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Rationale of indications for caesarean delivery and associated factors among primigravidae in Tanzania



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المخلص

أهداف البحث: تهدف الدراسة إلى تحديد مدى انتشار طرق الولادة وما يرتبط بها من نتائج الأمهات والمواليد الجدد بين المواليد المفردين في الحمل الأول في منطقة إيريغا في تنزانيا.

طرق البحث: أجريت دراسة مقطعية تحليلية وتحليلية في المستشفيات في منطقة إيريغا بين ٣٥٦ من الحوامل للمرة الأولى بحمل مفرد بين أبريل وأغسطس ٢٠١٨. وقد تم أخذ عينات مناسبة وجمع البيانات على التوالي باستخدام استبانة قائمة على المقابلات الشخصية.

النتائج: تم تضمين ما مجموعه ٣٥٦ امرأة من النساء الحوامل للمرة الأولى بحمل مفرد في الدراسة بمتوسط عمر ٢٢ سنة (نطاق، ١٥-٤٩ سنة). وكانت أغلبية المشاركات (٧٣٪؛ ن=٢٥٠) في الفئة العمرية ٢٠ إلى ٣٥ سنة. وأجريت الولادة القيصرية والمهبلية في (٤١.٣٪؛ ن=١٤٧) و(٥٨.٧٪؛ ن=٢٠٩) من المشاركات، على التوالي. وارتبط طول الأم ووزن الأطفال المولودين الجدد بشكل كبير بالولادة القيصرية. باستخدام التحليل متعدد المتغيرات، كان الاختناق عند الولادة، وانخفاض الوزن عند الولادة، مرتبطين بالولادة القيصرية.

الاستنتاجات: تشير نتائج دراستنا إلى أن انتشار العملية القيصرية في هذه الدراسة هو ثلاثة أضعاف ما أبلغت عنه منظمة الصحة العالمية. وينبغي النظر

في النساء الحوامل مع طول أقل من ١٥٠ سم لعملية قيصرية. لذلك، هناك حاجة للجهات المعنية في القطاع الصحي لصياغة مبادئ توجيهية للإشارة المطلقة للعمليات القيصرية.

الكلمات المفتاحية: الولادة القيصرية؛ الولادة؛ حديثي الولادة؛ الأمهات؛ النتائج

Abstract

Objective: This study aimed to determine the prevalence of modes of delivery and associated maternal and newborn outcomes among singleton primigravidae in the Iringa region of Tanzania.

Methods: A cross-sectional, analytical hospital-based study was conducted in the Iringa region among 356 singleton primigravidae between April and August 2018. Convenience sampling and consecutive collection of data using a face-to-face interviewer-administered questionnaire was done.

Results: A total of 356 singleton primigravid women with a mean age of 22.0 years (range: 15–49) participated in the study. The majority of the participants (73.0%, n = 250) were in the 20–35 age group. Caesarean and vaginal delivery were performed in 41.3% (n = 147) and 58.7% (n = 209) of the cases, respectively. The maternal height and weight of the newborn were significantly associated with caesarean delivery; ($p = 0.001$) and ($p = 0.029$), respectively. After adjusting for all variables, birth asphyxia (AOR = 3.25, 95% CI: 1.867–5.646, $p = 0.000$) and low birth weight (AOR = 0.03, 95% CI: 0.003–0.211, $p = 0.001$) were associated with caesarean delivery.

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Conclusions: The findings of our study indicated the prevalence of caesarean section to be three times more than that recommended by the World Health Organization. Pregnant women with a height of less than 150 cm should be considered for caesarean section. Therefore, it is necessary for stakeholders in the health sector to formulate guidelines for absolute indications for caesarean section.

