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Health facility-based prevalence of pregnancy-related complications and course of labour of women who gave birth in selected health facilities in Rwanda

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Abstract

Objectives

This study estimated hospital-based prevalence rates for pre-eclampsia/eclampsia, post-partum haemorrhage, and caesarean section (CS) due to prolonged labour/dystocia. Further, course of labour and background characteristics of women, who gave birth in Rwandan health facilities, and their relation to pregnancy outcomes, were investigated.

Methods

This is health facility-based study and data were collected in 2014/2015 through structured interviews and medical records (N=817), in Kigali and the Northern Province of Rwanda. Frequencies and prevalence rates were used to describe participants' background factors, labour and delivery-related characteristics. Univariable and multivariable logistic regression models were performed for different background factors and pregnancy/delivery outcomes.

Results

Pre-eclampsia/eclampsia, post-partum haemorrhage, and CS due to prolonged labour/dystocia represented 1%, 2.7% and 5.4% of all participants, respectively. In total, 56.4% of participants were transferred from low level to higher level of health care, and the majority, (62.4%) were transferred from health centres to district hospitals with CS as the main reason of transfer. Participants who arrived to the health facility with cervical dilation grade of ≤3 cm spent more hours in maternity ward compared to those who arrived with cervical dilatation grade of ≥4 cm. Risk factors for CS due to prolonged labour or dystocia were poor households, nulliparity, and residence far from health facility.

Conclusions

The estimated hospital-based prevalence rates of preeclampsia/eclampsia, post-partum haemorrhage, and CS due to prolonged labour/dystocia were relatively low in this sample from Rwanda. The majority of women were transferred from health centres to district hospitals, and indication "caesarean section" was the main reason for transfer. Upgrading the capacity of health centres in the management of pregnant women is needed in Rwanda.

Keywords: Prevalence, health facility, pregnancy, pregnancy complications, labour, delivery, Rwanda

STRENGTHS AND LIMITATIONS OF THIS STUDY

- All eligible women consented to participate in the study
- Female nurses and midwives were acting as interviewers in order to make pregnant women confident enough to respond
- There may be under-reporting of the prevalence of complications related to pregnancy, for example in a case of maternal deaths occurring in the community
- There may also be under-reporting of cases and physicians's diagnosis of pregnancy-related complications not following the pre-established guidelines due to insufficient knowledge or misinterpretation or lack of time due to heavy workload
- There may be over-reporting in relation to the population-based prevalence due to selection bias, as cases with complications are aggregated in hospitals for more advanced level of health care

BACKGROUND

Although pregnancy is usually a planned and happy event, some pregnancies end tragically with maternal or foetal/child death or cause severe maternal and/or child impairment.[1] On 2013, about 300,000 maternal deaths occurred worldwide, and every year more than one and half million women suffer from pregnancy-related complications during pregnancy and delivery worldwide.[2 3] The most common pregnancy-related complications are maternal haemorrhage, maternal sepsis, abortion, hypertensive disorders (pre-eclampsia, eclampsia, and pregnancy-induced hypertension), and obstructed labour.[4 5] Maternal haemorrhage is the leading cause of maternal mortality and represents 33.9% of all maternal deaths in Africa.[6] Post-partum haemorrhage is associated with significant morbidity and is one of the two most common reasons for maternal hospital admission worldwide.[7] According to the World Health Organization (WHO), hypertensive disorders during pregnancy complicate approximately 5-10% of all pregnancies and account for 9% of maternal mortality in Africa and Asia.[5 8] Preeclampsia complicates about 3-5% of pregnancies worldwide and is characterized by hypertension, proteinuria, and oedema.[8] Preeclampsia can develop into eclampsia, characterized by seizures that may become potentially fatal for both mother and fetus.[9]

Obstructed labour represents 8% of the of maternal deaths globally.[1] In 2010, the incidence of obstructed labour was 12.2% in Ethiopia.[10] Prolonged labour or obstructed labour occur when the fetus does not progress into the birth canal despite strong uterine contractions.[11] The most frequent cause of obstructed labour is cephalo-pelvic disproportion. This type of obstruction may be the result of a large fetus relative to the maternal pelvic brim. Cephalo-pelvic disproportion often occurs in

diabetic woman or in women whose pelvis is undeveloped or malformed, a condition found in women suffering from malnutrition.[12] Obstructed labour may also be caused by foetal mal-presentation or malposition or pelvic tumours.[11] Obstructed labour may cause trauma to the bladder and/or rectum and increases the risk of a uterine rupture with consequent haemorrhage, circulatory shock, or even death. Trauma to the bladder and rectum during vaginal or instrumental delivery may lead to urinary incontinence, anal incontinence, or fistula.[11]

In 2015, Rwanda had a maternal mortality ratio of 210 per 100,000 live births and is one of few African countries that has managed to fulfil the 5th Millennium Development Goal (MDG5) of reducing maternal mortality by over 75% between 1990 and 2015.[13] In the last decade, Rwanda has made significant efforts to achieve MDG5, however, there is still insufficient information on the prevalence of pregnancy-related complications in the country.

This study aims to fill the knowledge gap in this area and to serve as documentation of Rwanda's improvements in maternal health.

In Rwanda's national guidelines, preeclampsia is defined as blood pressure of ≥140/90 mm Hg after 20 weeks of gestation plus proteinuria of 300 mg per 24 hours or >2+ on a urine dipstick.[14] Furthermore, eclampsia is defined as onset of convulsion/generalized seizures in a woman with pre-eclampsia that can not be attributed to other causes.[14] Post-partum haemorrhage is defined as blood loss of more than 500 ml after vaginal delivery or 1,000 ml after caesarean delivery or excessive vaginal bleeding resulting in signs of hypovolemia or a 10% decline in post-partum hemoglobin concentration from antepartum levels.[14] Dystocia/prolonged labour is defined as difficult labour or an abnormally slow progression of labour.[14]

This study is part of the Maternal Health Research Programme (MaTHeR) undertaken by the University of Rwanda in collaboration with University of Gothenburg and Umeå University in Sweden.

AIMS

This study's overall aim was to determine the hospital-based prevalence rates of pregnancy-related complications and to describe the course of labour and the background characteristics of women giving birth in selected Rwandan health facilities.

Specific aims were:

- To estimate the hospital-based prevalence of *i)* pre-eclampsia and eclampsia, *ii)* post-partum haemorrhage, and *iii)* prolonged labour or obstructed labour or dystocia labour resulting in a caesarean section.
- To describe the course of labour from the time of arrival to a health facility and until delivery.
- To describe background characteristics of women who give birth in Rwandan health facilities and to describe these characteristics' associations with pregnancy outcomes.

METHODS

The study setting

The Rwandan public health system is composed of health posts, health centres, district hospitals, military hospitals, provincial hospitals, and referral hospitals.[15] A

health centre is the lowest level of health care and is where pregnant women with uncomplicated pregnancy receive health care. Complicated cases are referred to higher levels of health care, such as district, provincial and referral hospitals.[16] Health centres are mainly staffed by A2 nurses (enrolled nurses with secondary level of education).[17] Private health care is available in Kigali and other large cities in Rwanda in the form of private dispensaries, private clinics, and private hospitals. Only large private hospitals provide assisted delivery.[15] This study was conducted in Kigali city and the in Northern province of Rwanda, and included eight health centres, seven district hospitals, one provincial hospital, one referral hospital and at one private hospital.

This study used diagnoses made by physicians from patient's medical records. Physician's diagnoses were presumed to be based on definitions and guidelines of pregnancy, labour, and delivery related problems pre-established by the Rwandan Ministry of Health.[14]

Study design and recruitment of study participants

This is a comprehensive cross-sectional health facility-based study. During 2013, there were total 67,077 vaginal deliveries occurred in Kigali city and the Northern province of Rwanda, 28,786 of these (42%) occurred in Kigali city and 38,292 (58%) in the Northern province. Therefore, 18 health facilities with a high number of vaginal deliveries were selected, eight in Kigali and ten in the Northern Province. The selected health facilities correspond to approximately 10% of the health facilities in Kigali and the Northern Province (18). The target population were women who

delivered in the selected health facilities during the time of the data were collection (from 2 December 2014 to 26 January 2015). The number of participants to be included in the study was selected proportionally relative to the number of vaginal deliveries that occurred in 2013 in each of the selected health facilities (i.e. the year before the data collection). The sample size of 817 women was calculated based on the estimation of the prevalence of CS of 14.8% in Rwanda in 2013, [18] with an absolute precision of 5%, and with about 10% of non response. The heads of the selected health facilities helped facilitate contact with the heads of the maternity wards at each selected health facility. With the support of the heads of maternity wards, delivered women who were about to be discharged during the data collection period were invited to participate in the study. Before the individual interviews, information about the study was provided to the eligible participants. All invited participants signed a written consent form before their participation in the study. Most of the time, data collection was performed on several occasions (i.e. on more than one day), in order to fulfil the predefined number of participants from each selected health facility.

Data collection procedures

A structured questionnaire was developed by the study team and included questions about socio-demographic background characteristics such as age, marital status, educational level, information on previous pregnancies and the last pregnancy with additional information on outcomes of labour and delivery. The questionnaire was translated from English into Kinyarwanda. The questionnaire was piloted at one non-selected district hospital and its two health centres located in the Southern Province of Rwanda. After the pilot study no major changes were made in the questionnaire apart

from a few adjustments in wording to improve clarity. A group of eight experienced interviewers (nurses and midwives) collected data through individual structured interviews under the supervision of the supervisory team of this research. Data entry was performed by three skilled personnel. After the primary data entry the first author re-registered 81 questionnaires, corresponding to approximately 10% of the total study sample, each including 285 variables used in this study, to check the accuracy of the first data entry. The results of this re-registration showed 138 errors, corresponding to an error rate of 0.59% (138/23,085). The erroneous data were corrected.

Descriptions of variables

Variables related to pregnancy outcomes

Binary variables were *post-partum haemorrhage* and *preeclampsia*/eclampsia which was a combination of the variables *pre-eclampsia before labour, eclampsia before labour, pre-eclampsia during labour, eclampsia during labour, pre-eclampsia post-partum, and eclampsia post-partum.* These variables were collected from medical records, from diagnoses made by physicians. The dichotomized variable *caesarean section due to prolonged labour or dystocia,* was created from the variable *what was the main indication of caesarean section* and this was collected from medical records as this is where physicians noted the indication of a *caesarean section.*

Variables related to socio-demographic factors

Maternal age, was a continuous numerical variable was divided into the following categories; <20 years, 20-24 years, 25-29 years, 30-34 years, 35-39 years and ≥40

years. *Maternal age* was also categorized into 3 categories, i.e. <25 years, 25-34 years and ≥35 years. *Marital status* included married, cohabiting, separated or divorced, widowed, and unmarried or single. *Marital status* was dichotomized into married or cohabitating where single, divorced, or widowed were collectively categorized as the exposure category. *Education* included never attended school, primary level not complete, primary level completed, vocational training, secondary level not completed, secondary level completed and tertiary level. Education was grouped into three categories: never attended school, completed primary level, completed secondary school and reached tertiary university level. *Occupations* included student, unskilled worker, skilled worker, civil servant, not employed, and other employment; these were dichotomized as employed and non-employed. For each variable about main health problems during pregnancy, data were collected for the first, second, and the third trimesters. *First trimester* referred to the first three months of the pregnancy. *Second trimester* referred to four to six months of pregnancy. *Third trimester* referred to seven months or more. The variables *anaemia* and *hypertension* during the first, second, and third trimester were combined to become *anaemia during pregnancy*, and *hypertension during pregnancy,* respectively. *Hypertension* was defined as blood pressure of ≥140/90 mm Hg [14].

