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Fetal Head-to-Perineum Distance as a Predictor of Successful Vaginal Delivery: A Secondary Analysis of Intrapartum Ultrasound Data

Distância da Cabeça Fetal ao Períneo como Preditor do Parto Vaginal: Análise Secundária de Dados de Ultrassom Intraparto

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ABSTRACT

Purpose: The primary aim of this secondary analysis is to assess the clinical utility of intrapartum ultrasound measurements of the fetal head-to-perineum distance (HPD) as a predictor for successful vaginal delivery.Methods: This secondary analysis was conducted on a cross-sectional study involving 33 pregnant women admitted for labor. HPD was measured using intrapartum ultrasound by certified sonographers. Additional variables such as age, BMI, and gestational age were also considered. Results: Our findings reveal a significant relationship between HPD and the occurrence of vaginal delivery. The odds ratio was calculated as 0.60 (95% Confidence Interval: 0.42-0.88), remaining significant after adjusting for other variables.Conclusion: In this secondary analysis, HPD measurements via intrapartum ultrasound were found to effectively predict the likelihood of vaginal delivery. This method offers a streamlined approach for labor management without sacrificing predictive accuracy.

Keywords: Intrapartum Ultrasound; Fetal Head-to-Perineum Distance; Vaginal Delivery; Secondary Analysis; Labor Management; Predictive Accuracy.

RESUMO

Objetivo: O objetivo principal desta análise secundária é avaliar a utilidade clínica das medições da distância da cabeça fetal ao períneo (HPD) por ultrassom intraparto como um preditor para o sucesso no parto vaginal. Métodos: Esta análise secundária foi conduzida em um estudo transversal envolvendo 33 gestantes internadas em trabalho de parto. A HPD foi medida usando ultrassom intraparto por sonografistas certificados. Variáveis adicionais como idade, IMC e idade gestacional também foram consideradas.Resultados: Nossos achados revelam uma relação significativa entre HPD e a ocorrência de parto vaginal. A razão de chances foi calculada como 0,60 (Intervalo de Confiança de 95%: 0,42-0,88), permanecendo significativa após ajuste para outras variáveis. Conclusão: Nesta análise secundária, as medições de HPD por ultrassom intraparto mostraram-se eficazes para prever a probabilidade de parto vaginal. Este método oferece uma abordagem simplificada para o manejo do trabalho de parto sem sacrificar a precisão preditiva.

Palavras-chave: Ultrassom Intraparto; Distância da Cabeça Fetal ao Períneo; Parto Vaginal; Análise Secundária; Manejo do Trabalho de Parto; Precisão Preditiva.

INTRODUCTION

The advent of ultrasound technology in obstetrics has significantly advanced the field, particularly in enhancing labor management through improved fetal monitoring and weight estimation. These innovations have enabled more accurate predictions of delivery types, potentially elevating the standard of care for expectant mothers.(GHI et al., 2018) However, the adoption of ultrasound technology in obstetric practice faces challenges due to the complexity of the techniques and the significant time constraints within busy maternity settings Ultrasound can aid clinicians in detecting intrapartum changes that may necessitate medical interventions such as cesarean sections or forceps deliveries.(HJARTARDÓTTIR et al., 2021; TSE et al., 2019) In a teaching maternity hospital in Jaraguá do Sul, which handles approximately 350 births monthly, established protocols for labor induction and management include the Bishop score and ultrasound-based fetal weight estimation. Yet, the practical limitations and time demands associated with ultrasound use have restricted its widespread application in intrapartum evaluation. (MALVASI et al., 2018)

A primary pilot study by Usman et al. sought to address these limitations by exploring the use of a novel tool, the "Intrapartum App," designed to predict vaginal delivery outcomes in obstetric populations. This innovative approach incorporated a broader range of parameters, such as maternal age, Body Mass Index (BMI), and the presence of certain conditions, alongside the fetal head-to-perineum distance (FHPD) and transperineal scans to assess fetal head station using FHPD and caput succedaneum. Cervical dilatation was recorded from corresponding digital vaginal examinations, and maternal and labor parameters, including maternal age, BMI, and presence of prolonged labor, were recorded in the app. The published model defined the likelihood of vaginal delivery across a spectrum from "less likely" to "highly unlikely" based on a comprehensive assessment of these factors.(USMAN et al., 2019)

Some authors have used a simplified approach with fetal head-to-perineum distance to predict obstetric outcomes.(ANGELI et al., 2022; EL-BISHRY et al., 2020a; RABEI et al., 2017)

Building on the foundation of the primary pilot study, the current research focuses on utilizing data gathered from that study, specifically evaluating the fetal head-to-perineum distance (FHPD) as a predictive factor for vaginal delivery. This secondary analysis aims to assess the clinical utility of intrapartum ultrasound FHPD measurements in predicting vaginal delivery outcomes and investigate its correlation with actual delivery occurrences.

