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Modelling external pelvic dimensions as a screening tool for cephalopelvic disproportion

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ABSTRACT

Cephalopelvic disproportion (CPD) remains one of the leading causes of labor complications and cesarean deliveries, particularly in low-resource settings where pelvimetric assessment is limited. The absence of a simple, accurate, and non-invasive screening tool in primary healthcare complicates early detection and management. This study aimed to design and evaluate an external pelvic measurement tool to identify women at risk for CPD. This was a quantitative case-control study involving 60 postpartum women at Dr. Sardjito Hospital, Yogyakarta, Indonesia, between 2018 and 2023. The case group included 30 women diagnosed with CPD, while the control group comprised 30 women with spontaneous vaginal deliveries. External pelvic measurements were conducted at the Michaelis rhomboid and other anatomical landmarks (AB, AD, CB, CD, BD, AC) using standardized procedures. Sociodemographic variables were controlled through matching by age, parity, and gestational age. Significant differences were observed in external pelvic dimensions between the case and control groups. The average AB, AD, CB, and CD distances were consistently shorter in the CPD group (mean ~5.7–5.8 cm) compared to the control group (mean ~6.8 cm). Pelvic circumference and distances such as distansia cristarum and Boudeloque diameter were also smaller in CPD cases. These findings suggest that women with smaller external pelvic dimensions are at higher risk for CPD. The study highlights those specific external pelvic measurements, particularly within the Michaelis rhomboid area, have potential as practical indicators for early CPD detection. Implementing this tool in antenatal care, especially in primary healthcare settings, may improve screening, guide referral decisions, and reduce the risk of obstructed labor.

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INTRODUCTION

Maternal mortality continues to pose a grave public health challenge globally. In 2023, an estimated 260,000 women died from pregnancy-related causes equating to 712 maternal deaths per day worldwide. Though the global maternal mortality ratio (MMR) has declined by ~40% since 2000, global progress has stagnated post-2016, and many countries remain far from the Sustainable Development Goal target of <70 per 100,000 live births by 2030.(1) In Indonesia, despite significant reduction efforts, MMR remains among the highest in Southeast Asia. The national MMR decreased from 249 per 100,000 live births in 2020 but estimates suggest it remained at ~140 per 100,000 in 2023, still well above the SDG target.

Jurnal Kesehatan Ibu dan Anak Vol.18, No.1, July 2024, pp. 52~63
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Infant mortality (IMR) also remains elevated at approximately 17 per 1,000 live births in 2023.(2)

A major contributor to these high maternal and infant mortality rates is complications of labor, including obstructed labor resulting from cephalopelvic disproportion (CPD). CPD occurs when there is a mismatch between fetal head size and the maternal pelvis, due to a narrow pelvis, a large fetus, or both. CPD can delay labor progression, increase emergency cesarean sections, and elevate risks to both mother and baby.(3) CPD is especially relevant in Asian populations. Women in many Southeast Asian countries tend to be shorter on average, often under 150 cm in height, which correlates with smaller pelvic dimensions and elevated risk for CPD compared to Western populations.(4) While global incidence data are limited, an American College of Nurse-Midwives (ACNM) source estimates CPD occurs in approximately 1 in 250 pregnancies.(5) Locally, Indonesian studies have reported CPD prevalence as high as 21.7% in community deliveries.(6,7) Despite its clinical importance, tools for early detection of CPD are scarce, especially simple, low-cost screening methods integrated into antenatal care at the primary health level. This gap underscores the need to develop and validate practical detection methods that can aid early identification of CPD risk particularly among short-statured or primigravida women in low-resource settings. Although pelvimetry has been utilized for over six decades to estimate pelvic adequacy and detect potential cephalopelvic disproportion (CPD), its effectiveness and clinical relevance remain controversial.(8)(9) Radiological pelvimetry (e.g., CT, MRI) is considered more accurate, but it is costly, not universally available in low- and middle-income countries (LMICs) and raises concerns regarding safety and feasibility in routine antenatal care.(10) On the other hand, manual pelvimetry is subjective, lacks standardized procedures across clinical settings, and is highly dependent on the examiner's experience and consistency.(11)