Keywords: Caesarean section; Delivery; Maternal; Neonates; Outcomes

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Introduction

The health of a mother and her newborn is of the utmost importance in determining the health of the subsequent generation,^{1,2} yet there are many challenges and risks associated with pregnancy and childbirth. Efforts have been made to ensure a significant reduction in the maternal mortality rate (MMR) globally; however, nearly 800 pregnant women die every day from pregnancy- and childbirth-related complications. This indicates that the Millennium Development Goal (MDG) number 5 advocated by the United Nations for the global reduction of MMR has not been met.³ As this significant challenge remains, the Sustainable Development Goals (SDGs) for 2015–2030 seek to implement the unaddressed MDG projections, including that of global MMR reduction.⁴

There is global agreement that vaginal delivery (VD) is a safe mode of childbirth. On the other hand, caesarean delivery (CD), which involves a surgical incision, has also been utilised as a mode of delivery particularly in pregnant women with medical or obstetric indications.⁵ CD may be utilised both as an emergency or elective means of saving the lives of mother and child when VD is deemed to be risky. Improved technology and increased knowledge of reproductive gynaecology have contributed greatly to an increase in relative and unnecessary CD, which is of concern to medical professionals. CD is usually avoided because of related complications and is only indicated when there are unavoidable.⁶

Caesarean delivery rates (CDRs) have been increasing worldwide. The World Health Organization (WHO) recommends an optimal CDR of 10%–15% live births, as reported by Gibbons et al.⁷ However, reported CDRs in developing countries, including Tanzania, still outweigh the rate recommended by the WHO.⁸

Other studies have reported an increase in the global CDR average from 12.4% to 18.6% and a rate of increase of 4.2% per annum.^{9,10} Assisted reproductive technology, maternal age, maternal health condition, obstetrical complications, smoking during pregnancy, and

socioeconomic status have been reported as factors contributing to increasing CDRs globally.¹¹ Similar experiences have been reported in sub-Saharan Africa (SSA), where only 7.3% of newborns are born via CD.¹² Data regarding the Tanzania CDR are scarce, but it is estimated to range between 5% and 6%.¹³

Given the scarcity of the data on CDR and its indications of CD in Tanzania, we were convinced of the importance of conducting this study so as to determine the actual figures and true indications of CD by determining its prevalence among singleton primigravidae in the Iringa region, its rationale of indications, and associated maternal and newborn outcomes.

Materials and Methods

Study design

This was a cross-sectional, analytical hospital-based study that applied a quantitative approach. The study was conducted between April and August 2018, and the process of data collection was done prospectively. The study involved consecutive collection of data, which assisted in providing insightful information on modes of delivery and associated obstetrics outcomes among singleton primigravidae in the Iringa region.

Study area

The study was conducted in the Iringa region, which is located in the southern highlands zone of Tanzania. According to the national census report of 2012, the total population of the region was 941,238, of whom 452,052 were males and 489,186 were females. There were 230,407 women of reproductive age.¹⁴ Data were obtained from both the labour and postnatal wards of the following six health facilities found in the region: Iringa regional referral hospital (IRRH), Frelimo regional hospital, Iringa medical consultation clinic (IMECC), Mafinga district hospital, and Tosamaganga and Ilula designated district hospitals (DDHs). Except MECC, which is a private health facility, the rest are public health facilities.

Participants' characteristics

Singleton primigravidae who delivered by either VD or CD and were admitted to hospitals and who agreed to sign a written informed consent were included in the study. However, critically ill, multigravida, and abortion cases, and those who refused to give consent were excluded from the study.

Sample size determination

A sample size of 356 participants was sufficient to produce 80% power at a 5% error rate to achieve the desired results of the study. We applied the 1975 Cochrane formula as it was adopted in the study conducted by Singh and Masuku in

2014¹⁵ and considered a prevalence of indication for CD of 31.8% among singleton primigravidae from a study previously conducted in Tanzania by Muganyizi et al.¹⁶

Sampling procedure

A convenience sampling method was used in selecting all the six hospitals in the region. All study participants were selected conveniently and consecutively until a sample size of 356 participants was achieved in a period of five months (April–August 2018).

Data collection tools

A semi-structured interviewer-administered questionnaire was used during data collection. Pre-testing of the questionnaire was first performed at IRRH to ensure the validity of the data collected. The reliability of the research tool used in this study was observed by adopting and modifying the standard questionnaire from the Tanzania Demographic Health Survey (TDHS).¹⁷ We also adopted and modified the checklist for the absolute and relative indications of CD from the Association of Scientific Medical Societies in Germany (AWMF).¹⁸ The Apgar score chart used in this study was adopted from women health care physicians.