Variables related to course of labour and delivery

The binary variables *intake of traditional drugs during pregnancy* and *transfer from another health facility* were the only labour and delivery self-reported variables. Others variables were collected from the medical records. *Number of hours in maternity ward* was a calculated variable using *time of admission* at the maternity ward and *time of delivery*. It was categorized into ≤4 hours, >4-8 hours, >8-10 hours,

and >10 hours. *Foetal presentation* included cephalic, breech, face, transverse, and other presentations. *Period when transferred* was a variable that included transferred before labour started and transferred during labour before delivery. *Cervical dilation grade at arrival to the hospital* and *cervical dilation grade at 4 hours in the hospital* were continuous numerical variables that were categorized into ≤3 cm, 4-5 cm, and ≥6 cm. *Number of contractions at arrival* and *number of contractions* after four hours in the hospital included 0, 1, 2, 3 or more contractions. *Duration of contractions/ ten minutes at arrival to the hospital* and *duration of contractions at four hours in hospital* included ≤20 seconds, 21-40 and >40 seconds. There were other binary variables such as *spontaneous rupture of membranes*, *use of parthogram during labour*, *provision of pharmacological pain relief during labour*, *artificial rupture of membranes*, *artificial augmentation of labour with oxytocin*, *episiotomy done*, *intake of traditional drugs during labour*, *vacuum extraction* and *forceps extraction*.

Statistical analysis

Frequency and prevalence (n and %) were used to describe participants' socio-demographic and reproductive history characteristics, self-reported pregnancy-related problems, and delivery-related characteristics including the features of course of the labour. Pearson's Chi-Squared test and Fisher's exact test were used for bivariable analyses and t-test was used to compare means. This study identified the factors associated with CS due to prolonged labour/dystocia using univariable logistic regression analysis. Variables that were statistically significantly associated with CS due to prolonged labour/dystocia were considered for the final logistic regression model. Then a multivariable logistic regression model was built that calculated odds ratios (OR) and their 95% confidence intervals (CI). In the multivariable model,

forward stepwise regression was used, and all statistically significant variables in univariable analyses were entered one at a time to identify factors that were associated with CS due to prolonged labour/dystocia, keeping in the final model only factors that were statistically significant ($p<0.05$). All multivariable models included parity and women's age for theoretical reasons as other studies have shown these variables to be associated with CS due to prolonged labour/dystocia. Because no variable was highly correlated ($r\geq0.40$), no variable was excluded in the final model. Two dependent variables (post-partum haemorrhage and preeclampsia/eclampsia) demonstrated a very low number of cases n=22 (2.7%) and n=8 (1.0%), respectively so no further analysis was possible.

ETHICAL CONSIDERATIONS

Participation in this study was voluntary. Before the interviews, participants were verbally informed in detail about the aims of the study and the content of the questionnaire. They were ensured about the confidentiality of their responses, and reminded that they could withdraw from the study at any time of the interview or thereafter. To assure confidentiality, the interview was conducted in privacy. All selected participants signed a written consent form before their participation in the study. This study was conducted according to the guidelines established by the Declaration of Helsinki.[19] The research protocol and the study questionnaire were approved by the University of Rwanda, College of Medicine and Health Sciences Institutional Review Board (Ref: 010/UR/CMHS/SPH/2014). Before the data collection, authorization to conduct the study was obtained from the Ministry of Health in Rwanda (Ref: 20/4029/MCH/2014).

RESULTS

Socio-demographic and reproductive history characteristics

In total, 817 women (16 to 44 years old, with a mean age of 27.8 years), participated in the study. Married women represented 49.9% of participants and 40.0% of the women were cohabiting and 8.6% were single. The proportion of primiparous women was 41.1%; multiparous women with two to four births were 54.7%; and multiparous of more than five births were 4.3%. Frequencies and percentages of socio-demographic and reproductive history characteristics of participants are presented in Table 1.

Table 1. Socio-demographic and reproductive history characteristics of participating women (N=817)

Participants (pregnant women):		
Variable	**Mean age (years)**	**SD[a]**
Mean maternal age	27.83	5.57
Woman's mean number of years of education	7.67	4.18
Partner mean age (years; SD)	32.77	6.52
Partner's mean number of years of education (years; SD)	8.97	4.23
	N	**%**
Maternal age in age group (years)	**816**	**99.0**
<20	46	5.6
20-24	191	23.4
25-29	250	30.6
30-34	221	27.1
35-39	90	11.0
≥40	18	2.2
BMI[b] calculated	**367**	**44.9**
<18.5	18	4.9
18.5-24.9	240	65.4
25-29.9	73	19.9
≥30	36	9.8
Woman's height (m)	**375**	**45.9**
<1.50	23	6.1
≥1.50	352	93.9
Woman's weight before pregnancy (kg)	**793**	**97.1**
<50	106	13.4
≥50	678	86.6
Marital status	**814**	**99.6**

Single or unmarried	70	8.6
Widowed	2	0.2
Separated or divorced	11	1.4
Cohabiting	326	40.0
Married	406	49.9
Religion	**814**	**99.6**
Catholicism	220	27.0
Protestantism	439	53.9
Adventist	92	11.3
Islam	25	3.1
Other religion	31	3.8
No religion	7	0.9
Education	**815**	**99.8**
No education	29	3.6
Primary level, not completed	219	26.9
Primary level, completed	187	22.9
Secondary school, not completed	61	7.5
Secondary school, completed	115	14.1
Vocational training	83	10.2
Tertiary, university level	121	14.8
Occupation	**800**	**97.9**
Student	33	4.1
Non-skilled worker	470	58.8
Skilled worker	60	7.5
Civil servant	99	12.4
Not employed	109	13.6
Other employment	29	3.6
Number of births (including index birth)	**816**	**99.9**
1	335	41.1
2	213	26.1
3	155	19.0
4	78	9.6
≥5	35	4.3
Number of previous children delivered at home	**817**	**100**
0	756	92.5
1	33	4.0
2	15	1.8
3	8	1.0
≥4	5	0.6
Number of previous miscarriages	**817**	**100**
0	732	89.6
1	72	8.8
2	10	1.2
≥3	3	0.4
Woman's HIV status	**817**	**100**
Negative	765	93.6
Positive	52	6.4
ANC visits	**808**	**98.9**

Yes	778	96.2
No	30	3.7
Number of ANC visits	**812**	**99.4**
1 visit	67	8.3
2 visits	153	18.8
3 visits	259	31.9
4 visits	231	28.4
≥5	102	12.6
Partner to participant		
Partner's age in group (years)	**730**	**89.4**
<25	50	6.8
25-29	207	28.4
30-34	198	27.1
35-39	172	23.6
≥40	103	14.1
Partner's education	**728**	**89.1**
No education	35	4.8
Primary level, not completed	119	16.3
Primary level, completed	144	19.8
Secondary school, not completed	44	6.0
Secondary school, completed	164	22.5
Vocational training	84	11.5
Tertiary, university level	138	19.0
Household information		
Health insurance	**814**	**99.6**
No insurance	13	1.6
Community health based insurance	650	79.9
Public insurance (RAMA, MMI, MIS/UR)[c]	135	16.6
Other private	16	2.0
Household income per month	**772**	**94.5**
<17,500 RWF	32	4.1
17,500-35,999 RWF	68	8.8
36,000-99,999 RWF	231	29.9
100,000-199,999 RWF	213	27.6
200,000-499,999 RWF	163	21.1
>500,000 RWF	65	8.4
Distance from home to the nearest health facility (km)	**814**	**99.6**
<1	445	54.7
2-5	289	35.5
6-10	64	7.9
≥10	16	2.0

[a]SD=Standard deviation

[b]BMI=Body Mass Index (kg/m^2)

[c]RAMA=La Rwandaise d'Assurance Maladie, MMI= Military Medical Insurance, MIS/UR= Medical Insurance of University of Rwanda

Self-reported health problems during pregnancy

Prevalence rates of anaemia, severe vaginal bleeding, hypertension, and diabetes mellitus during pregnancy were 14.9%, 5.6%, 5.3%, and 0.2%, respectively. Prevalence rates of self-reported pregnancy-related health problems during pregnancy are presented in Table 2.

Table 2. Prevalences of self-reported pregnancy-related problems in 1st, 2nd, and 3rd trimesters[a] of pregnancy, and the cumulative prevalence[b]

Variable	1st trimester[a]		2nd trimester		3rd trimester		Cumulative prevalence	
	N	%	N	%	N	%	N	%
Hypertension	17	2.1	8	1.0	25	3.1	43	5.3
Convulsions	12	1.5	3	0.4	3	0.4	15	1.8
Diabetes mellitus	2	0.2	1	0.1	0	0	2	0.2
Bad smelling of vaginal discharge	60	7.4	40	4.9	47	5.8	92	11.3
Anemia	77	9.4	70	8.6	43	5.3	122	14.9
Severe vaginal bleeding	30	3.7	14	1.7	3	0.4	46	5.6
Abdominal pain and severe bleeding			2	0.2	4	0.5	6	0.7
Fever			21	2.6	35	4.3	50	6.1
Leaking of fluid from vagina			52	6.4	60	7.4	94	11.5
Swollen extremities			69	8.4	248	30.5	266	32.4
Preterm premature rupture of membranes			1	0.1	9	1.1	9	1.1
Abdominal pain			90	11.0	96	11.8	140	17.1
Regular and painful uterine contractions			3	0.4	26	3.2	28	3.4

[a] The first trimester represents the first 3 months of the pregnancy, the second trimester represents 4 to 6 months and the third trimester was defined as 7 months or more of pregnancy

[b] The third trimester do not include events or complications during delivery

Course of labour and delivery and their background characteristics

Almost three quarters of pregnant women started labour spontaneously, 5% had induced labour. In total, 28.4% of all pregnant women delivered by CS including 20.3% who delivered by CS before start of labour and 8.7% who underwent CS during labour (Table 3).