In many primary healthcare settings, particularly in rural areas of Indonesia and other LMICs, systematic assessment of pelvic dimensions is rarely performed.(12) This is due to limited access to tools, lack of training in standardized techniques, and absence of a simple, validated screening instrument that can be used easily by frontline providers such as midwives.(13) As a result, CPD is often only identified intrapartum, when complications have already occurred, leading to delayed referral, emergency cesarean sections, or worse maternal-fetal outcomes.(14) Despite CPD being a well-known risk factor for obstructed labor and maternal mortality, there is no affordable, non-invasive, and easy-to-use tool currently recommended for routine screening at the community or primary health level.(15) This gap in early detection capacity undermines the potential for preventive interventions, especially among women with known anthropometric risk factors (e.g., short stature, high BMI, excessive gestational weight gain). Given these challenges, there is an urgent need for a practical, low-cost detection tool that can accurately assess the risk of CPD using simple anthropometric or anatomical markers. Such a tool should be designed for use by midwives and primary healthcare workers, especially in settings where radiologic facilities and specialist obstetricians are unavailable.

This study proposes a novel approach by designing a detection tool based on external pelvic landmarks, particularly the Michaelis sacral area, which has been suggested in prior studies as a reliable proxy for internal pelvic dimensions. By incorporating this measurement into a predictive model, the tool aims to support early risk identification, guide timely referral, and reduce the burden of intrapartum CPD-related complications.

METHOD

This study employed a quantitative approach with a case–control design, which is suitable for identifying and analyzing potential risk factors associated with relatively rare obstetric conditions such as cephalopelvic disproportion (CPD). The case–control design was chosen because it allows for retrospective comparison between women who experienced CPD (cases) and those who delivered vaginally without CPD (controls), thus enabling

Jurnal Kesehatan Ibu dan Anak Vol.18, No.1, July 2024, pp. 52~63
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efficient exploration of contributing factors without requiring large sample sizes or prolonged follow-up periods. The study was conducted at Dr. Sardjito Hospital, Yogyakarta, Indonesia, with data collection spanning from 2018 to 2023. The study population consisted of postpartum women with a confirmed diagnosis of CPD (case group) and women who underwent spontaneous vaginal delivery (control group). A total of 60 participants were recruited, comprising 30 cases and 30 controls. Subjects were matched based on several key characteristics to control for potential confounding variables, including maternal age (±2 years), parity (nulliparous or multiparous), gestational age at delivery (±1 week), singleton pregnancy, and absence of major obstetric complications unrelated to CPD. Inclusion Criteria: Singleton term pregnancy (≥ 37 weeks' gestation), cephalic fetal presentation, complete maternal and delivery records, and consent to participate in the study. Exclusion Criteria: known fetal anomalies, maternal history of pelvic or spinal deformities, preterm labor or multiple gestation, prior cesarean section or uterine surgery, and any condition that may interfere with pelvic measurements (e.g., orthopedic injuries). Data collection was conducted using primary data obtained directly from postpartum women after delivery. For each subject, pelvic measurements were taken once by trained clinical staff using a calibrated pelvimeter and measuring tape. Measurements focused on the external dimensions of the Michaelis sacral rhomboid (points A–B, A–D, C–B, C–D, and A–C), as well as maternal height and weight. Measurements were performed within 24 hours postpartum, by two independent observers to ensure inter-observer reliability. Discrepancies greater than 0.5 cm were re-measured jointly. The instruments used were calibrated prior to use in accordance with standardized procedures to minimize bias and variability. All measurements were conducted with the participant in a standing position to optimize accuracy and consistency. Hemoglobin levels at delivery and neonatal birth weights were also recorded from medical records. Dependent variable: Presence of cephalopelvic disproportion (CPD diagnosis confirmed by obstetrician based on intraoperative findings or labor arrest pattern). Independent variables: Various pelvic dimensions measured at the Michaelis rhomboid region. Descriptive statistics (mean, standard deviation) were used to summarize continuous data. A bivariate analysis was initially performed to assess each variable, statistical significance was set at $p < 0.05$., odds ratios (OR) and 95% confidence intervals (CI) were reported.