Data collection procedures

During data collection, five research assistants (nurse officers), who were given the task of collecting the data after being trained on how to do so, reviewed the participants' clinical files and clinic cards through face-to-face interviews. The data collection involved three procedures. First, information on demographic characteristics was collected from the participants. Second, the participants' clinical files and clinic cards were reviewed to extract the required information. Third, the study participants together with their newborns were clinically examined, and variables such as Apgar score, newborn weight, and maternal and newborn outcomes were recorded.

Statistical analysis

The collected data were analysed using Statistical Package for the Social Sciences (SPSS) programme version 20.0 (IBM statistics, Chicago, US). The collected data were entered in the questionnaires and then into the computer after coding them. Checking for errors and missing data was done by running frequency tables and crosstabs. Categorical and continuous variables were presented in proportions and mean \pm standard deviation (SD), respectively. A Chi-square statistical test was used to measure the association between categorical variables. For the prediction of the outcome of the mode of delivery and newborn, a logistic regression model using both univariate and multivariate analyses was applied. Both unadjusted and adjusted odds ratios at a 95% confidence interval (CI) were determined. A two-tailed $P < 0.05$ was used to justify statistical significance.

Results

Demographic characteristics of the study participants

A total of 356 participants were enrolled in the study during the study period. The mean \pm SD age of the participants was 22.0 ± 3.73 years (range: 15–49 years). A majority of the participants (73%, $n = 260$) were in the reproductive age group of 20–35 years. Most of the participants (43.5%, $n = 153$) had primary education, and only 12.4% ($n = 44$) had attained tertiary education. With respect to the participants' source of income, it was observed that more than half (57.9%, $n = 2016$) were self-employed. Other sociodemographic characteristics are detailed in Table 1.

Prevalence of modes of delivery among the study participants

A total of 356 singleton primigravida deliveries were analysed in the present study. Most of the participants (58.7%, $n = 209$) delivered by VD, and the remaining 41.3% ($n = 147$) delivered by means of CD. Regarding the different categories of both CD and VD modes of delivery, it was

Table 1: Sociodemographic characteristics of the study participants ($n = 356$).

Variables	Frequency (n)	Percent (%)	Mean \pm SD
Maternal age (years)			22.0 \pm 3.73
15–19	95	26.7	
20–35	260	73.0	
36–49	1	0.3	
Maternal weight (kg)			62.8 \pm 8.69 (kg)
≤ 70	259	72.8	
> 70	97	27.2	
Newborn weight (kg)			2.97 \pm 0.49 (kg)
< 2.5	11	3.1	
≥ 2.5	345	96.9	
Apgar score			9.53 \pm 1.37
< 7	22	6.2	
≥ 7	334	93.8	
Place of residence			
Urban	168	47.2	
Rural	188	52.8	
Religion			
Christian	322	90.4	
Muslim	34	9.6	
Marital status			
Single	124	34.8	
Married	229	64.3	
Divorced	2	0.6	
Widow	1	0.3	
Level of education			
No formal education	10	2.8	
Primary education	153	43.5	
Secondary education	147	41.3	
Tertiary education	44	12.4	

Table 2: Antenatal care visits and maternal characteristics (n = 356).

Variables	Number (n)	Percent (%)	Mean \pm SD
Number of ANC visits			3.97 \pm 1.16 visits
≥ 4 visits	229	64.3	
< 4 visits	127	35.7	
Health facility for attending ANC			
Region referral hospital	15	4.2	
District or designated hospital	80	22.5	
Health centre	66	18.5	
Dispensary	195	54.8	
GA during the first ANC visit			16.54 \pm 5.28 weeks
≤ 12 weeks	99	27.8	
> 12 weeks	257	72.2	
Last haemoglobin level (gm/dl)			12.10 \pm 1.12
≥ 11 (not anaemic)	257	72.2	
< 11 (anaemic)	45	12.6	
Missing data	54	15.2	
BP during labour			
Normal	301	84.6	
Hypertension	4	1.1	
Hypotension	18	5.1	
Missing data	33	9.3	
Height of the mother (cm)			
≥ 150	332	93.3	167.3 \pm 12.51
< 150	24	6.7	

ANC-antenatal care, BP-blood pressure, GA-gestational age.

found that, of the participants who underwent CD during delivery, a majority of them (95.9%, n = 141) were emergency cases, and only 4.1% (n = 6) were elective. In this study, VD was largely spontaneous, comprising 98.5% (n = 206) of the participants who delivered by VD. Vacuum and assisted breech deliveries for VD were reported in 1% (n = 2) and 0.5% (n = 1) of cases, respectively.