Table 3. Characteristics of labour and delivery

Variable	All participants		Participants with spontaneous labour[a]		Participants with induced labour[a]	
	N=817		n=594		n=40	
	n	%	n	%	N	%
Intake of traditional drugs during pregnancy[b]	**814**	**99.6**	**592**	**99.7**	**40**	**100**
Yes	163	20.0	130	22.0	9	22.5
No	651	80.0	462	78.0	31	77.5
Transferral from another health facility[b]	**815**	**99.8**	**592**	**99.7**	**40**	**100**
Yes	460	56.4	368	62.2	34	85.0
No	355	43.6	224	37.8	6	15.0
Reason for transfer from another health facility	**460**	**56.4**	**594**	**100**	**40**	**100**
For caesarean section	60	7.4	28	4.7	2	0.5
For pre-eclampsia	1	0.1	1	0.2	0	0.0
For prolonged labour/dystocia	39	4.8	36	6.1	1	2.5
For fetal distress	13	1.6	11	1.9	0	0.0
For uterine rupture	1	0.1	1	0.2	0	0.0
For severe bleeding	7	0.9	6	1.0	0	0.0
For other reasons	339	41.4	285	48.0	35	87.5
Reason for transfer from another health facility	**460**	**56.4**	**402**	**63.6**	**40**	**100**
For caesarean section	102	12.5	66	11.1	5	12.5
For pre-eclampsia	1	0.1	1	0.3	0	0.0
For placenta praevia	1	0.1	0	0.0	1	2.6
For prolonged labour/dystocia	46	5.6	40	10.6	2	5.3
For fetal distress	19	2.3	15	4.0	0	0.0
For uterine rupture	1	0.1	1	0.3	0	0.0
For prolapse of umbilical cord	1	0.1	1	0.3	0	0.0
For severe bleeding	3	0.4	3	0.8	0	0.0
For better management of pregnant woman	218	26.7	181	30.5	19	47.5
For "scarred uterus"	30	3.7	22	3.7	2	5.0
For post term	16	2.0	5	0.8	9	22.5
For other reasons	22	2.6	15	4.0	2	5.3
Period when transferred[c]	**460**	**56.4**	**366**	**61.6**	**38**	**95.0**
Transferred before labour started	179	38.9	106	29.0	32	84.2
Transferred during labour before delivery	281	61.1	260	71.0	6	15.8
Fetal presentation[c]	**747**	**91.4**	**582**	**98.0**	**40**	**100**
Cephalic	735	98.4	574	98.6	38	100
Breech	7	0.9	5	0.9	0	0.0
Face	2	0.3	2	0.3	0	0.0
Transverse	2	0.3	0	0.0	0	0.0
Other	1	0.1	1	0.2	0	0.0
Spontaneous rupture of membranes before arrival to the health facility[c]	**810**	**99.1**	**590**	**99.3**	**40**	**100**
Yes	202	24.9	186	31.5	10	25.0
No	608	75.1	404	68.5	30	75.0
Systolic blood pressure at arrival to health facility (mmHg) [c]	**792**	**96.9**	**579**	**97.5**	**35**	**87.5**
≥160	31	3.9	5	0.9	0	0.0

140-159	71	9.0	57	9.8	1	2.9
<140	690	87.1	517	89.3	34	97.1
Systolic blood pressure at 4 hours in health facility (mmHg) [c]	**147**	**18.0**	**137**	**23.1**	**31**	**22.5**
≥160	2	1.4	2	1.5	0	0.0
140-159	2	1.4	2	1.5	0	0.0
<140	143	97.3	133	97.1	9	100
Diastolic blood pressure at arrival to health facility (mmHg) [c]	**784**	**96.0**	**572**	**96.3**	**34**	**85.0**
≥95	55	7.0	14	2.4	1	2.9
90-94	38	4.8	19	3.3	1	2.9
<90	691	88.1	539	94.2	23	94.1
Diastolic blood pressure at 4 hours in health facility (mmHg) [c]	**147**	**18.0**	**137**	**23.1**	**31**	**22.5**
≥95	1	0.7	1	0.7	0	0.0
90-94	0	0.0	0	0.0	0	0.0
<90	146	99.3	136	99.3	9	100
Hypertension at arrival to health facility[c]	**817**	**100**	**594**	**100**	**40**	**100**
Yes	101	13.8	70	11.8	3	7.5
No	633	86.2	524	88.2	37	92.5
Labour[c]	**789**	**96.6**	**594**	**100**	**40**	**100**
Spontaneous start of labour	594	74.7	594	100		
Induction of labour	40	5.0			40	100
Caesarean section before start of labour	161	20.3				
Cervical dilation grade at arrival to the health facility[c]	**769**	**94.1**	**571**	**96.1**	**38**	**95.0**
≤3 cm	341	44.3	157	27.5	34	89.5
4-5 cm	169	20.7	161	28.2	2	5.3
≥6 cm	259	33.7	253	44.3	2	5.3
Cervical dilation grade at 4 hours in health facility[c]	**172**	**21.1**	**161**	**27.1**	**10**	**25.0**
≤3 cm	1	0.6	1	0.6	0	0
4-5 cm	9	5.2	8	5.0	1	10
≥6 cm	162	94.2	161	94.4	9	90
Number of contractions 10-minutes after arrival to the health facility[c]	**559**	**68.4**	**519**	**87.4**	**33**	**82.5**
0	4	0.7	2	0.4	2	6.1
1	28	5.0	21	4.0	5	15.2
2	247	44.2	230	44.3	16	48.5
3 or more	280	50.1	266	51.3	10	30.3
Number of contractions after 4 hours in health facility[c]	**174**	**21.3**	**165**	**27.8**	**28**	**70.0**
0	0	0.0	0	0.0	0	0.0
1	0	0.0	0	0.0	0	0.0
2	51	29.3	45	27.3	6	50
3 or more	123	70.7	120	72.7	6	50
Duration of contractions at arrival to the health facility[c]	**556**	**68.1**	**517**	**87.0**	**32**	**80.0**
≤20 seconds	70	12.6	62	12.0	6	18.8
21-40 seconds	485	87.2	454	87.8	26	81.3
>40 seconds	1	0.2	1	0.2	0	0.0
Duration of contractions after 4 hours in health facility[c]	**172**	**21.1**	**159**	**26.8**		
≤20 seconds	4	2.3	4	2.5	0	0.0
21-40 seconds	168	97.7	155	97.5	12	30.0
>40 seconds	0	0.0	0	0.0	0	0.0
Position of the head of the fetus at 4 hours in health facility[c]	**175**	**21.4**	**163**	**27.4**	**11**	**27.5**

5/5	2	1.1	2	1.2	0	0.0
4/5	18	10.3	17	10.4	1	9.1
3/5	50	28.6	47	28.8	3	27.3
2/5	31	17.7	29	17.8	2	18.2
1/5	24	13.7	24	14.7	0	0.0
0/5	50	28.6	44	27.0	5	45.5
Use of parthogram during labour[c]	**726**	**88.9**	**559**	**94.1**	**33**	**82.5**
Yes	555	76.4	519	92.8	32	97.0
No	171	23.6	40	7.2	1	3.0
Number of hours in maternity ward[c]	**740**	**90.6**	**527**	**88.7**	**39**	**97.5**
≤4	318	43.0	249	47.2	3	7.7
>4-8	123	16.6	112	21.3	3	7.7
>8-10	21	2.8	15	2.8	2	5.1
>10	10	37.6	151	28.7	31	79.5
Provision of pharmacological pain relief during labour[c]	**817**	**100**	**594**	**100**	**40**	**100**
Yes	10	1.2	10	1.7	0	0.0
No	807	98.8	584	98.3	40	100
Artificial augmentation of labour with oxytocin[c]	**817**	**100**	**594**	**100**	**40**	**100**
Yes	99	12.1	71	12.0	28	100
No	722	88.4	523	88.0	12	30
Reasons for artificial augmentation of labour with oxytocin[c]	**99**	**12.1**	**71**	**12.0**	**28**	**70.0**
Not enough uterine contractions	77	8.9	59	48.8	18	64.3
The cervix dilation was not progressing well	7	2.9	4	3.3	3	10.3
The fetus was not progressing well into pelvis	2	3.7	1	0.8	1	3.4
Other reasons	13	1.1	7	5.8	6	20.7
Artificial rupture of amnion done during labour[c]	**815**	**99.8**	**593**	**99.8**	**39**	**97.5**
Yes	215	26.2	202	34.1	13	33.3
No	601	73.7	391	65.9	26	66.7
Reasons for artificial rupture of amniotic membranes[c]	**215**	**26.2**	**202**	**34.1**	**13**	**33.3**
Not enough uterine contractions	54	6.6	54	21.9	5	31.3
The cervix dilation was not progressing well	8	2.2	8	3.2	1	6.3
The fetus was not progressing well into pelvis	9	3.7	9	3.6	2	12.5
The routine amniotomy	105	14.4	105	42.2	3	18.8
Completed cervix dilation	39	4.0	39	15.9	2	12.5
Episiotomy[c]	**817**	**100**	**594**	**100**	**40**	**100**
Yes	102	12.5	100	16.8	2	5.0
No	723	88.5	494	83.2	38	95.0
Reasons for episiotomy[c]	**102**	**12.5**	**100**	**16.8**	**2**	**5.0**
To protect the perineum	94	11.5	92	62.2	5	100
Routine episiotomy	5	0,6	5	3.4	0	0.0
Acute fetal distress	2	0.2	2	1.4	0	0.0
Other reasons	1	0.1	1	0.7	0	0.0
Intake of traditional drugs during labour[b]	**813**	**99.5**	**633**	**99.8**	**40**	**100**
Yes	42	5.2	41	6.5	11	27.5
No	771	94.8	592	93.5	29	27.5
Vacuum extraction[c]	**817**	**100**	**594**	**100**	**40**	**100**
Yes	10	1.2	9	1.5	1	2.5
No	807	98.8	495	98.5	39	97.5

Forceps extraction[c]	**817**	**100**	**594**	**100**	**40**	**100**
Yes	3	0.4	3	0.5	0	0.0
No	814	99.6	591	99.5	40	100.0
Indication for performed caesarean section[c]	**170**	**20.8**	**70**	**11.8**	**10**	**25.0**
Pre-eclampsia/eclampsia	2	1.2	0	0.0	0	0.0
Placenta praevia/Abnormal placenta insertion	1	0.6	0	0.0	0	0.0
Prolonged labour/dystocia	49	28.8	43	61.4	6	60.0
Acute fetal distress	6	3.5	3	4.3	1	10.0
Twin pregnancy	1	0.6	1	0.2	0	0.0
Bad presentation (not cephalic)	5	2.9	4	5.7	0	0.0
Scarred uterus	78	45.9	18	25.7	2	10.0
Post term pregnancy	16	9.4	0	0.0	1	20.0
Generally retracted pelvis	5	2.9	1	1.4	0	0.0
Other reasons	7	4.1	0	0.0	0	0.0
Preeclampia/eclampsia[c]	**817**	**100**	**594**	**100**	**40**	**100**
Yes	8	1.0	4	0.7	0	0
No	809	99.0	630	99.3	40	100
Post-partum haemorrhage[c]	**817**	**100**	**643**	**100**	**40**	**100**
Yes	22	2.7	20	3.4	0	0.0
No	795	97.3	614	96.6	40	100
Post-partum haemorrhage [c]	**809**	**99.0**	**590**	**99.3**	**39**	97.5
<500ml	785	96.1	568	96.3	39	100.0
500-1000ml	17	2.1	16	2.7	0	0.0
>1000 ml	7	0.9	6	1.0	0	0.0
	Mean value	**SD**	**Mean value**	**SD**	**Mean value**	**SD**
Mean cervical dilation (cm) at arrival to the health facility[c]	4.21	3.22	5.38	2.38	1.26	1.8
Mean cervical dilation at 4 hours in health facility[c]	8.31	1.70	8.30	1.6	8.30	2.0
Mean number of hours in maternity ward[c]	10.38	14.19	8.63	11.97	27.49	24.14

[a]Women with spontaneous start of labour or with induced labour excluding those with elective caesarean section – Self-reported data

[b]Self-reported data

[c]Medical records data

For 69% of the women who underwent CS during labour (8.7%), prolonged labour/dystocia was the indication. In total, 56.4% of pregnant women were transferred from lower level to the higher level of health care and 61.1% of all transferred pregnant women were in labour. About 68% of all pregnant women who delivered in district hospitals or in referral hospitals were transferred from lower levels of care (Table 4).