MATERIALS AND METHODS

This study represents a secondary analysis of data collected from the parent study, "The Use of the Intrapartum App in a New Population." The primary investigation, which was discontinued, aimed to develop a predictive model for vaginal delivery, focusing on variables such as maternal age, Body Mass Index (BMI), gravidity, the incidence of protracted labor, cervical dilation, and the fetal head's position and distance from the perineum. However, the pilot study revealed challenges in the practical implementation of the examinations and proper use of the app (USMAN et al., 2019) within the high-paced environment of a maternity admission unit.

The decision to undertake a secondary analysis was driven by the richness of the data collected before the discontinuation of the primary study. Despite the primary study's cessation, the collected data hold valuable insights into the clinical utility of intrapartum ultrasound measurements, particularly the fetal head-to-perineum distance (HPD), as a predictive factor for successful vaginal delivery. This analysis aims to delve into specific research questions not covered by the initial study, thereby extending the utility of the previously collected data.

The primary study's procedures involving human participants were conducted in accordance with the ethical standards of the institutional and national research committee. Written informed consent was obtained from all participants included in the study. The secondary analysis has been approved by the relevant ethics committees, ensuring adherence to ethical standards. CAAE: 68880822.9.0000.5366

The cohort for this study consisted of 33 first-time pregnant women admitted for labor at Maternity Hospital Jaraguá from March 1st to March 31st, 2023. All participants

were 17 years or older and had reached a gestational age of at least 37 weeks. Written informed consent was secured from each participant.

Data collection spanned demographic variables, maternal and fetal health indicators, including conditions such as gestational diabetes and hypertension, contraction duration, and cervical dilation. A significant aspect of the study was assessing the Head-Perineum Distance (HPD) through transperineal ultrasound procedures.

Transperineal ultrasounds were performed by certified sonographers or obstetricians using a Logic C5 Premium ultrasound machine, equipped with a 3-5 MHz two-dimensional convex probe. The procedure entailed positioning the pregnant woman either supine or in the lithotomy position, with the bladder emptied to optimize imaging quality and reduce discomfort. A water-based gel was applied to ensure optimal acoustic contact. The transducer was carefully placed on the perineum, exerting minimal pressure, and the probe was adjusted to obtain a mid-sagittal view of the fetal head and perineum, clearly displaying relevant anatomical landmarks.(GHI et al., 2018)

HPD measurements were taken three times for each participant, with the mean value being recorded. (GHI et al., 2018). Descriptive statistics and appropriate statistical tests, considering the data's distribution, were employed for data analysis. Variables associated with birth outcomes were analyzed, with those showing a p-value of less than 0.20 in univariate analysis included in a multiple logistic regression model with L2 regularization to mitigate multicollinearity and overfitting. The model's efficacy was assessed through stratified 5-fold cross-validation, and a bootstrap analysis with 1000 samples was conducted to evaluate the variability of logistic regression coefficients and the area under the Receiver Operating Characteristic (ROC) curve.

The dataset from the primary study is securely stored in compliance with the Brazilian General Data Protection Law (LGPD, Law No. 13,709/2018), with strict access controls implemented by the principal investigator(s). This compliance ensures the protection of participant privacy while facilitating potential data sharing for legitimate research purposes, such as transparency, verification, or replication of findings. Researchers interested in accessing the data are invited to contact the principal investigator directly. Access requests will be considered based on ethical guidelines, the

potential impact on participant privacy, and the requesting research's objectives. Provision of data access will occur under a Data Use Agreement detailing data use terms, security requirements, and commitments to maintaining participant confidentiality and privacy.

RESULTS

The results of this study are based on the data gathered from 33 study participants. The group's average anthropometric details are displayed in Table 1.