RESULTS

The total subjects in this study were 60 respondents who were divided into two groups: the case group and the control group. Based on the examination results, the following results are obtained:

Table 1. The characteristics of respondents

Characteristics	Case (CPD)		Control (Normal)	
	n/mean	%/SD	n/mean	%/SD
Parity				
Primiparous	20	74.1	7	23.3
Skundiparous	9	33.3	18	60.0
Multiparous	1	16.7	5	16..7
Age	28.3	5.73	30.5	4.530
Height	149.3	7.23	157.9	5.747
Weight	63.07	14.55	66.88	12.781
Haemoglobin	11.9	1.22	12.26	0.740

Based on Table 1, most respondents in the group of cases who experienced CPD were primiparous mothers as many as 20 people (74.1%), with an average age of 28.3 years 5.73, an average height of 149.3 cm with a standard deviation of 7.23, an average body weight of 63.07 kg with a standard deviation of 14.55, and an average hemoglobin level of

Jurnal Kesehatan Ibu dan Anak Vol.18, No.1, July 2024, pp. 52~63
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11.9 g / dL with a standard deviation of 1.22. The majority of respondents in the control group were mothers who had given birth 2 times as many as 18 people (66.7%), had an average age of 30.5 years with a standard deviation of 4.53, had an average height of 157.9 cm with a standard deviation of 5.74, an average body weight of 66.8 kg with a standard deviation of 12.78, and an average hemoglobin level of 12.26 g / dL with a standard deviation of 0.74.

Table 2. Overview of Pelvic Size of patients with CPD and Normal Delivery

Variable	Group	N	$\underline{X}$	SD
AB	Case	30	5.8	1.055
	Control	30	6.8	.960
AD	Case	30	5.8	1.037
	Control	30	6.8	.911
CB	Case	30	5.7	1.208
	Control	30	6.8	1.029
CD	Case	30	5.7	1.208
	Control	30	6.8	.983
BD	Case	30	8.1	1.016
	Control	30	8.7	2.003
AC	Case	30	7.3	1.652
	Control	30	8.1	1.630
Hip Circumference	Case	30	89.1	13.269
	Control	30	166.1	230.514
Distancia Spinarum	Case	30	30.2	48.173
	Control	30	24.0	2.009
Distancia Cristarum	Case	30	25.0	2.918
	Control	30	27.8	1.952
Boudeloque	Case	30	20.9	4.1134
	Control	30	21.9	2.5811

Based on Table 2, the pelvic size of patients with CPD and normal delivery consisted of measurements in the Michelis Square showing that the mean length of point AB in the case group was 5.8 cm with a standard deviation of 1.055 and in the control, group was 6.8 cm with a standard deviation of 0.960. The mean length of the AD point in the case group was 5.8 cm with a standard deviation of 1.037 and in the control group was 6.8 cm with a standard deviation of 0.911. The average length of the CB point in the case group was 5.7 cm with a standard deviation of 1,208 and in the control group was 6.8 cm with a standard deviation of 1,029. The average CD point length in the case group was 5.7 cm with a standard deviation of 1.208 and in the control group was 6.8 cm with a standard deviation of 0.982. The average length of the BD point in the case group was 8.1 cm with a standard deviation of 1,016 and in the control group was 8.7 cm with a standard deviation of 2,003. The average length of the AC point in the case group was 7.3 cm with a standard deviation of 1,652 and in the control group was 8.1 cm with a standard deviation of 1,630.

The size of pelvic circumference in the case group respondents had an average value of 89.1 cm with a standard deviation of 13.2 and in the control group of 166.1 cm with a standard deviation of 230.5. The size of the Spinarum Dysansia in the case group respondents had an average value of 30.2 cm with a standard deviation of 48.1 and in the control group of 24.0 cm with a standard deviation of 2,009. The size of Distansia Cristarum in the case group respondents had an average value of 25 cm with a standard deviation of