Table 4. Background factors and characteristics of labour in relation to level of health care. Test of difference between groups using Pearson's Chi-Square test (p-value)

Variable	Health centre		District hospital		Referral/Private		p-value
Maternal age (years)	n	%	n	%	n	%	
<25	62	40.5	105	25.1	70	28.7	
25-34	70	45.8	252	60.1	149	61.1	
≥35	21	13.7	62	14.8	25	10.1	**0.003**
Marital status							
Married or cohabiting	13	90.8	368	87.8	225	92.6	
Unmarried/single/widow/separated	14	9.2	51	12.2	18	7.4	0.135
Woman's education							
Completed secondary school and reached university	11	7.2	126	30.1	67	27.6	
Completed primary level	13	86.9	280	66.8	169	69.5	
No education	9	5.9	13	3.1	7	2.7	**<0.001**
ANC attendance							
Yes	14	99.3	412	99.0	217	89.7	
No	1	0.7	4	1.0	25	10.3	**<0.001**
Woman have a job							
Yes	22	14.4	118	28.2	84	34.6	
No	13	85.6	301	71.8	159	65.4	**<0.001**
Health insurance							
Yes	15	100.	408	97.6	241	98.8	
No	0	0.0	10	2.4	3	1.2	**0.182**
Woman's height (m)							
<1.50	2	3.9	19	9.6	2	1.6	
≥1.50	49	96.1	178	90.4	125	98.4	**0.010**
Woman's weight before pregnancy (kg)							
<50	15	10.1	65	16.0	26	10.9	
≥50	13	89.9	3411	84.0	213	89.1	0.080
Body mass index (BMI, kg/m²)							
<18.5	1	2.0	11	5.8	6	4.8	
18.5-24.9	39	76.5	121	63.4	80	64.0	
25-29.9	8	15.7	45	23.6	20	16.0	
≥30	3	5.9	14	7.3	14	15.2	0.098
Weight gained during pregnancy (kg)							
0 or weight decrease	9	6.5	18	4.6	16	7.0	
1-10	10	76.3	305	77.2	149	64.8	
10-20	23	16.5	67	17.0	62	27.0	
>20	1	0.7	5	1.3	5	1.3	**0.035**
Number of miscarriages							
0	13	88.9	376	89.5	220	90.2	
1	13	8.5	36	8.6	23	9.4	
2	3	2.0	7	1.7	0	0.0	
>2	1	0.7	1	0.2	1	0.4	0.538
Number of births (including the index child)							
Primiparity	54	35.3	177	42.1	103	42.4	
Multiparity	99	64.7	243	57.9	140	57.6	0.290

Number of children born at home							
0	13	87.6	387	92.1	234	95.9	
≥1	19	12.4	33	7.9	10	4.1	**0.009**
Hypertension during pregnancy							
No	14	96.7	391	93.1	235	96.3	
Yes	5	3.3	29	6.9	9	3.7	0.095
Anaemia during pregnancy							
No	12	81.0	361	86.0	210	86.1	
Yes	29	19.0	59	14.0	34	13.9	0.301
Transfer from other health facility							
Yes	6	3.9	287	68.3	167	68.4	
No	14	96.1	133	31.7	77	31.6	**<0.001**
Labour							
Spontaneous labour and vaginal delivery	14	96.7	221	52.6	164	67.2	
Spontaneous labour and delivery by caesarean section	0	0.0	44	10.5	17	7.0	
Induction of labour	2	1.3	27	6.4	11	4.5	
Caesarean section before labour	0	0.0	122	29.0	39	16.0	**<0.001**
Cervical dilation grade at arrival at health facility							
≤ 3cm	20	13.4	201	52.1	120	51.3	
4-5cm	49	32.9	71	18.4	49	20.9	
≥6cm	80	53.7	114	29.5	65	27.8	**<0.001**
Cervical dilation grade at 4 hours in the health facility							
≤3cm	0	0.0	1	1.0	0	0.0	
4-5cm	0	0.0	6	6.2	3	11.5	
≥6cm	49	100.	90	92.8	23	88.5	0.217
Duration of contractions at arrival in the health facility							
≤20 seconds	23	15.9	37	14.7	10	6.3	
21-40 seconds	12	84.1	213	84.9	150	93.8	
>40 seconds	0	0.0	1	0.4	0	0.0	**0.048**
Duration of contractions at 4 hours in the health facility							
≤20 seconds	2	4.0	1	1.0	1	3.8	
21-40 seconds	48	96.0	95	99.0	25	96.2	
>40 seconds	0	0.0	0	0.0	0	0.0	0.454
Use of partogram							
Yes	14	99.3	248	67.4	163	76.5	
No	1	0.7	120	32.6	50	23.5	**<0.001**
Pharmacological pain relief during labour							
Yes	2	1.3	6	1.4	2	0.8	
No	15	98.7	414	98.6	242	99.2	0.785
Caesarean section done during labour							
Yes	0	0.0	50	11.9	21	8.6	
No	15	100.	370	88.1	223	91.4	**<0.001**
Health provider assisting the delivery							
Nurse	12	84.5	25	6.0	3	1.2	
Midwife	23	15.5	170	41.0	130	53.3	
Doctor	0	0.0	220	53.0	111	45.5	**<0.001**
Preeclampsia/eclampsia							
Yes	2	1.3	4	1.0	2	0.8	

No	15	416	99.0	2	242	99.2	0.888
Caesarean section due to prolonged labour							
Yes	0	0.0	19	4.5	24	9.8	
No	15	100	401	95.5	220	90.2	**<0.001**
Post-partum haemorrhage							
Yes	6	3.9	13	3.1	3	1.2	
No	14	96.1	407	96.9	241	98.8	0.209
Self-rated health before pregnancy[a]							
Good	13	90.2	375	89.5	234	95.9	
Poor	15	9.8	44	10.5	10	4.1	**0.014**
Self-rated health during pregnancy[a]							
Good	10	66.0	284	67.8	177	72.5	
Poor	52	34.0	135	32.2	67	27.5	0.309
Self-rated health postpartum[a]							
Good	13	88.9	366	87.1	201	82.4	
Poor	17	11.1	54	12.9	43	17.6	0.123

[a]Poor-SRH (Poor self-rated health status) includes very poor and poor health status categories and Good-SRH (Good self-rated health status) includes very good and good health status categories.

The majority of transferred pregnant women (n=460; 62.4%) were transferred from health centres to a district hospital (Figure 1) with "CS" (12.5%) or scarred uterus (3.7%), or to ensure "better management" (26.7%) as the main reasons of transferral.

Table 3 presents background characteristics related to course of labour and delivery for all pregnant women who started labour spontaneously or whose labour was induced. A parthogram was used during labour for almost all women who delivered at health centres, but a parthogram was only used by 67% of the district hospitals (Table 4). Table 4 presents background characteristics related to course of labour and delivery in relation to health care level. In total, 44.3% of pregnant women arrived at a health facility with a cervical dilation grade ≤3 cm, 22% with cervical dilation grade between 4-5cm, and 31.7% with cervical dilation grade ≥6cm (Figure 1). Pregnant women who arrived at the a health facility with a cervical dilation grade ≤3 cm spent more hours in maternity ward (mean value 16.40 hours; SD 18.26) compared to those who arrived with a cervical dilation grade of 4-5 cm (7.27; 6.93) (t- test; p<0.001) and

those who arrived with cervical dilation grade of ≥6cm (3.51; 5.96) (t- test; p<0.001) (Figure 2).

Pregnant women who arrived at a health facility with a cervical dilation grade ≤3 cm and who did not receive oxytocin during labour spent more hours in a maternity ward (mean value 27.89 hours; SD 26.83) compared to those who arrived with a cervical dilation grade ≤3 cm and who received oxytocin during labour (14.38; 15.27) (t-test; p=0.001) (Figure 3). There was no statistical difference (t-test) between pregnant women who arrived at a health facility with cervical dilation grade of 4-5 cm or cervical dilation grade ≥6 cm and who did or did not receive oxytocin during labour (p=0.094 and p=0.070, respectively).

Prevalence of pregnancy-related complications

The prevalence of hypertension upon arrival to the health facility was 13.8%. The prevalence of eclampsia/pre-ecalmpsia, post-partum haemorrhage and CS due to prolonged/dystocia labour was 1%, 2.7%, and 5.4% of all pregnant women respectively, and prolonged/dystocia labour represented 28.8% of all indication for CS.

Factors associated with caesarean section due to prolonged labour/dystocia

In bivariable analysis, household monthly income less than 36,000 RWF (45 USD), distance from home to a health facility >1 km, and cervical dilation grade <6 cm upon arrival to a health facility were statistically significant factors associated with CS due to prolonged labour/dystocia. In multivariable analysis, the same background factors

and nulliparity were statistically significantly associated with CS due to prolonged labour/dystocia (Table 5).