Table 1: Sociodemographic and Clinical Characteristics of the Participants

Variable	Mean/Proportion	Standard Deviation
Age (years)	24.52	± 3.94
Height (m)	1.62	± 0.08
Weight (kg)	67.24	± 11.43
Body Mass Index (BMI)	25.61	± 4.12
Newborn Weight (g)	3265.55	± 424.57

The average age was 24.52 years, the average height was 1.62 m, and the weight was approximately 67.24 kg. The average body mass index (BMI) was recorded as 25.61, while the average weight of newborns was about 3265.5g. Other key metrics include the average head-perineum distance (HPD) which was 36.94 mm and the average dilation was about 4.70 cm.

When we delve deeper into the health conditions and interventions among the participants, we found that 18.18% of the participants were diagnosed with diabetes mellitus and 12.12% had systemic arterial hypertension. This is depicted in Table 2. In addition, oxytocin was administered during childbirth in 57.58% of the cases.

Table 2: Frequency of Comorbidities and Interventions Among Participants

Variable	Frequency	Percentage (%)
Diabetes Mellitus	6	18.18
Systemic Arterial Hypertension	4	12.12
Oxytocin Use	19	57.58

The odds ratio for each variable concerning the occurrence of vaginal delivery was calculated and these are shown in Table 4. Among these variables, only HPD displayed a significant association with the occurrence of vaginal delivery. An increase in one unit of HPD corresponded to a 39.63% decrease in the chances of vaginal delivery, assuming all other variables remained constant. This result was statistically significant ($p = 0.0022$).

Table 3: Correlation Between Head-Perineum Distance (HPD) and Other Variables

Variable	Correlation Coefficient (r)
Age	0.0733
Height	0.3460
Weight	0.1426
BMI	-0.0658
Oxytocin	0.6151

Table 4: Odds Ratio and 95% Confidence Interval for Vaginal Delivery Occurrence

Variable	Odds Ratio (OR)	95% CI	p-value
HPD	0.6037	0.9203	0.0022
Age	0.7663	1.0421	0.1612
Oxytocin	0.4654	0.7702	0.0002
Amniorrhexis	0.6131	1.0707	0.0039

DISCUSSION

In today's intricate landscape of obstetrics—a field at the intersection of medical innovation and diverse societal and cultural expectations—our study zeroes in on the clinical relevance of head-perineum distance (HPD) as a predictor for vaginal delivery. This focus aligns with the broader objectives of precision medicine, which aims to leverage cutting-edge scientific and technological advancements to optimize maternal-fetal health and safety. Within this framework, the adoption of transperineal intrapartum ultrasound has surfaced as an innovative approach for improving the monitoring of childbirth, allowing for more personalized medical care tailored to individual patients.(GHI et al., 2018; HASSAN; TAYLOR; LEES, 2021; MALVASI et al., 2019)

Our study, involving 33 first-time pregnant women, significantly highlights the predictive value of HPD in vaginal delivery outcomes. Specifically, we found that a unit increase in HPD was associated with a 39.63% decrease in the odds of vaginal delivery, assuming all other variables remained constant. This finding is groundbreaking in its implications, reinforcing the clinical importance of HPD of a simple and easy to perform measurements during labor as a tool for predicting the likelihood of vaginal delivery.(ANGELI et al., 2022; EL-BISHRY et al., 2020a)

The decision-making process preceding cesarean sections is multifaceted, influenced by a broad spectrum of physical and non-physical factors. Even with the incorporation of predictive tools such as the Bishop score, cardiotocography, partograph, and physical examination findings (e.g., unexpected fundal height), each decision inherently prioritizes the safety and well-being of the mother and child in each unique scenario.(FELTOVICH, 2017; USMAN et al., 2023)

It was noteworthy that 18.18% of the participants had diabetes mellitus, and 12.12% had systemic arterial hypertension. The administration of oxytocin was prevalent in 57.58%, highlighting the intricate interaction of factors that could affect childbirth outcomes. It is important to note that the fetal Head to Perineum Distance only indicates how close a baby is to being born vaginally, and this is only one of the factors that must be in order for a delivery to occur, as a patient with a small head to perineum Distance

whose baby is not in condition may need a cesarean section at any point during labor.(EDOZIEN, 2016; GHI et al., 2018)

In the realm of medical research, particularly in obstetrics, the integration of technology into clinical practice offers promising avenues for enhancing patient care. However, the journey from theoretical innovation to practical application is fraught with challenges, as evidenced by the pilot study focused on the "Intrapartum App." This study aimed to streamline labor management through the application of an app designed to predict vaginal delivery outcomes, with a particular focus on the fetal head-to-perineum distance (FHPD) as a key parameter. (USMAN et al., 2019)Despite the app's potential benefits, the study uncovered significant hurdles in the practical implementation of examinations and the app's usage within the fast-paced environment of a maternity admission unit. The time-intensive nature of these processes proved incompatible with the demands of a busy clinical setting.