Jurnal Kesehatan Ibu dan Anak Vol.18, No.1, July 2024, pp. 52~63
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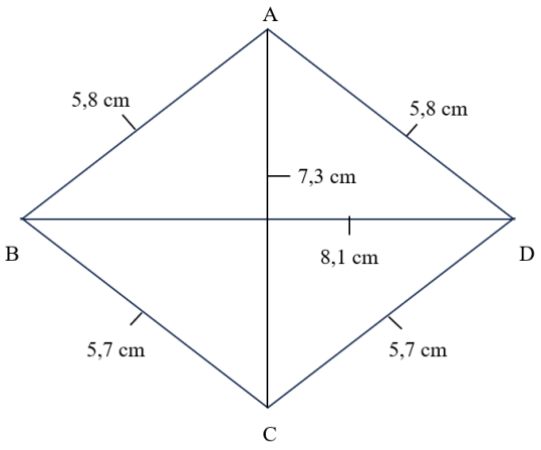
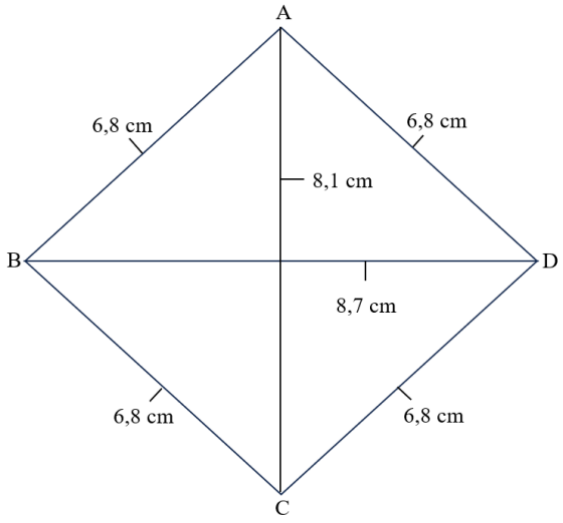
2.9 and in the control group of 27.8 cm with a standard deviation of 1.9. Boudeloque measures in the case group respondents had an average value of 20.9 cm with a standard deviation of 4.1 and in the control group of 21.9 cm with a standard deviation of 2.5.

Information
AB : 5.8 cm
AD : 5.8 cm
CB : 5.7 cm
CD : 5.7 cm
AC : 7.3 cm
BD : 8.1 cm



Picture 1. Picture of Pelvic Size with Michelis Square in CPD Patients

Information
AB : 6.8 cm
AD : 6.8 cm
CB : 6.8 cm
CD : 6.8 cm
AC : 8.1 cm
BD : 8.7 cm



Picture 2. Picture of Normal Pelvic Size with Michelis Square

DISCUSSION

In analyzing the sociodemographic characteristics of respondents, several important findings emerged that are relevant for interpreting the association between maternal pelvic measurements and the incidence of cephalopelvic disproportion (CPD). Overall, differences were observed between the case and control groups in terms of parity, maternal age, height, and hemoglobin level, all of which may act as confounding variables if not adequately controlled.

Primiparity was more prevalent among CPD cases (74.1%) compared to the control group (23.3%), suggesting that first-time mothers may be more vulnerable to mechanical complications during labor, including disproportion between fetal head and pelvic capacity. This is consistent with previous literature indicating that nulliparous women have a higher

Jurnal Kesehatan Ibu dan Anak Vol.18, No.1, July 2024, pp. 52~63
ISSN: 2599-3224 (Online), ISSN: 2302-6014 (Print)

risk of labor dystocia due to the untested nature of their birth canal. Therefore, parity was considered a potential confounder and was matched during subject selection to enhance group comparability. Experience as a source of knowledge by repeating is one way to obtain truth knowledge by repeating knowledge gained in solving problems faced in the past. According to Hasibuan's research (2019), the majority of respondents with the highest very know category, namely Skundipara parity of 6 people (50%) followed by grande multipara parity of 4 people (50%).(16) The researchers' assumption is that mothers who give birth more often are more experienced and therefore more knowledgeable than mothers who have given birth once or have never given birth. Our study found that 74.1% of CPD cases were primiparous, compared to only 23.3% in the control group. This is consistent with a study in Zimbabwe that reported that primigravidas had an increased risk (OR ≈ 1.6, 95% CI 1.2–2.2) of CPD delivery compared to multiparas or multigravidas after adjusting for other demographic variables.(17) This suggests that parity is an important confounding factor, and the literature supports the need to compare groups based on parity status.