Table 5. Bivariable and multivariable logistic regression analyses with calculation of Crude Odds ratios (COR) and their 95% confidence intervals (CI) for caesarean section due to prolonged labour/dystocia in relation to specified background variables

Variable	Caesarean section due to prolonged labour/dystocia							
	Bivariable analysis						Multivariable analysis	
	Yes		No					
Maternal age (years)	**N**	**%**	**N**	**%**	**Crude OR**	**95% CI**	**Crude OR**	**95% CI**
<25	13	5.5	224	94.5	1		1	
25-34	28	5.9	443	94.1	0.91	0.46-1.80	0.67	0.30-1.48
≥35	2	1.9	106	98.1	0.29	0.70-1.27	0.40	0.09-1.80
Marital status								
Married or cohabiting	41	5.6	690	94.4	1			
Unmarried or single or widow or separated	2	2.4	81	97.6	0.41	0.09-1.75		
Women's education								
Completed secondary level or reached university level	13	6.4	191	93.6	1			
Completed primary level	29	5.0	553	95.0	0.77	0.92-1.51		
Never attended school	1	3.4	28	96.6	0.52	0.06-4.16		
Woman's employment								
Employed	37	5.4	654	94.6	1			
Not employed	6	5.5	102	94.5	1.03	0.42-2.50		
Number of births								
Multiparity	12	2.7	434	97.3	1		1	
Primiparity	1	2.9	34	97.1	1.03	0.13-8.18	**3.79**	**1.79-8.01**
Number of previous children delivered at home								
None	40	5.3	715	94.7	1			
1 or more	3	4.8	59	95.2	0.90	0.27-3.02		
History of miscarriages								
No	37	5.6	621	94.4				
Yes	5	6.6	71	93.4	1.18	0.45-3.10		
HIV status								
Negative	42	5.5	723	94.5	1			
Positive	1	1.9	51	98.1	2.96	0.40-		
Health Insurance								
Yes	42	5.2	760	94.8	1			
No	1	7.7	12	92.3	1.50	0.19-		
Household monthly income								
≥36,000 RWF	11	10.9	90	89.1	**1**		1	
<36,000RWF	32	4.8	641	95.2	**2.44**	**1.19-5.02**	**4.86**	**2.08-11.35**
Distance to the health facility								

≤1km	32	7.2	413	92.8	1		1	
>1km	11	3.0	358	97.0	**2.55**	**1.25-5.07**	**3.30**	**1.53-7.11**
Antenatal care visit								
Yes	41	5.3	737	94.7	1			
No	1	3.3	2996.		1.61	0.21-		
Anaemia during pregnancy								
No	39	5.6	656	94.4	1			
Yes	4	3.3	118	96.7	0.57	0.20-1.62		
Bad smelling during pregnancy								
No	42	5.8	683	94.2	1			
Yes	1	1.1	91	98.9	0.17	0.02-1.31		
Transfer from another health facility								
No	14	3.9	343	96.1	1			
Yes	29	6.3	431	93.7	1.64	0.85-3.16		
When transferred								
Before start of labour	7	3.9	172	96.1	1			
During labour before delivery	22	7.8	259	92.2	2.08	0.87-4.99		
Cervical dilation grade at arrival to health facility								
≤3cm	28	8.2	313	91.8	**4.54**	**1.73-**	**6.17**	**2.20-17.28**
4-5cm	10	5.9	159	94.1	**3.19**	**1.07-9.51**	**4.03**	**1.27-12.71**
≥6cm	5	1.9	254	98.1	1		1	
Woman's weight (kg)								
<50	5	4.7	101	95.3	1.11	0.42-2.91		
≥50	36	5.2	651	94.8	1			
Self-rated health before pregnancy[a]								
Good	42	5.6	705	94.4	1			
Poor	1	1.4	68	98.6	0.24	0-03-.82		
Self-rated health during pregnancy[a]								
Good	39	6.9	523	93.1	1		**1**	
Poor	4	1.6	250	98.4	**0.21**	**0.07-0.60**	**0.22**	**0.07-0.65**

[a]Poor-SRH (Poor self-rated health status) includes very poor and poor health status categories and Good-SRH (Good self-rated health status) includes very good and good health status categories.

DISCUSSION

In this study, we found that the prevalence rates of health facility-based pre-eclampsia/eclampsia and post-partum haemorrhage were very low (1% and 2.7%, respectively). CS was the main reason for transfer of women from health centres to district hospitals, and dystocia/prolonged labour was the main indication for CS. Furthermore, risk factors for having a CS due to prolonged labour included living in a poor household, nulliparity, and residence far from a health facility.

The estimated prevalence rates of self-reported pregnancy-related health problems during pregnancy - i.e., anaemia, severe vaginal bleeding, hypertension, and diabetes mellitus - were comparable to results from other studies. Previously, self-reported anaemia for women of reproductive age in Rwanda have been found to be of a similar size as in our study.[20] In addition, self-reported post-partum anaemia investigated in China is comparable to our findings,[21] and sub-Saharan African prevalences of gestational diabetes mellitus are also similar to the range found in our study.[9 22] The estimated prevalence rates of pregnancy-related complications preeclampsia/eclampsia and post-partum haemorrhage were very low compared to previous publications.[8 23 24] For example, in other low and middle income sub-Saharan African countries the prevalence of pre-eclampia is estimated to be three times higher than our result.[8] In referral hospitals in Rwanda and Uganda, post-partum haemorrhage is ten times more common than estimated in our study.[23 24] Possible explanations for these differences may be due to misclassifications by health care providers. For example pre-eclampia may have been incorrectly classified as other hypertensive disorder during pregnancy, or received non-classification. Another explanation of these differences is that we only included survivors of pregnancy-related complications so we underestimated the true prevalence of a condition if a number of women actually died from these complications. In a tertiary care level hospital in Rwanda, post-partum heamorrhage and pre-eclampsia/eclampsia represent a case fatality rate of 22% and 16%, respectively.[23] Health providers may have underreported post-partum haemorrage cases after having managed to stabilise the woman because they mis-evalueted the quantity of blood loss. Other explanation may be that health care providers have not been able to evaluate total blood loss adequately because the woman was transferred from another health facility. Moreover, some

physicians may not want to report postpatum haemorrage to avoid audit problems because in health centres and district hospitals in Rwanda such cases are under high surveillance as the Ministry of Health has introduced maternal death audits.[25]

The majority of referred pregnant women were transferred from health centres to district hospitals. Most of pregnant women who gave birth in district and referral hospitals were transferred women from a lower level of health care. These results are in the line with the pyramidal composition of the Rwandan health system where a large number of cases are managed at lower levels of health care (i.e. health centres), and only complicated cases are referred to the next level of health care.[18] In about one-third of cases a parthogram was not used to monitor labour in pregnant women delivering in district and in referral hospitals. This result is low compared to WHO recommendations of using parthograms for all women in labour monitoring, although it is comparable to the results obtained in Uganda.[26 27]

CS was the main reason for being transferred, and previous studies show that in sub-Saharan Africa transfer of pregnant women in labour is always associated with risk of delay due to lack of transportation and bad roads, a situation that increases risks of additional complications such as maternal fistula or even foetal death.[28 29] Up-grading the capacity of health centres in management of pregnant women with special focus on management of prolonged labour/dystocia and performing CS may decrease the number of maternal transfers, prevent risks related to prolonged labour, and allow district hospitals to receive fewer cases, enabling the district hospitals to spend more time focusing on other pregnancy-related complications. The use of newly trained clinical officers in Rwandan health centres, a strategy used in other middle and low income sub-Saharan countries, may be of significance as it has been shown that there

are few differences in clinical outcomes after CS performed by clinical officers or physicians.[30 31] In this study, the CS rate was almost two times higher than the national rate and higher than the recommended WHO rate but the CS rates was in the range of CS rates in Kigali hospitals.[15 23 32]

Being a poor household located far from a health facility was a statistically significant factor associated with CS due to prolonged labour/dystocia. This finding agreed with previous studies reporting a statistical association between prolonged labour and low socio-economic level and being a pregnant woman living in a rural area.[33] Poor roads and long distance to a health facility are risk factors for prolonged labour/distocia.[29] Arriving at a health facility with cervical dilation grade of less than 6 cm and being nulliparious were factors associated with CS due to prolonged labour/dystocia. It has been reported previously that less advanced cervical dilation grade at admission and nulliparity are risk factor for prolonged labour.[33 34]

CONCLUSIONS

The hospital-based prevalence rates of preeclampsia/eclampsia, post-partum haemorrhage, and CS due prolonged labour/dystocia were low in this sample from Rwanda. The majority of pregnant women delivering in district hospitals were women transferred from health centres, and caesarean section was the main reason for being transferred. Up-grading the capacity of Rwandan health centres by using clinical officers may decrease the number of maternal transfers due to CS and prevent risks related to prolonged labour, allowing district hospitals to receive fewer cases and more effectively focus on other pregnancy-related complications.

COMPETING OF INTEREST

The authors declare no competing interests.

AUTHORS' CONTRIBUTIONS

JPSS participated in the design of the study and the development of the study tools, data collection in the field. JPSS performed the data analysis, wrote the manuscript and approved the final version of the manuscript.

GK participated in the design of the study and the development of the study tools, drafting of the manuscript, and approved the final version of the manuscript.

MN participated in the design of the study and the development of the study tools. He participated in data collection in the field, drafting of the manuscript, and approved the final version of the manuscript.

CM participated in the design of the study and the development of the study tools. He participated in data collection in the field, drafting of the manuscript, and approved the final version of the manuscript.

KE participated in the design of the study and the development of the study tools, drafting of the manuscript, and approved the final version of the manuscript.

IM participated in the design of the study and the development of the study tools. IM supervised the data analysis and the manuscript writing and approved the final version of the manuscript.

DATA AND MATERIALS SHARING

The datasets used and analyzed during the current study will be available from the corresponding author upon receiving a reasonable request.

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Figure 1. Type of health facility where participants were transferred, cervical dilation grade upon arrival at health facility, and description of delivery