Recognizing the inherent value of the data collected, the research team made a strategic decision to repurpose this data for further study, particularly focusing on the associations with FHPD. This decision was driven by a commitment to not squander the data and research efforts already expended (BEETS et al., 2021)In the broader scientific community, some authors have adopted a simplified approach, leveraging FHPD to predict obstetric outcomes, underscoring the potential utility of this parameter beyond the initial scope of the "Intrapartum App"(BRIAN NYATANGA, [s.d.]).

Despite the small sample size potentially impacting generalizability, rigorous methodological standards and statistical validations enhance the study's credibility. The use of L2 regularization in logistic regression, stratified 5-fold cross-validation, and a bootstrap analysis with 1000 samples fortifies the robustness of the findings (DWIVEDI; MALLAWAARACHCHI; ALVARADO, 2017). The alignment with existing literature and minimal variability in the logistic regression coefficients and ROC curve further substantiate the utility of HPD as a predictive factor in managing delivery outcomes.

The practice of repurposing research data presents a compelling opportunity for the advancement of medicine, facilitating the exploration of new hypotheses without the need for additional data collection NYATANGA, 2005)

Our study's analysis highlighted a statistically significant relationship between delivery mode and various maternal attributes, such as BMI, age, height, and weight.(EL-BISHRY et al., 2020a; ERLIK et al., 2020; USMAN et al., 2023) We found that older, taller, and heavier women, as well as those at a later gestational stage, were more likely to undergo cesarean delivery. These findings are consistent with prior research, which has reported increased cesarean rates among shorter and obese women.(CUERVA et al., 2019; SIERGIEJ et al., 2019; WIAFE et al., 2018)Our data further corroborate earlier studies that indicate a greater likelihood of Fetal Pelvic Disproportion (FPD) in shorter women, and a higher risk of complications from gestational diabetes leading to cesarean sections in obese women.(EDOZIEN, 2016)

The decision-making process preceding cesarean sections is multifaceted, influenced by a broad spectrum of physical and non-physical factors. Even with the incorporation of predictive tools such as the Bishop score, cardiotocography, partograph, and physical examination findings (e.g., unexpected fundal height), each decision inherently prioritizes the safety and well-being of the mother and child in each unique scenario.(BURKE et al., 2017; JANSSEN et al., 2017)

Our study evaluated the potential predictive value of the head-perineum distance (HPD) as a determinant of the delivery route in laboring women. We observed that women who underwent cesarean delivery presented higher HPD values, a finding that aligns with the extant literature. Importantly, an HPD of 5 cm exhibited the greatest predictability (97% sensitivity, 88% specificity) of successful induction.(EL-BISHRY et al., 2020b)

The logistic regression analysis suggested that the adjusted model includes HPD as a significant variable ($p = 0.012$), with an odds ratio of 0.8827 (0.6644-1.1729; $p = 0.39$). This implies that, assuming all other variables remain constant, an increase of one unit in HPD correlates with a decrease of 39.63% in the probability of vaginal delivery. This finding is in alignment with existing literature, which states that HPD offers the most accurate prediction method for both spontaneous and induced deliveries. (EL-BISHRY et al., 2020b; UDAYASANKAR; RAJESH; MOSELHI, 2007)

CONCLUSIONS

The findings of this study carry multiple implications, both clinical and ethical. Clinically, HPD can serve as a valuable tool for assessing the likelihood of vaginal delivery, allowing for more personalized care to improve birth outcomes. It can also identify women at a higher risk for cesarean delivery, enabling targeted support and resources during labor. Ethically, however, care must be taken to ensure that the use of HPD doesn't result in discrimination against women more likely to require a cesarean. Privacy concerns surrounding HPD assessment also warrant consideration. Further, knowledge of low chances for a successful vaginal delivery could demotivate women and may even prompt doctors to opt for a cesarean prematurely, potentially exacerbating the already high rates of such procedures.

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