter non elastic tape measure with the mother in the standing position. Head circumference-is distance between highest occipital peak and mid fore head line [12] measured by standard non elastic tape meter. Middle upper arm circumferences were taken from the left upper arm at mid-way between the olecranon process and head of humerus. All measurements are taken three times and the average was taken [12]. Every measurement was recorded to the nearest 0.5 cm interval. Mode of delivery was collected from delivery report recorded in patient card and subjects were divided into normal delivery and subjects with CPD. The transverse diameter of the Michaelis sacral rhomboid was measured between the two posterior superior iliac spines. The vertical diameter of the rhomboid was measured between the L5 spine (one space below the L3-L4 disc which is in line with the uppermost point of the iliac crest) and the upper limit of the natal cleft [6,13].

Statistical analysis

Data entry and cleaning was done by EPI data version 3.3 and checked for values that are inconsistent with other information gathered in the study. The data was also checked for missing item and decisions was taken accordingly. Finally data was transferred to SPSS version 23 statistical package. Bivariate logistic analysis was carried out to distinguish the independent effect of each variable. P-value less than 0.05 were taken as statistically significant. The mean ± SD was compared using analysis of variance (ANOVA) followed by Scheffe test. Cut off values for maternal anthropometric measurements were defined as the values closest to the 10^{th} percentile of the population. Sensitivity, specificity and positive predictive values with their 95% confidence intervals (CI) were calculated using these thresholds. The data was presented by using statements, frequency tables, figures and percentages.

Results

To conduct the study total of 384 primigravideum women were recruited for the study based on inclusion criteria. Among these 345 of them were mothers who gave birth through spontaneous vaginal delivery without any complication and the rest 39 (10.1%) mothers give birth by cesarean section due to confirmed CPD. The mean age of the women who give birth through spontaneous vaginal delivery was 26.1 years with standard deviation of 4.9 while the mean age of the women who give birth by cesarean section were 21.7 years with standard deviation of 3.7.

As shown in Table 1 about 384 primigravideum mothers were included in the study. Based on their mode of delivery these mothers were grouped into two groups (normal vaginal delivery and cesarean section group) and different maternal anthropometric measurements are compared. The current study shows that the mean maternal age is decreased in mothers complicated by CPD with P=0.005 and it is statistically significant (Table 1). Similarly several measurements were lower in mothers who had cesarean delivery for CPD when compared with mothers who delivered vaginally. The mean of maternal height, foot length, Michaelis horizontal diameter and maternal head circumference are smaller in the cesarean section group than in the normal vaginal delivery group. The mean of Michaelis vertical diagonal, mid upper arm circumference and bi-acromial diameter has no significant difference between the normal vaginal delivery and cesarean section group (Table 1).

Variables	Normal delivery (n=337)	Cephalopelvic disproportion (n=47)	P*
Age (years)	24.2 ± 3.4	22.7 ± 3.3	0.005
Height (cm)	1.65 ± 0.06	1.53 ± 0.06	0
Foot length (cm)	23.7 ± 0.9	22.6 ± 0.72	0

Michaelis horizontal diagonal (cm)	9.1 ± 0.8	8.5 ± 0.56	0
Michaelis vertical diagonal (cm)	9.3 ± 0.9	9.3 ± 0.52	0.883
Head circumference (cm)	53.4 ± 2.9	48.9 ± 4.9	0
Bi-acromial diameter (cm)	33.6 ± 3.1	33.2 ± 2.8	0.428
Mid upper arm circumference	22.4 ± 2.4	22.8 ± 2.7	0.987

Table 1: Comparison of maternal characteristics between the two groups (normal vaginal delivery and CPD group) in Addis Ababa governmental Hospital, Addis Ababa, Ethiopia, 2017 [Values are given as mean ± SD; P*: Computed by one way ANOVA].

Maternal height, transverse diagonal of the Michaelis sacral rhomboid area, maternal head circumference and foot length had the highest sensitivity, specificity and positive predictive value respectively. The result is computed by using 10th percentile of age and all measurements as cut-off value. After cut-off values are determined sensitivity percentage, specificity percentage and PPV percentage are calculated. Different methods are applied to decide cut-off point for maternal anthropometric measurements. Among these methods is the use of ROC curves to decide the cut-off limits [14]. Another method of deciding a cut-off limit for an anthropometric measurement to predict CPD has been to identify the 10th percentile of the measurement for the study population [15]. Similarly in the current study the 10th percentiles were used as cut-off value for all maternal anthropometric measurements (Table 2).

Variables	Sensitivity percentage	Specificity percentage	PPV Percentage
Age (years)<10th percentile	26.6	88.4	21.3
Height (cm)<10th percentile	85.4	96.4	64.9
Foot length (cm)<10th percentile	28.8	90.6	21.7
Michaelis rhomboid–transverse (cm)<10th percentile	51.3	89.4	14.8
Michaelis rhomboid-vertical (cm)<10th percentile	25	87.9	2.1
Head circumference (cm)<10th percentile	34.3	89.7	23.4
Bi-acromial diameter (cm)<10th percentile	17.4	88.4	14.9
Mid upper arm circumference<10th percentile	17.9	87.6	15.2

Table 2: Shows sensitivity, specificity and PPV percentage of maternal age and anthropometric measurements as predictors of CPD in Addis Ababa governmental Hospital, Addis Ababa, Ethiopia, 2017.