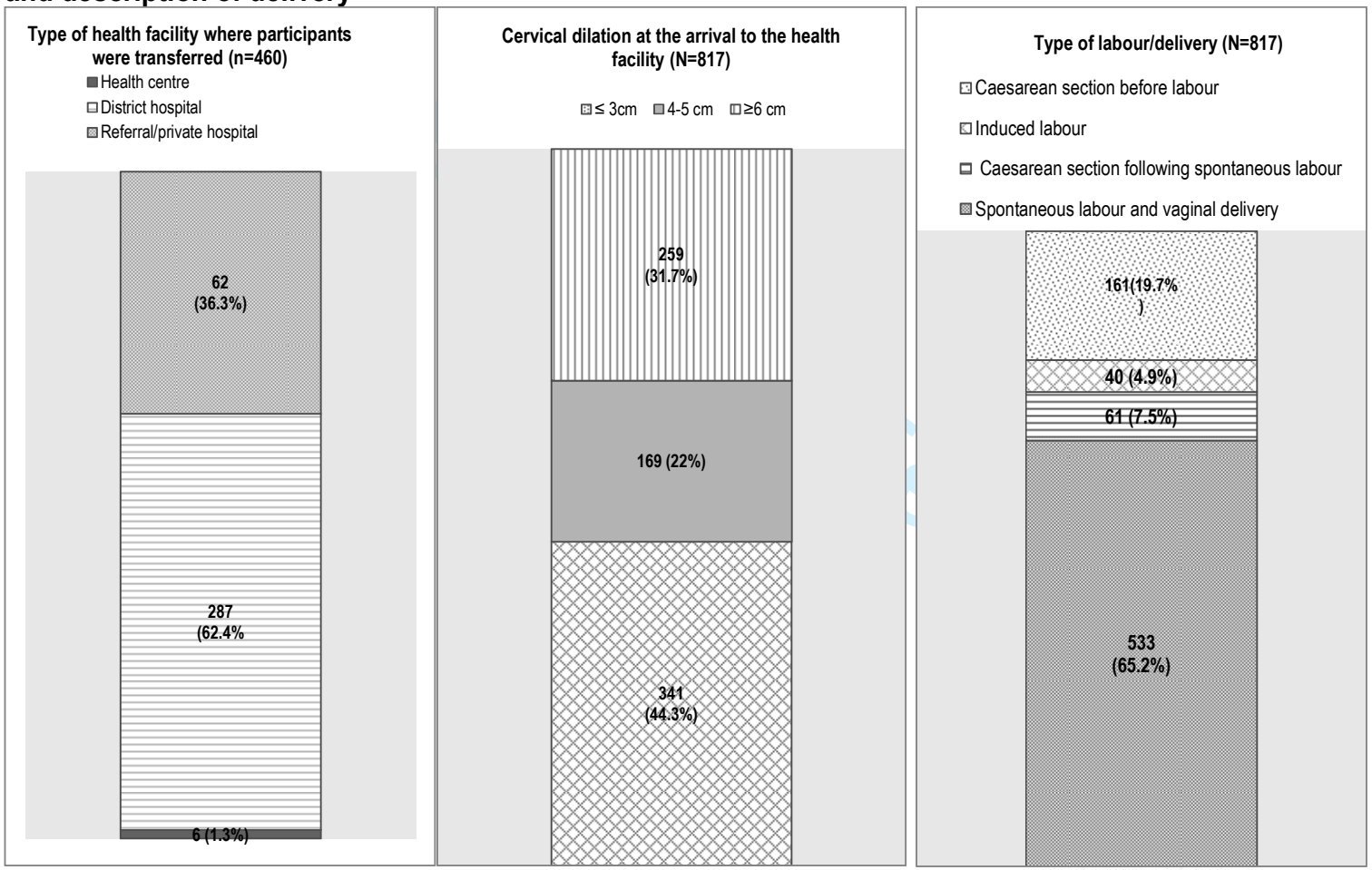


Figure 2. Frequency of participants in relation to the number of hours in the maternity ward until delivery and in relation to category of grade of cervical dilation at arrival to health facility

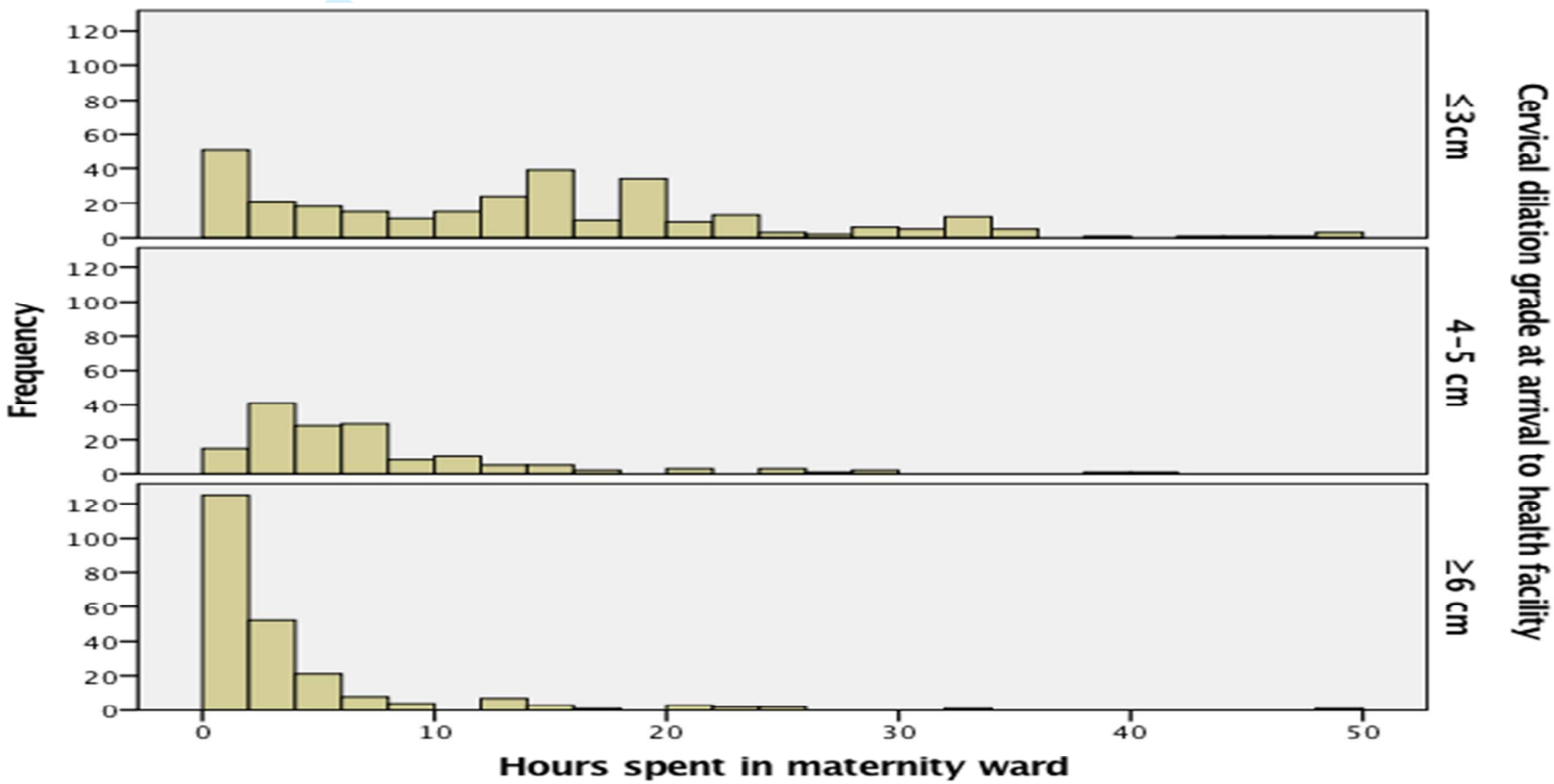
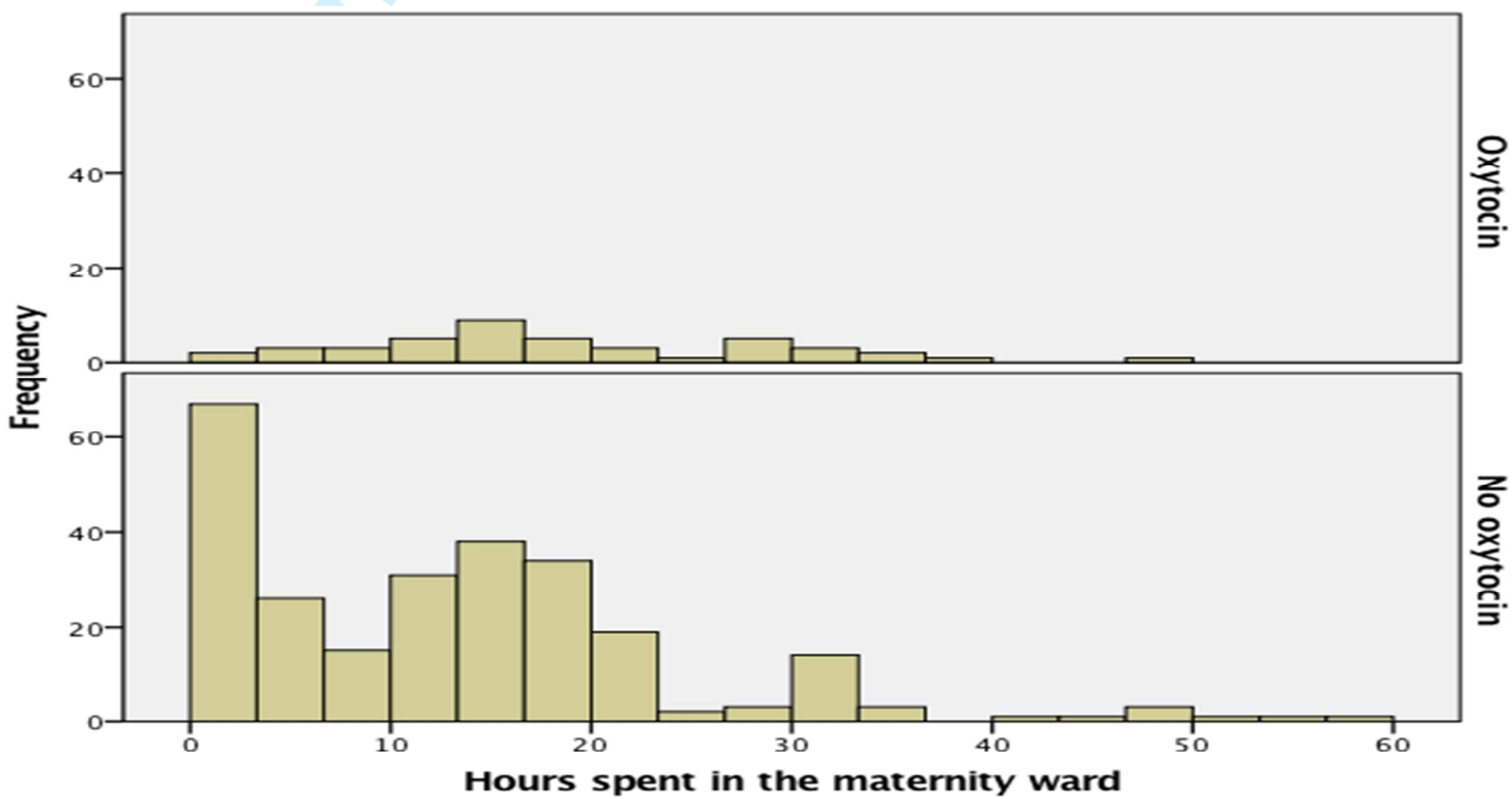


Figure 3. Frequency of participants in relation to the number of hours in the maternity ward until delivery and in relation to use (n=49) or non-use of oxytocin (n=292) for participants with cervical dilation grade of ≤3 cm upon arrival to the health facility



STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2 and 7
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6,7 and 8
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	8
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5, 9, 10 and 11
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	9,10 and 11
Bias	9	Describe any efforts to address potential sources of bias	*3 and 7*
Study size	10	Explain how the study size was arrived at	7 and 8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	11 and 12
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	11 and 12
		(*b*) Describe any methods used to examine subgroups and interactions	11 and 12
		(*c*) Explain how missing data were addressed	11 and 12
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	11 and 12
		(*e*) Describe any sensitivity analyses	11 and 12
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7 and 8
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	13-15
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	25-26
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	25-26
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	26-27
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	26-27
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	29
Generalisability	21	Discuss the generalisability (external validity) of the study results	29
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Health facility-based prevalence of pregnancy-related complications and course of labour of women who gave birth in selected health facilities in Rwanda

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Health facility-based prevalence of pregnancy-related complications and course of labour of women who gave birth in selected health facilities in Rwanda

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Abstract

Objectives

This study estimated hospital-based prevalence for pre-eclampsia/eclampsia, post-partum haemorrhage, and caesarean section (CS) due to prolonged labour/dystocia. Background characteristics of Rwandan pregnant women, course of labour and level of health care were investigated in relation to pregnancy and delivery outcomes.