Maternal characteristics during antenatal care visits

Regarding the type of health facility where the participants would seek antenatal care (ANC) services, we found that most of the participants (54.8%, n = 195) obtained ANC services from dispensaries, and the vast majority of them (64.3%, n = 226) had ≥ 4 ANC visits (Table 2). Of the study participants, a majority of them (72.2%, n = 257) sought ANC services at the gestation point of more than 12 weeks indicating that they were late. Most of the participants (51.7%, n = 184) had normal blood pressure, and 5.1% (n = 18) and 1.1% (n = 4) had hypotension and hypertension, respectively. Additionally, a majority of the participants (93.3%, n = 332) had a height measuring ≥ 150 cm.

Association between mode of delivery and maternal and newborn characteristics

Among the maternal and newborn characteristics which were associated with the modes of delivery (VD and CD) in

this study, we found that short stature among pregnant women of < 150 cm was associated with CD (p = 0.001). We found 20 pregnant women of < 150 cm who underwent CD, compared to only two pregnant women with a height ≥ 150 cm who underwent CD. This difference was significant. We also found increased newborn weight to be associated with CD (p = 0.029). There were 106 newborns with body weight > 3.5 kg delivered by CD, compared to 28 newborns delivered by VD. Other maternal characteristics were not associated with modes of delivery (Table 3).

Rationale for the indication of caesarean delivery among the singleton primigravidae

The majority of the CD indications (79.6%, n = 283) in this study had a well-established rationale (absolute indications), and the remainder (20.4%, n = 73) had relative indications. Of the absolute indications for CD, foetal distress was the leading indication, comprising 32% (n = 47), followed by cephalopelvic disproportion (CPD), comprising 19.1% (n = 28). Induction failure was the least frequent among the absolute indications and comprised only 0.7% (n = 1). Most of the relative indications of CD in this study (13.6%, n = 20) were due to prolonged labour. Other relative indications of CD comprised 1.4% (n = 2) (Table 4).

Frequency of maternal and newborn outcomes for Caesarean and vaginal deliveries

Maternal morbidity appeared to be more common among women who underwent CD, compared to those with VD (Table 5). Adverse maternal outcomes were found in 23.9% (n = 85) of all the cases. A relatively higher proportion of such adverse maternal outcomes (63.5%, n = 54) was present in participants who underwent CD, compared to 36.5% (n = 31) who delivered through VD. Among the maternal outcomes, fever comprised 37.7% as the most common maternal outcome, and fever comprised 28.2% in those who underwent CD, compared to only 9.4% in those who underwent VD. Other complications of VD included headache (0.5%), malaise (0.5%), eclampsia (0.5%), perineal tear (0.5%), low haemoglobin level (0.5%), and high blood pressure (2%), whereas other complications of CD included high blood pressure (1%).

A total of 39.0% (n = 139) newborns in this study had different outcomes. CD contributed to most of the newborn outcomes (55.4%, n = 77), compared to VD, which accounted for 44.6% (n = 62). In both modes of delivery, birth asphyxia was the most common form of newborn outcome, occurring in 32.4% (n = 45) and 18.7% (n = 26) of CD and VD cases, respectively. Regarding the occurrence of death among the newborns in this study, we observed that there were more deaths among newborns delivered by CD (4.3%) than VD (2.2%) (Table 5).

Logistic regression analysis for the predictors of newborn outcomes

Table 6 presents the logistic regression analysis applied in this study. The univariate analysis showed that only birth asphyxia was associated with CD (p = 0.000). Newborns

Table 3: Association between mode of delivery and maternal and newborn characteristics.