According to this study some combined anthropometric measurements show increment in sensitivity, specificity and PPV. Foot length alone has sensitivity percentage of 28.8, specificity percentage 90.6 and PPV of 21.7%. When foot length is combined with other anthropometric measurements such as height, Michaelis horizontal and maternal head circumference its sensitivity increased to 57.9%, 31.3% and 30.4% respectively. As shown above when height is combined with other anthropometric measurements it doesn't show increment in all sensitivity, specificity and PPV (Table 3).

Combined Variables	Sensitivity percentage	Specificity percentage	PPV Percentage
Height<10th percentile + Foot length<10th percentile	57.9	91.5	45.1
Height<10th percentile + Michaelis vertical<10th percentile	81	90.5	35
Height<10th percentile + Michaelis horizontal<10th percentile	71.1	91.1	39.3
Height<10th percentile + Head circumference<10th percentile	60.9	92.2	44.7
Height<10th percentile + Bi-acromial diameter<10th percentile	57.6	90.7	40.4
Foot length<10th percentile + Michaelis vertical<10th percentile	26.5	90.1	12.4
Foot length<10th percentile + Michaelis horizontal<10th percentile	31.3	91.3	17.7

Foot length<10th percentile + Head circumference<10th percentile	30.4	89.7	22.6
Foot length<10th percentile + Bi-acromial diameter<10th percentile	27.7	91.1	18.9

Table 3: Validity of combining different maternal anthropometric measurements for prediction of CPD in Addis Ababa governmental Hospital, Addis Ababa, Ethiopia, 2017.

Discussion

In the health centers which are not equipped to perform a caesarean section, accurate prediction of women at risk for CPD is difficult. Long referral distances and poor local transport may lead to obstructed labor and uterine rupture [16-18]. Conversely, in a resource limited setting, prediction of CPD in women at risk must be sufficiently specific to avoid unnecessary referral. This study compared different maternal anthropometric measurements such as height, foot length, bi-acromial diameter, mid upper arm circumference and maternal head circumference, Michael's horizontal and vertical diameter of those mothers who give birth through spontaneous vaginal delivery and for those mothers who undergo CS for confirmed CPD.

Maternal age is among several factors used to screen pregnant women for potential risk of labor complications [19]. Adolescents under 15 years of age experienced more obstetric complications than adult women [20]. According to this study the mean value of maternal age 22.7 years for CS and 24.2 years for normal vaginal delivery and it's statistically significant. This study agrees with another study which states as the high prevalence (89.4%) of women who were less than 18 years of age indicates early start of reproductive activity in Sudan [21]. But another study did not find the cutoff point of less than 18 years of age as a significant risk factor for CPD [22]. This difference with may be due to chosen cut-off point, genetic, environmental, nutritional or cultural effect.

It is well established that the height of the mother is correlated to the size of the pelvis and several studies have demonstrated that mothers with CPD are shorter than those who have normal vaginal deliveries [6,23-31] which is in line with this study in which the mean of maternal height for mothers with CPD is 1.51 cm and 1.65 cm for mothers who undergo normal vaginal delivery. This study is not in line with other studies [32,33] that failed to document a significant association between short stature and mode of delivery which may be due to genetic, environmental, nutritional or cultural effect. However, there is no consensus on the height below which CPD is likely to occur. Several studies have used a cutoff value of 150 cm for height to predict CPD. However, this will not be appropriate for all ethnic populations and the nutritional status of the mother and genetic factors would also determine fetal size [34]. In comparison with women with normal/tall stature, fewer women with short stature delivered vaginally. This is has been reported by earlier investigators [19,35].