Methods

This is health facility-based study and data were collected in 2014/2015 through structured interviews and medical records (N=817), in Kigali and the Northern Province of Rwanda. Frequencies and prevalence were used to describe participants' background factors, labour and delivery-related characteristics. Bivariable and multivariable logistic regression models were performed for different background factors and pregnancy/delivery outcomes.

Results

Pre-eclampsia/eclampsia, post-partum haemorrhage, and CS due to prolonged labour/dystocia represented 1%, 2.7% and 5.4% of all participants, respectively. In total, 56.4% of participants were transferred from low level to higher level of health care, and the majority, were transferred from health centres to district hospitals with CS as the main reason of transfer. Participants who arrived to the health facility with cervical dilation grade of ≤3 cm spent more hours in maternity ward compared to those who arrived with cervical dilatation grade of ≥4 cm. Risk factors for CS due to prolonged labour or dystocia were poor households, nulliparity, and residence far from health facility.

Conclusions

The estimated hospital-based prevalence of pregnancy-related complications was relatively low in this sample from Rwanda. Caesarean section was the main reason for transferral of pregnant women from health centres to district hospitals. Upgrading the capacity of health centres in the management of pregnant women in Rwanda may improve maternal and fetal health.

Keywords: Prevalence, health facility, pregnancy, pregnancy complications, labour, delivery, Rwanda

STRENGTHS AND LIMITATIONS OF THIS STUDY

- All eligible women consented to participate in the study
- Female professional interviewers with nursing and midwifery background who were not working at the selected health facilities were employed to make female pregnant women feel comfortable while responding to questions.
- There may be under-reporting of the prevalence of complications related to pregnancy, for example in a case of maternal deaths occurring in the community
- There may also be under-reporting of cases and physicians's diagnosis of pregnancy-related complications not following the pre-established guidelines due to insufficient knowledge or misinterpretation or lack of time due to heavy workload and lack of necessary equipment for management of complicated pregnancies.
- There may be over-reporting in relation to the population-based prevalence due to selection bias, as cases with complications are aggregated in hospitals for more advanced level of health care

BACKGROUND

Although pregnancy is usually a planned and happy event, some pregnancies end tragically with maternal and/or foetal/child death or cause severe maternal and/or child impairment.[1] In 2013, about 300,000 maternal deaths occurred worldwide, and every year more than one and half million women suffer from pregnancy-related complications during pregnancy and delivery worldwide.[2 3] The most common pregnancy-related complications are maternal haemorrhage, maternal sepsis, abortion, hypertensive disorders (pre-eclampsia, eclampsia, and pregnancy-induced hypertension), and obstructed labour.[4 5] Maternal haemorrhage is the leading cause of maternal mortality and represents 33.9% of all maternal deaths in Africa.[6] The prevalence of post-partum haemorrhage (PPH) in the world is approximately 6%.[7] In Uganda, between 2013-2014, the incidence of PPH was 9%, while the prevalence of maternal haemorrhage was estimated to 19.3% in Rwandan referral hospitals.[8 9] According to the World Health Organization (WHO), hypertensive disorders during pregnancy account for 9% of maternal mortality in Africa and Asia.[5 10] Preeclampsia, characterized by hypertension and proteinuria, complicates about 3-5% of pregnancies worldwide.[10] Preeclampsia can develop into eclampsia, characterized by seizures that may become potentially fatal for both mother and fetus.[11] In 2013, the prevalence of preeclampsia/eclampsia the East African region (i.e. Democratic Republic of Congo, Kenya and Uganda) was 1.02%, 2.27% and 1.15% respectively.[12]

Prolonged labour or obstructed labour occur when the fetus does not progress into the birth canal despite strong uterine contractions.[13] Obstructed labour represents 8% of maternal deaths globally.[1] In 2011, the incidence of obstructed labour was estimated to 3.7% in Rwanda, and 12.2% in Ethiopia in 2010.[14 15]

During the last decade, Rwanda has made significant improvements in maternal health.[16] In 2015, Rwanda reported a maternal mortality ratio of 210 per 100,000 live births and is one of few African countries that has managed to fulfil the 5th Millennium Development Goal (MDG5) of reducing maternal mortality by over 75% between 1990 and 2015.[17 18] There are some few studies in Rwanda that have investigated abortion and post abortion care, antenatal care (ANC), use of community health workers and rapid-SMS to promote ANC and childbirth attendance.[16 19 20] However, the literature is limited on course of labour, and pregnancy-related complications in Rwanda.

This study aims to fill the knowledge gap in this area and to serve as documentation for policy-makers for improvement of women's intra-partum and post-partum health status.

In Rwanda's national guidelines, preeclampsia is defined as blood pressure of ≥140/90 mm Hg after 20 weeks of gestation plus proteinuria of 300 mg per 24 hours or >2+ on a urine dipstick.[21] Furthermore, eclampsia is defined as onset of convulsion/generalized seizures in a woman with pre-eclampsia that cannot be attributed to other causes.[21] Post-partum haemorrhage is defined as blood loss of more than 500 ml after vaginal delivery or 1,000 ml after caesarean delivery or excessive vaginal bleeding resulting in signs of hypovolemia or a 10% decline in post-partum hemoglobin concentration from antepartum levels.[21] Dystocia/prolonged labour is defined as difficult labour or an abnormally slow progression of labour.[21]

This study is part of the Maternal Health Research Programme (MaTHeR) undertaken by the University of Rwanda in collaboration with University of Gothenburg and Umeå University in Sweden.

AIMS

This study's overall aim was to determine the hospital-based prevalence of pregnancy-related complications (pre-eclampsia/eclampsia, post-partum haemorrhage and prolonged labour or obstructed labour or dystocia labour resulting in a caesarean section) and to describe the course of labour and the background characteristics of women giving birth in selected Rwandan health facilities.

Specific aims were:

- To estimate the hospital-based prevalence of *i)* pre-eclampsia and eclampsia, *ii)* post-partum haemorrhage, and *iii)* prolonged labour or obstructed labour or dystocia labour resulting in a caesarean section.
- To describe the course of labour from the time of arrival to a health facility until delivery, and describe characteristics related to the course of labour and delivery in relation to the level of health care.
- To describe background characteristics of women who give birth in Rwandan health facilities and to describe these characteristics' associations with pregnancy outcomes.

METHODS

The study setting

The Rwandan public health system is composed of health posts, health centres, district hospitals, military hospitals, provincial hospitals, and referral hospitals.[22] A

health centre is the lowest level of health care, where pregnant women with uncomplicated pregnancy receive health care. Complicated cases are referred to higher levels of health care, such as district, provincial and referral hospitals.[23] Health centres are mainly staffed by A2 nurses (enrolled nurses with secondary level of education).[24] Private health care is available in Kigali and other large cities in Rwanda in the form of private dispensaries, private clinics, and private hospitals. Only large private hospitals provide assisted delivery.[22] This study was conducted in Kigali city and the in Northern province of Rwanda, and included eight health centres, seven district hospitals, one provincial hospital, one referral hospital and one private hospital.

This study used self-reported data from women in post-partum and data from medical records.

This study used diagnoses made by physicians from patient's medical records. Physician's diagnoses were presumed to be based on definitions and guidelines of pregnancy, labour, and delivery related problems, pre-established by the Rwandan Ministry of Health.[21]

Study design and recruitment of study participants

This was a comprehensive cross-sectional health facility-based study. During 2013, there were in total 67,077 vaginal deliveries in Kigali city and the Northern province of Rwanda, and 28,786 of these (42%) occurred in Kigali city and 38,292 (58%) in the Northern province. Eighteen health facilities (10%) with a high number of vaginal deliveries were selected (eight health facilities in Kigali and ten in the Northern Province), selecting at least one health facility with large number of vaginal deliveries

in each district of eight districts of Kigali city and the Northern Province. The sample size of 817 women was calculated based on the estimation of the prevalence of CS of 14.8% in Rwanda in 2013, [25] with an absolute precision of 5%, and with about 10% of non response. The target population were women who delivered in the selected health facilities during the time of the data collection, i,e. from 2 December 2014 to 26 January 2015. The number of participants to be selected in each health facility was determined proportionally relative to the number of vaginal deliveries that occurred in each selected health facility in 2013, i.e. the year before the data collection. This means that health facilities with high numbers of deliveries contributed with higher numbers of selected participants. The heads of the selected health facilities facilitated contact with the heads of the maternity wards at each selected health facility. With the support of the heads of maternity wards, delivered women who were about to be discharged during the data collection period were invited to participate in the study. Before the individual interviews, information about the study was provided to the eligible participants. All invited participants signed a written consent form before their participation in the study. Most of the time, data collection was performed on several occasions (i.e. on more than one day), in order to fulfil the predefined number of participants from each selected health facility.

Data collection procedures

A structured questionnaire was developed by the study team and included questions about socio-demographic background characteristics such as age, marital status, educational level, information on previous pregnancies and the last pregnancy with additional information on outcomes of labour and delivery. The questionnaire was translated from English into Kinyarwanda. The questionnaire was piloted at one non-

selected district hospital and its two health centres located in the Southern Province of Rwanda. After the pilot study no major changes were made in the questionnaire apart from a few adjustments in wording to improve clarity. A group of eight experienced interviewers (nurses and midwives), working only as data collectors and not working as an health professional at any of the selected health facilities during the data collection period, collected data through individual structured interviews under the supervision of the supervisory team of this research (JPSS, MN and CM). Data entry was performed by three skilled personnel. After the primary data entry the first author re-registered 81 questionnaires, corresponding to approximately 10% of the total study sample, each including 285 variables used in this study, to check the accuracy of the first data entry. The results of this re-registration showed 138 errors, corresponding to an error rate of 0.59% (138/23,085). The erroneous data were corrected.