Maternal characteristics	Mode of delivery				X ²	P
	VD		CD			
	n	%	n	%		
Maternal age (years)					1.059	0.304
≥20	149	71.3	112	76.2		
<20	60	28.7	35	23.8		
Maternal height (cm)					23.813	0.001
≥150	207	99.0	127	86.4		
<150	2	1.0	20	13.6		
ANC visits					2.095	0.148
≥4 visits	128	61.2	101	68.7		
<4 visits	81	38.8	46	31.3		
GA during the first ANC visit					2.881	0.108
Timely (≤12 weeks)	52	24.0	48	32.7		
Late (>12 weeks)	157	75.1	99	67.3		
Missing data	182	87.6	128	87.1		
Newborn weight (kg)					19.113	0.029
Not overweight (≤3.5)	181	86.6	28	13.4		
Overweight (>3.5)	41	27.9	106	72.1		
Maternal weight (kg)					3.201	0.431
Not overweight (≤70)	72	20.2	69	19.4		
Overweight (>70)	118	33.1	97	27.2		
Place of residence					0.321	0.571
Rural	113	60.1	75	39.9		
Urban	96	57.1	72	42.9		
Marital status					2.885	0.089
Living with a spouse	142	62.0	87	38.0		
Not living with a spouse	67	57.8	60	47.2		
Occupation					0.055	0.814
Employed	144	58.3	103	41.7		
Not employed	65	59.6	44	40.4		

VD-vaginal delivery, CD-caesarean delivery, ANC-antenatal care, GA-gestational age, X²-Chi-square, p-value

born by CD in this study were 1.77 times more likely to develop birth asphyxia than newborns born by VD (45 cases vs. 26 cases). Neonatal death was not associated with CD ($p = 0.117$). However, the number of deaths among newborns delivered by CD was higher than that of newborns delivered by VD (six cases vs. three cases).

Table 4: Distribution of caesarean delivery indications in the study (N = 147).

Indications	Number (n)	Percentage (%)
Absolute indications		
Foetal distress	47	32.0
Cephalopelvic disproportion	28	19.1
Obstructed labour	14	9.5
Malpresentation	8	5.4
Eclampsia	7	4.8
Face presentation	5	3.4
Cervical dystocia	4	2.7
Ante partum haemorrhage	3	2.0
Induction failure	1	0.7
Relative indications		
Prolonged labour	20	13.6
Big baby	2	1.4
Breech presentation	2	1.4
Overdue	2	1.4
Pregnancy induced hypertension	2	1.4
Premature rupture of membrane	2	1.4

When the variables were adjusted for each other under multivariate analysis, it was observed that birth asphyxia and low birth weight (premature) were associated with CD ($p = 0.000$) and ($p = 0.001$), respectively. The risk of newborns delivered by CD developing birth asphyxia was 3.25 times that of those delivered by VD. On the other hand, CD had a preventive effect on low birth weight (AOR = 0.03) among newborns, compared to those delivered by VD (19 cases versus 26 cases). The difference was statistically significant ($p = 0.001$).

Table 5: Frequency of maternal and newborn outcomes for the modes of delivery.

Outcomes	Caesarean delivery		Vaginal delivery		Total	
	n	%	n	%	n	%
Maternal outcomes (n = 85)						
Severe bleeding	12	14.1	6	7.1	18	21.2
Fever	24	28.2	8	9.4	32	37.7
Wound burst	15	17.6	5	5.9	20	23.5
Other complications	6	7.1	9	10.6	15	17.6
Newborn outcomes (n = 139)						
Birth asphyxia	45	32.4	26	18.7	71	51.1
Low birth weight	19	13.7	26	18.7	45	32.4
Neonatal sepsis	7	5.0	7	5.0	14	10.0
Death	6	4.3	3	2.2	9	6.5

Table 6: Univariate and multivariate analyses under the logistic regression model for the association of newborn outcomes with modes of delivery.