Maternal age also differed slightly between groups, with the CPD group being younger (mean 28.3 years) than the control group (mean 30.5 years). Although both means fall within the optimal reproductive age range, the slight age difference was accounted for during group matching (±2 years), thereby minimizing its confounding effect on the pelvic dimensions or fetal growth parameters. According to Herwandi's research (2019), most of the <20 years old as many as 56 people (69.1%) who experience sectio caesarea.(18) The age of the mother affects the health of the mother, closely related to pregnancy, childbirth, postpartum, and caring for her baby. In general, the optimal productive age for good reproduction is the age of 20-35 years, safe for pregnancy and childbirth. At maternal age <20 and >35 years, non-reproductive ages are associated with higher risk during pregnancy and childbirth. At the age of <20 years, the condition of the uterus and pelvis is not well developed, while the age of the mother >35 years the condition and health of the uterus is not as good as at the age of 20-35 years.(19) There are several medical indications so that delivery by section caesarea is carried out, namely indications of mother and fetus. Indications for mothers include having undergone SC, a history of poor pregnancy and childbirth, pregnancy problems, or birth deformities (ovarian cysts, uterine myoma), pelvic narrowness, pregnancy with heart disease, placenta previa, diabetes mellitus, cephalopelvic disproportion (CPD), severe preeclampsia, and premature rupture of membranes (PROM).(20) Our study showed that the mean age of the CPD group was 28.3 years (SD 5.73), slightly lower than that of the control group (30.5 years, SD 4.53). Although most of our subjects were within the optimal reproductive range (20–35 years), we performed age matching (± 2 years) to minimize age-related bias.

A notable finding was the difference in maternal height, with the CPD group averaging 149.3 cm compared to 157.9 cm in the control group. This supports previous evidence suggesting that shorter maternal stature is associated with a narrower pelvic structure and increased risk for CPD. Since height is a non-modifiable factor that directly correlates with pelvic capacity, this reinforces the rationale for including anthropometric screening in early pregnancy. According to Laming (2013) women who have a height of less than 145 cm have the potential to have a narrow pelvis. Height is one indicator of growth in addition to weight, tooth eruption and bone growth. Height is one of the growth indicators that can be influenced by many factors. Height is influenced by many factors. Internal factors are gene factors and hormonal states.(21) External factors that affect the process of growth and development of living things come from environmental factors. Environmental factors that affect the growth and development of living things are nutrition, chronic diseases and congenital abnormalities, and socioeconomic circumstances.(22) Our study showed that mothers in the CPD group had an average height of 149.3 cm, significantly lower than the 157.9 cm in the control group. A local study also confirmed that height below 145 cm is a significant risk marker for CPD.(4)(23) Our findings confirm the

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≥150 cm cutoff as a new threshold that is demographically relevant for Southeast Asian populations.

In terms of maternal weight, the mean was slightly lower in the CPD group (63.07 kg) than in the control group (66.8 kg). Current literature examining the direct relationship between weight and CPD is limited, as most studies focus on fetal weight or maternal BMI. For instance, gestational weight gain in twin pregnancies averaged 23.3 ± 9.3 lbs, 40.1 ± 7.4 lbs, and 59.0 ± 11.5 lbs, demonstrating substantial deviation within cohorts.(24) The intricate interplay of factors such as pre-pregnancy BMI and gestational weight gain rates further complicates the assessment of maternal weight in multifetal gestations, as evidenced by significant differences observed in GDM twin pregnancies.(25) Women with gestational diabetes mellitus were found to have lower gestational weight gain despite being more likely to be overweight or obese at baseline.(26) Although weight is not a direct predictor of CPD, it may be associated with maternal BMI and nutritional status, which are potential confounding variables that need to be controlled for in multivariate models.