According to this study about 57.4% of women's with foot length less than 22.6 cm and (p=0.000) delivered by CS and this finding indicates as foot length has strong relation with mode of delivery which is in line with study conducted by Mohamed et al. [21]. According to Mohamed et al. [21] women with foot length less than 18 cm has less chance (P<0.001) for vaginal delivery compared to the category of 18 cm and more. Taking foot length as a constant factor, most women of foot length less than 18 cm delivered by caesarean section than vaginal delivery. Awonuga et al. [22] and Mahmood et al. [2] found the measurement of shoe size is not useful as predictor of the mode of delivery. Frame et al. found as it is useful. Instead of the shoe size, in this study foot length is investigated. In contrast to Bogaert et al. the current study shows as foot length has value to predict mode of delivery. In the current study the mean SD of maternal head circumference for delivery with CS is 48.9±4.9 and 53.4±2.9 for delivery by SVD and P=0.000. This study is in line with the study conducted by Connolly et al. According to Connolly et al. the most important anthropomorphic risk factors for CPD were maternal head circumference in relation of height (P<0.001) [15]. This study is also in line with the study conducted by Rahele et al. [12] which states as the mean ratios of head circumference to height in normal delivery and dystocia groups were significant (P=0.001). Another maternal anthropometric measurement performed in this study is maternal Bi-acromial diameter. The finding for this study is bi-acromial diameter with mean (SD) 33.2 ± 2.8 in mothers with CS and 33.6 ± 3.1 for SVD and it is statistically insignificant (P=0.428). This study is in line with the study conducted by Benjamin et al. [35] with cut-off value 33.4 cm, sensitivity 55.6%, specificity 89.2% and PPV of 14.4% and p-value of 0.688 which has no association with mode of delivery. In the current study, mid upper arm circumference (MUAC) was found to be insignificant predictor of cesarean delivery rate on the basis of multivariate analysis and the study agrees with the findings of Mohamed et al. [21]. Previous studies have shown that MUAC well correlated with an increase in cesarean delivery rate [36-45].

Michaelis sacral region is a diamond-form area in sacral bone and its superior angle is between L5-S1, inferior angle at caudal part and lateral angle at superior-posterior spines [36]. For the first time, Michaelis GA mentioned its importance for pelvic capacity [6]. The transverse diameter is visible between posterior superior spines on the skin. Its measurement could be related to pelvic capacity [23]. The size of the Michaelis transverse is associated with the transverse pelvic capacity. Among black women, the proportion of anthropoid pelvises, characterized by a reduction in the pelvic transverse diameters, is twice that in white women [37]. Therefore, in black women, the transverse pelvic capacity may be more critical during labor, and the Michaelis transverse may be more associated with dystocia than in white women. Anyhow, most white women live in the Western world where caesarean section during labour is readily available, limiting the interest of screening for dystocia. According to the current study the mean value of Horizontal diagonal of Michaelis sacral rhomboid area is 8.5 0.56 for CS and 9.1 0.8 for spontaneous vaginal delivery and its (P=0.000) which is statistically significant. In Chinese women, the proportion of anthropoid pelvises is intermediate between white and black women [38] and this method could be useful. Rozenholc et al. [23] showed that based on measuring transverse diagonal of Michaelis sacral could identify more than 50% of abnormal labor progresses. Liselele et al. [15] and Alijahan et al. [39] showed that transverse diagonal of Michaelis sacral has high diagnostic accuracy to assess labor progress.

According to the current study the mean value of vertical diagonal of Michaelis sacral rhomboid area is 9.3 0.52 for CS and 9.3 0.9 for spontaneous vaginal delivery and its (P=-0.883) which is statistically insignificant. The current study is in line with study done by Rahele et al. [12] in which they found that women's with vertical diagonal of Michaelis sacral rhomboid area ≤ 9.5 cm undergo CS. Attempts have been made before to combine more than one anthropometric measurement in the hope that the predictive value of the combined measurements would be greater [6,23,41]. According to this study when foot length was combined with other anthropometric measurements such as height, Michaelis horizontal and maternal head circumference its sensitivity increased to 59.6%, 33.3% and 30.4% respectively.

The current study shows combination of mothers' height with the other anthropometric measurements does not show better prediction compared to mothers' height alone. This study is not consistent with the study conducted by Rahele et al. [12] which shows as the best predictor was pair combination of mothers' transverse diagonal of Michaelis sacral rhomboid area and height with a sensitivity of 58.3%, specificity of 89.9%, and accuracy of 86.2 and Rozenholc et al. [23] and Liselele et al. [6] study showed, combination of mothers' height with transverse diagonal of Michaelis sacral diameter and mothers' foot length, resulted in better predictors concerning sensitivity and specificity. This inconsistent result may be due to difference of chosen cut-off value.

Conclusion

This study concludes age and maternal anthropometric measurements can predict CPD to some extent. Combining some of maternal anthropometric measurements with each other enhances the predictive value to a relatively modest degree. According to the current study when height is combined with other anthropometric measurements it doesn't show increment in predictive value. Measurements of maternal height, foot length, head circumference and the transverse diagonal of the Michaelis sacral rhomboid area using a measuring tape may represent a simple method to detect nulliparous women at risk for CPD. This method, after being validated in other populations, may be useful in peripheral antenatal clinics to identify pregnant women at risk for CPD and to refer them to district hospitals before the onset of labor. In this study factors that might have influenced the decisions of mode of delivery e.g. use of oxytocin and fetal head size were not investigated in this study and age of the mother were not limited and even women who were younger than 18 years were included which may affect the result. External pelvimetry associated with specific other anthropometric parameters could be helpful in the screening of generally contracted pelvis, and consequently pregnancies at high risk of CPD in nulliparous women, particularly in developing countries with limited resources. Further investigations are requested to deal with this topic in depth, meticulous research that assesses accuracy of maternal anthropometric measurements to predict CPD with larger sample size.

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Conflicts of Interest

The authors report no conflict of interest.

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