Variable	n	Mode of delivery		Univariate analysis			Multivariate analysis		
		CD	VD	COR	95% CI	P	AOR	95% CI	P
Newborn outcomes									
Asphyxia									
Yes	71	45	26	1.77	0.188–0.553	0.000	3.25	1.867–5.646	0.000
No	285	102	183						
LBW (gm)									
<2500	45	19	26	0.96	0.508–1.803	0.892	0.03	0.003–0.211	0.001
>2500	311	128	183						
Sepsis									
Yes	14	7	7	0.69	0.238–2.020	0.500	0.41	0.037–3.784	0.406
No	342	140	202						
Death									
Yes	9	6	3	0.34	0.084–1.391	0.117	0.12	0.598–106.936	0.116
No	347	141	206						

CD-caesarean delivery, VD-vaginal delivery, CI-confidence interval, LBW-low birth weight, COR-crude odds ratio, AOR-adjusted odds ratio, P: p-value.

Discussion

The mode of delivery among primigravidae has been proven to affect the decision about the mode of delivery in subsequent deliveries.¹⁹ If a primigravida delivers by CD, there is a high possibility of having CD in subsequent pregnancies, because of the previous scar.²⁰ The WHO has recommended the global optimal CDR to be between 5% and 15% of all births.²¹ Wise reported that CDR is escalating drastically, increasing from 12% of global births in 2000 to 21% of births in 2015.²² An increase in UK CDR has also been reported, from 19.7% of births in 2000 to 26.2% of births in 2015.²²

Recently, a WHO report disclosed that global CDR increased from 12.4% in 1990 to 18.6% in 2014. The rate ranged from 6% to 27.2%, depending on the region, and the average increase was of 4.4% per year.²³ The report revealed that the lowest CDR of 7.3% was reported in Africa and highest CDRs of 19.2%, 25.0%, 31.1%, 32.3% and 40.5% were found in Asia, Europe, North America and Latin America respectively.²³ Therefore, North America and Latin America reported the highest CDRs globally for the period between 1990 and 2014. In 2016, Harrison and Goldenberg reported that the CDR in Sub-Saharan Africa (SSA) was increasing, albeit at a slow rate compared to other regions globally. Studies from various areas of Africa have reported that CD is appropriately used on some occasions, but the majority of CDs are based on unnecessary requests. Surprisingly, the demand for CD has been noted to be higher in those who do not require it than in those who really need such mode of delivery.⁸ In two different studies conducted in Tanzania and Ethiopia, the majority of CDs were found to be unnecessary and to contribute to high CDRs that could have been avoided.^{24,25}

The prevalence of CD among singleton primigravidae of 41.3% of births observed in this study was almost three times higher than the optimal CDR recommended by WHO. It was also relatively higher than the CDR of 32.0% reported in Kenya²⁶ and KSA⁵ in referral hospitals. Two other studies conducted in Tanzania by the IRRH (2018) and

Kilimanjaro Christian Medical Centre (KCMC) (2015) reported CDRs of 21.6% and 26.75%, respectively^{27,28} which are lower than the CDR in our study. Ochieng et al.²⁶ reported the highest CDR of 67.4% in a study conducted in Kenya. Marked and 'alarming' CDRs have also been communicated in different countries, including the Dominican Republic (58.1%), Brazil (55.5%), Egypt (55.5%), and Turkey (53.1%).²²

The CDR of 76.2% among singleton primigravidae aged between 20 and 35 years in this study was lower than the 84.5% reported in a study conducted in mainland China of women aged between 21 and 34 years.²⁹ In both studies, the CDRs were much higher than the CDR of 5%–15% recommended by WHO.

While CDRs have been increasing in various parts of the SSA, studies conducted in different regions have shown a decrease in CDR. For example, a study conducted in Guinea reported that the CDR dropped from 3.3% of births in 2012 to 2.4% of births in 2016.²³ In Nigeria, the CDR decreased from 2.9% of births to 2% for a period of five years until 2013.³⁰ In other countries of the SSA region, such as Zimbabwe, the CDR has been constant at 6% for the past 10 years.²³

Furthermore, when we reviewed CDRs reported by various countries, we noticed that hospital-based CDRs were higher than population-based CDRs across the globe. Studies conducted in Sweden, Nigeria, and Uganda reported population-based CDRs to be 16.3%, 11.0%, and 2.4%.^{30–32} In 2016, Cavallaro et al.³³ reported a population-based CDR of 6.0% in Tanzania. These findings suggest that hospital-based CDRs are biased and may not truly depict the actual CDR of a given setting.