Hemoglobin levels were also slightly lower in the CPD group (mean 11.9 g/dL) compared to the control group (12.26 g/dL), though both fall within the normal range, indicating that anemia was unlikely to be a major confounding factor in this population. Low hemoglobin levels in pregnant women who stay until the time of approaching labor can affect the work of the muscles of the reproductive organs, namely the uterine muscles, pelvic muscles, and ligaments. As a result, the mother does not have adequate power. Therefore, it will cause the opening of the birth canal to be not optimal.(27) In this study, the average hemoglobin level in the case group was 11.9 g / dL with a standard deviation of 1.22 and the average hemoglobin level was 12.26 g / dL with a standard deviation of 0.74. A recent systematic meta-analysis showed that anemia (Hb <11g/dL) is associated with an increased risk of preterm birth, low birth weight, and other perinatal morbidities (OR ~1.9–2.9).(28) Although the difference in Hb in this study was relatively small and within normal limits, this variable was still considered a potential confounder because anemia can affect uterine contractions and the labor process. By ensuring comparability between the case and control groups through matching criteria including age, parity, and gestational age and evaluating potential confounders such as height and hemoglobin levels, this study strengthens the internal validity of its findings. These efforts help isolate the effect of pelvic dimensions on CPD incidence, thus supporting the hypothesis that external pelvic measurement can serve as a reliable predictive indicator.

This study demonstrates that specific external pelvic dimensions, particularly those measured from the Michaelis rhomboid area and pelvic anthropometric landmarks, show statistically and clinically significant differences between women diagnosed with Cephalopelvic Disproportion (CPD) and those who experienced normal vaginal delivery. These findings support the potential of certain external pelvic measurements as early, non-invasive indicators for identifying women at risk of CPD. In particular, the measurements at point AB, AD, CB, CD, BD, and AC in the Michaelis Square area consistently revealed smaller dimensions in the CPD group compared to the control group, with differences reaching approximately 1.0 cm on average. Notably, point AB and AD had identical means of 5.8 cm in CPD cases, in contrast to 6.8 cm in controls, highlighting their predictive relevance. Similarly, points CB and CD were both measured at 5.7 cm in the case group versus 6.8 cm in the control group. In the broader pelvic measurements, the pelvic circumference showed a stark contrast: an average of 89.1 cm in the CPD group compared to 166.1 cm in controls, although the large standard deviation in the control group suggests the need for cautious interpretation. Additionally, the Distansia Cristarum and Spinarum Dysansia were shorter in the CPD group, indicating a narrower pelvic outlet, which is consistent with known anatomical risk factors for obstructed labor. These findings align with previous literature suggesting that a reduced transverse pelvic diameter may compromise fetal descent during labor.(29) The measurement of Boudeloque's diameter, an important

Jurnal Kesehatan Ibu dan Anak Vol.18, No.1, July 2024, pp. 52~63
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indicator of pelvic inlet adequacy, was slightly lower in the CPD group (20.9 cm) compared to controls (21.9 cm), further suggesting that external pelvic dimensions reflect internal pelvic capacity relevant to labor outcomes.

The findings of this study revealed consistent differences in external pelvic dimensions between patients with cephalopelvic disproportion (CPD) and those with normal vaginal deliveries. Notably, the measurements of the Michaelis rhomboid particularly points AB, AD, CB, and CD showed an average reduction of approximately 1 cm in the CPD group compared to the control group. These results are in line with the study by Archana and Patra, which demonstrated that a transverse diameter (TD) of ≤9.75 cm was significantly associated with the risk of CPD, showing an odds ratio (OR) of 3.3 (95% CI: 1.7–6.7) and diagnostic accuracy of 78%.(30) Similarly, a study conducted in Ethiopia using both 3D camera and tape measurements reported that narrower transverse pelvic dimensions predicted CPD with high accuracy, with an area under the curve (AUC) of 0.918 for 3D measurements and 0.873 for tape-based assessments.(15) Although the Ethiopian study did not explicitly measure points AB–CD, the anatomical equivalence to the transverse rhomboid suggests that similar anatomical constraints were being evaluated. Furthermore, our study found that the average Boudeloque diameter (BD) and Distansia Cristarum (DC) were also smaller in the CPD group, measuring 20.9 cm and 25.0 cm, respectively, compared to 21.9 cm and 27.8 cm in the control group. These findings are supported by prior literature that indicates a reduction in external pelvic diameters especially outlet and transverse diameters is a consistent risk factor for CPD.(14) While few recent studies explicitly discuss BD and DC values, historical anthropometric data have long emphasized their role in predicting labor complications.(11)(13) Additionally, the AC point represent part of the longitudinal axis of the pelvis was also shorter in the CPD group (7.3 cm vs. 8.1 cm), further reinforcing the idea that a combination of transverse and longitudinal external measurements can enhance prediction models. This aligns with recent recommendations for combining multiple pelvic dimensions to improve diagnostic precision for CPD screening, especially in low-resource settings.(14)(30) Overall, the current findings add empirical support to the growing body of evidence suggesting that simplified external pelvic measurements can serve as reliable, low-cost indicators for early CPD detection in clinical practice.