Various factors seem to contribute to CDR variation across regions and even within the same country. Differences in the main study participants were among the factors contributing to the CDR variation among the compared studies. In studies in which the majority of the participants were younger, the CDR was likely to be higher than in studies comprising a majority of older participants. This explanation includes other maternal characteristics such as

height and body mass index (BMI) that tended to produce differences. Place of residence, level of parity, level of education, and socioeconomic status (SES) of the participants were also reported to contribute to CDR variation for the different cases reported in the literature.^{28,30,34} For example, it is known that primigravid women are more likely to undergo CD than multigravid women.

Regarding the association of the modes of delivery with maternal and newborn characteristics in our study, we found that maternal height and foetal weight were the only characteristics that were significantly associated with CD. Other correlated maternal characteristics were not associated with CD in our series (Table 3), unlike in other cases reported in the literature.

Participants with a maternal height measuring less than 150 cm were more likely to undergo CD compared to those with a maternal height ≥ 150 cm (20 cases versus two cases), and the difference was statistically significant ($p = 0.001$). This finding was in agreement with the results of a study conducted at Rama Medical College (India), which revealed that nearly all participants with a maternal height of less than 145 cm underwent CD, compared to participants whose maternal height was ≥ 145 cm (93.2% versus 4.6%), and the difference was statistically significant ($p < 0.001$).³⁵ Another study conducted in Sweden by Mogren et al. reported that maternal height was an independent predictor of CD among the study participants ($p < 0.001$). Their study revealed that maternal height exerted an absolute effect on the risk of CD, and the risk of CD for women of short stature was higher than for those of normal or high maternal height.³¹

In 1997, Moller and Lindmark conducted a study in Tanzania comparing the associations between maternal height and the possibility of CD among pregnant women from two different areas (Ilula and Ikwiriri). The study found that 54% of pregnant women from Ilula village who underwent CD had a maternal height of less than 150 cm, compared to 23% of women in Ikwiriri village; however, height was not associated with CD ($p = 0.31$).³⁶ This suggests that the proxy of height for those with short stature and tall stature may vary among pregnant women, even within the same country. Sheiner et al. also reported that the risk of participants of short stature (less than 155 cm) undergoing CD was twice that of participants with maternal height ≥ 155 cm, and the difference was significant ($p < 0.001$).³⁷

Foetal weight in our study was associated with CD. We found that foetal weight measuring greater than 3.5 kg in participants with a height of less than 150 cm was associated with CD (106 cases versus 41 cases), and the difference was statistically significant ($p = 0.029$) (Table 3). This observation is in line with the findings of studies conducted in India, Nigeria, and Tanzania.^{28,30,35}

In this study, we found that 79.6% of CD had rational (absolute) indications, meaning that CD could not be avoided. On the other hand, 20.4% had no rationale for indications of CD, implying that they were unnecessarily performed owing to either misdiagnosis or the intentional requests of pregnant mothers. Studies have shown that the proportion of relative (unnecessary) indications for CD has risen tremendously. The rate of 20.4% of relative indications of CD observed in this study was even lower than the 30%, 70%, 28.4%, and 54% previously reported in Tanzania,

KSA, China, and Uganda, respectively.^{5,29,32,33} A number of factors can be attributed to this increase in the rate of unnecessary (relative) indications of CD around the world, which include maternal request, early pregnancy, cephalopelvic disproportion (CPD), socioeconomic status, and the increased number of health facilities, particularly private ones.³⁸ However, most of the reported data in the literature include studies conducted in tertiary health facilities, where the rate of CDs is more likely to be high because most high-risk pregnancies are referred to such hospitals.²⁹