These results emphasize the practicality and predictive value of using external pelvic measurement tools, particularly in resource-limited or primary healthcare settings, where access to radiologic pelvimetry is limited. The relative simplicity, low cost, and non-invasive nature of these measurements make them a promising candidate for early screening of CPD risk, especially when performed by trained midwives or general practitioners. In summary, the study provides evidence that certain external pelvic dimensions especially those from the Michaelis Square area and transverse pelvic diameters can serve as feasible screening tools for CPD. These findings pave the way for the development of a standardized, field-adaptable CPD detection tool, which may improve obstetric decision-making and reduce adverse maternal-fetal outcomes due to delayed referral or undetected CPD.

This study presents several limitations that should be acknowledged. The sample size was relatively small and limited to a single tertiary hospital, which may restrict the generalizability of the findings to broader populations or to primary care settings. The measurements of external pelvic dimensions were conducted manually using tape measures, which may introduce inter-observer variability despite standardized procedures. The case-control design, while appropriate for identifying associations, does not establish a causal relationship between pelvic dimensions and CPD. Additionally, potential confounding variables such as fetal position, maternal soft tissue characteristics, and intra-labor interventions were not fully controlled. Based on the findings, it is recommended that external pelvic measurements particularly those involving the Michaelis rhomboid and

Jurnal Kesehatan Ibu dan Anak Vol.18, No.1, July 2024, pp. 52~63
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transverse diameters be considered as part of routine antenatal screening, especially for women at risk of CPD. The use of this simplified, low-cost tool can be integrated into primary care services to assist midwives and general practitioners in early identification of disproportion risks, thereby informing referral decisions and birth planning. Moreover, there is a need for developing standardized training modules for healthcare workers to ensure consistent and accurate measurement techniques. Future research should aim to validate these findings in larger, more diverse populations across multiple healthcare settings, including rural and low-resource areas. Prospective cohort designs or randomized controlled trials could help establish causality and improve risk prediction models. Moreover, the integration of technological innovations such as 3D imaging, mobile applications, or AI-based pelvimetric tools should be explored to enhance the accuracy and usability of CPD detection in clinical practice. Lastly, studies should investigate the acceptability, cost-effectiveness, and health outcomes associated with implementing these screening tools in routine maternal care.

CONCLUSION

This study demonstrated that significant differences exist in specific external pelvic dimensions particularly in the Michaelis rhomboid (points AB, AD, CB, CD, BD, and AC) between women diagnosed with cephalopelvic disproportion (CPD) and those who experienced normal vaginal delivery. The average measurements of these pelvic landmarks were consistently smaller in the CPD group, indicating that reduced external pelvic dimensions may serve as early, practical indicators of disproportion risk. These findings suggest that external pelvimetry, if conducted with standardized methods, can offer a low-cost, non-invasive tool for early screening of CPD in routine antenatal care.

The implications of this study are twofold. Clinically, the findings support the integration of simple external pelvic measurements into primary maternal healthcare settings, particularly in low-resource contexts where access to advanced radiological pelvimetry is limited. For healthcare providers such as midwives, these tools can enhance decision-making regarding referral and delivery planning, potentially reducing the incidence of obstructed labor and associated maternal and neonatal complications. Future research should validate this tool across larger, more diverse populations and healthcare systems. Technological refinement such as mobile-based applications or AI-supported tools for pelvic assessment should also be explored to increase accuracy, usability, and scalability. Furthermore, longitudinal studies are needed to assess the predictive power of these measurements and their impact on maternal and perinatal outcomes.

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AUTHOR CREDIT STATEMENT

DI: Data Collection, Formal Analysis, Writing – Original Draft, Writing – Review & Editing, Visualization; **YK**: Conceptualization, Methodology, Supervision, Validation; **SEA**: Supervision, Validation.

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DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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