CD has been associated with increases in both maternal and newborn complications (adverse outcomes) compared to VD. This is why the WHO emphasises the importance of absolute (true) indications of CD to prevent or reduce the most likely complications. In our study, birth asphyxia and neonatal deaths were found more in newborns delivered by CD, compared to VD. Further, maternal complications, such as wound burst (sepsis) and pyrexia (fever) were more common in singleton primigravidae who delivered by CD than in those who delivered by VD. This finding is similar to those of other studies. For example, Nakimuli et al. (2016) reported that in Uganda, various maternal and neonatal complications were the result of CD, including severe bleeding (17.2%), pyrexia (4.7%), and wound burst (3.0%), and neonatal complications were sepsis (32.7%), neonatal death (3.4%), and prematurity (23.8%).³⁹ In another study conducted in Tanzania by Nyamtema et al., (2016) it was reported that 10% of postpartum severe bleeding was maternal CD-related, and 0.2% of neonatal sepsis was CD-related. The same study reported the overall CD-related maternal death rate to be 18%.³⁹ Kola et al. (2006) also reported that 0.8% of neonatal sepsis was CD-related, compared to 0.5% of neonatal sepsis that resulted from VD.³⁸ In the review paper by Alexander et al., (2016) it was also communicated that CDs have a high propensity of adverse outcomes (complications) for both newborns and delivering mothers, including haemorrhage, sepsis, urinary bladder injury, and uterine rupture.⁴⁰

Therefore, a meticulous selection of expecting mothers should always be undertaken to minimise the rate of CDs and thereby reduce preventable maternal and neonatal complications and even death. Efforts to reduce the number of maternal-requested CDs ought to be made in all health facilities, particularly in urban areas, where CDs are reportedly common compared to rural areas.

Regarding the association of CD with adverse newborn outcomes (complications), we found a positive association between CD and birth asphyxia (AOR = 3.25, 95% CI = 1.87–5.65), and the difference between the two modes of delivery was statistically significant ($p = 0.000$). This finding is in agreement with those reported by Wosenu et al. (AOR = 3.58, 95% CI = 1.13–11.31), Gebreheat et al. (AOR = 6.97, 95% CI = 2.87–16.93), and Saugstad et al. (AOR = 2.07, 95% CI = 1.17–3.63).^{38,41,42} CD has been reported to have both positive and negative (preventive) effects on newborns with low birth weight (LBW). In our study, there was a preventive effect of CD on newborns with LBW (AOR = 0.03, 95% CI = 0.003–0.211). This is similar to the finding in the study by Hailu et al.,⁴³ where CD had a preventive effect on newborns born with LBW (AOR = 0.145, 95% CI = 0.183–0.941). On the other

hand, a positive association between CD and LBW was reported by Eddie et al. (AOR = 2.33, 95% CI = 1.19–4.55), Silva et al. (AOR = 1.11, 95% CI = 0.81–1.52), and Taha et al. (AOR = 2.29, 95% CI = 1.57–3.35).^{44–46}

Conclusion

Our study reported a CDR of 41.3% that was almost three times that of the maximum recommended global CDR of 15% by the WHO. The mode of delivery among singleton primigravidae appears to have been predicted by maternal and foetal characteristics. Maternal height and newborn weight were associated with CDs in this study. CD had a positive association with birth asphyxia and a preventive effect on LBW.

Recommendations

Based on the findings obtained in this study, it is recommended that the selection of CD be absolute as much as possible to bring down the CDR, which was almost three times the rate recommended by the WHO. We also recommend that newborns delivered by CD be placed under constant care owing to the high odds of their developing birth asphyxia.

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Conflict of interest

The authors have no conflict of interest to declare.

Ethical approval

Ethical approval was sought from the Research Ethical Committee (REC) of the University of Dodoma (UDOM/DRP/134/VOL.V/23–15) and issued on 3rd April 2018. Permission to conduct the study was obtained from the directors of the respective health facilities. All the participants were asked to provide written informed consent. Written informed consent for participation in the study for participants under 16 years old was obtained from their parent or guardian. The use of numbers instead of names was maintained throughout the study period to protect the anonymity of the participants.

Authors contributions

JCM conceived and designed the study, conducted the research, provided research materials, collected and organised the data, and wrote the initial manuscript. JJY organised the manuscript, performed an in-depth literature search, and wrote and critically revised the first manuscript. CKN organised the manuscript, designed the study, supervised the project, critically revised the manuscript, and provided

logistical support. IHM organised the data, critically revised the manuscript, provided logistical support, and supervised the project. All the authors critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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