Descriptions of variables

Variables related to pregnancy outcomes

Binary variables were *post-partum haemorrhage* and *preeclampsia/*eclampsia, which was a combination of the variables *pre-eclampsia before labour, eclampsia before labour, pre-eclampsia during labour, eclampsia during labour, pre-eclampsia post-partum, and eclampsia post-partum.* These variables were collected from medical records, from diagnoses made by physicians. The dichotomized variable *caesarean section due to prolonged labour or dystocia,* was created from the variable *what was the main indication of caesarean section* and this was collected from medical records as this is where physicians noted the indication of a *caesarean section.*

Variables related to socio-demographic factors

Maternal age, was a continuous numerical variable was divided into the following categories; <20 years, 20-24 years, 25-29 years, 30-34 years, 35-39 years and ≥40 years. *Maternal age* was also categorized into 3 categories, i.e. <25 years, 25-34 years and ≥35 years. *Marital status* included married, cohabiting, separated or divorced, widowed, and unmarried or single. *Marital status* was dichotomized into married or cohabitating where single, divorced, or widowed were collectively categorized as the exposure category. *Education* included never attended school, primary level not completed, primary level completed, vocational training, secondary level not completed, secondary level completed and tertiary level. Education was grouped into three categories: never attended school, completed primary level, completed secondary school and reached tertiary university level. *Occupations* included student, unskilled worker, skilled worker, civil servant, not employed, and other employment; these were dichotomized as employed and non-employed. For each variable about main health problems during pregnancy, data were collected for the first, second, and the third trimesters. *First trimester* referred to the first three months of the pregnancy. *Second trimester* referred to four to six months of pregnancy. *Third trimester* referred to seven months or more. The variables *anaemia* and *hypertension* during the first, second, and third trimester were combined to become *anaemia during pregnancy*, and *hypertension during pregnancy,* respectively. *Hypertension* was defined as blood pressure of ≥140/90 mm Hg [21].

Variables related to course of labour and delivery

The binary variables *intake of traditional medicines during pregnancy* and *transfer from another health facility* were the only labour and delivery self-reported variables. Others variables were collected from the medical records. *Number of hours in maternity ward* was a calculated variable using *time of admission* at the maternity ward and *time of delivery*. It was categorized into ≤4 hours, >4-8 hours, >8-10 hours, and >10 hours. *Foetal presentation* included cephalic, breech, face, transverse, and other presentations. *Period when transferred* was a variable that included transferred before labour started and transferred during labour before delivery. *Cervical dilation grade at arrival to the hospital* and *cervical dilation grade at 4 hours in the hospital* were continuous numerical variables that were categorized into ≤3 cm, 4-5 cm, and ≥6 cm. *Number of contractions at arrival* and *number of contractions* after four hours in the hospital included 0, 1, 2, 3 or more contractions. *Duration of contractions/ ten minutes at arrival to the hospital* and *duration of contractions at four hours in hospital* included ≤20 seconds, 21-40 and >40 seconds. There were other binary variables such as *spontaneous rupture of membranes*, *use of parthogram during labour*, *provision of pharmacological pain relief during labour*, *artificial rupture of membranes*, *artificial augmentation of labour with oxytocin*, *episiotomy done*, *vacuum extraction* and *forceps extraction*.

Statistical analysis

Frequency and prevalence (n and %) were used to describe participants' socio-demographic and reproductive history characteristics, self-reported pregnancy-related problems, and delivery-related characteristics including the features of course of the

labour. Cohen's kappa was calculated to assess concordance between responses from self-reported data and data from medical records.

Pearson's Chi-Squared test and Fisher's exact test were used for bivariable analyses. The adjustment for multiple comparisons was made by using the Holm-Bonferroni method.[26] The continuous variable "number of hours in maternity ward" was not normally distributed, wherefore Wilcoxon test was used to compare medians of the number of hours spent in maternity wards for women who arrived at health facility with a cervical dilation grade of ≤3 cm, and those who arrived with a cervical dilation of 4-5 cm, and those who arrived with a cervical dilation of ≥6 cm. This study identified the factors associated with CS due to prolonged labour/dystocia using bivariable logistic regression analysis. Statistically significant variables that were associated with CS due to prolonged labour/dystocia were considered for the final logistic regression model. Then a multivariable logistic regression model was built that calculated odds ratios (OR) and their 95% confidence intervals (CI). In the multivariable model, forward stepwise regression was used, and all statistically significant variables in bivariable analyses were entered one at a time to identify factors that were associated with CS due to prolonged labour/dystocia, keeping in the final model only factors that were statistically significant ($p<0.05$). All multivariable models included parity and women's age for theoretical reasons as other studies have shown these variables to be associated with CS due to prolonged labour/dystocia.

Because no variable was highly correlated ($r\geq0.40$), no variable was excluded in the final model. Two dependent variables (post-partum haemorrhage and preeclampsia/eclampsia) demonstrated a very low number of cases n=22 (2.7%) and n=8 (1.0%), respectively so no further analysis was possible.

ETHICAL CONSIDERATIONS

Participation in this study was voluntary. Before the interviews, participants were verbally informed in detail about the aims of the study and the content of the questionnaire. They were ensured about the confidentiality of their responses, and reminded that they could withdraw from the study at any time of the interview or thereafter. To assure confidentiality, the interview was conducted in privacy. All selected participants signed a written consent form before their participation in the study. This study was conducted according to the guidelines established by the Declaration of Helsinki.[27] The research protocol and the study questionnaire were approved by the University of Rwanda, College of Medicine and Health Sciences Institutional Review Board (Ref: 010/UR/CMHS/SPH/2014). Before the data collection, authorization to conduct the study was obtained from the Ministry of Health in Rwanda (Ref: 20/4029/MCH/2014).

RESULTS

Socio-demographic and reproductive history characteristics

In total, 817 women (16 to 44 years old, with a mean age of 27.8 years), participated in the study. Married women represented 49.9% of participants and 40.0% of the women were cohabiting and 8.6% were single. The proportion of primiparous women was 41.1%; multiparous women with two to four births were 54.7%; and multiparous of more than five births were 4.3%. Frequencies and percentages of socio-

demographic and reproductive history characteristics of participants are presented in Table 1.

Cohen's kappa was 0.74 for the concordance between responses from self-reported data and data from medical records.

Table 1. Socio-demographic and reproductive history characteristics of participating women (N=817)

Participants (pregnant women):		
Variable	**Mean age (years)**	**SD[a]**
Mean maternal age	27.83	5.57
Woman's mean number of years of education	7.67	4.18
Partner mean age (years; SD)	32.77	6.52
Partner's mean number of years of education (years; SD)	8.97	4.23
	N	**%**
Maternal age in age group (years)	**816**	**99.0**
<20	46	5.6
20-24	191	23.4
25-29	250	30.6
30-34	221	27.1
35-39	90	11.0
≥40	18	2.2
BMI[b] calculated	**367**	**44.9**
<18.5	18	4.9
18.5-24.9	240	65.4
25-29.9	73	19.9
≥30	36	9.8
Woman's height (m)	**375**	**45.9**
<1.50	23	6.1
≥1.50	352	93.9
Woman's weight before pregnancy (kg)	**793**	**97.1**
<50	106	13.4
≥50	678	86.6
Marital status	**814**	**99.6**
Single or unmarried	70	8.6
Widowed	2	0.2
Separated or divorced	11	1.4
Cohabiting	326	40.0
Married	406	49.9
Religion	**814**	**99.6**
Catholicism	220	27.0
Protestantism	439	53.9
Adventist	92	11.3
Islam	25	3.1

Other religion	31	3.8
No religion	7	0.9
Education	**815**	**99.8**
No education	29	3.6
Primary level, not completed	219	26.9
Primary level, completed	187	22.9
Secondary school, not completed	61	7.5
Secondary school, completed	115	14.1
Vocational training	83	10.2
Tertiary, university level	121	14.8
Occupation	**800**	**97.9**
Student	33	4.1
Non-skilled worker	470	58.8
Skilled worker	60	7.5
Civil servant	99	12.4
Not employed	109	13.6
Other employment	29	3.6
Number of births (including index birth)	**816**	**99.9**
1	335	41.1
2	213	26.1
3	155	19.0
4	78	9.6
≥5	35	4.3
Number of previous children delivered at home	**817**	**100**
0	756	92.5
1	33	4.0
2	15	1.8
3	8	1.0
≥4	5	0.6
Number of previous miscarriages	**817**	**100**
0	732	89.6
1	72	8.8
2	10	1.2
≥3	3	0.4
Woman's HIV status	**817**	**100**
Negative	765	93.6
Positive	52	6.4
ANC visits	**817**	**100**
Yes	812	99.4
No	5	0.6
Number of ANC visits	**812**	**99.4**
1 visit	67	8.3
2 visits	153	18.8
3 visits	259	31.9
4 visits	231	28.4
≥5	102	12.6
Partner to participant		
Partner's age in group (years)	**730**	**89.4**

<25	50	6.8
25-29	207	28.4
30-34	198	27.1
35-39	172	23.6
≥40	103	14.1
Partner's education	**728**	**89.1**
No education	35	4.8
Primary level, not completed	119	16.3
Primary level, completed	144	19.8
Secondary school, not completed	44	6.0
Secondary school, completed	164	22.5
Vocational training	84	11.5
Tertiary, university level	138	19.0
Household information		
Health insurance	**814**	**99.6**
No insurance	13	1.6
Community health based insurance	650	79.9
Public insurance (RAMA, MMI, MIS/UR)[c]	135	16.6
Other private	16	2.0
Household income per month	**772**	**94.5**
<17,500 RWF	32	4.1
17,500-35,999 RWF	68	8.8
36,000-99,999 RWF	231	29.9
100,000-199,999 RWF	213	27.6
200,000-499,999 RWF	163	21.1
>500,000 RWF	65	8.4
Distance from home to the nearest health facility (km)	**814**	**99.6**
<1	445	54.7
2-5	289	35.5
6-10	64	7.9
≥10	16	2.0

[a]SD=Standard deviation
[b]BMI=Body Mass Index (kg/m^2)
[c]RAMA=La Rwandaise d'Assurance Maladie, MMI= Military Medical Insurance, MIS/UR= Medical Insurance of University of Rwanda

Self-reported health problems during pregnancy

Prevalence of anaemia, severe vaginal bleeding, hypertension, and diabetes mellitus during pregnancy were 14.9%, 5.6%, 5.3%, and 0.2%, respectively. Prevalence of self-reported pregnancy-related health problems during pregnancy are presented in Table 2.

Table 2. Prevalence of self-reported pregnancy-related problems in 1st, 2nd, and 3rd trimesters[a] of pregnancy, and the cumulative prevalence[b]

[a] The first trimester represents the first 3 months of the pregnancy, the second trimester represents 4 to 6 months and the third trimester was defined as 7 months or more of pregnancy

[b] The third trimester do not include events or complications during delivery

Variable	1st trimester[a]		2nd trimester		3rd trimester		Cumulative prevalence	
	N	%	N	%	N	%	N	%
Hypertension	17	2.1	8	1.0	25	3.1	43	5.3
Convulsions	12	1.5	3	0.4	3	0.4	15	1.8
Diabetes mellitus	2	0.2	1	0.1	0	0	2	0.2
Bad smelling of vaginal discharge	60	7.4	40	4.9	47	5.8	92	11.3
Anemia	77	9.4	70	8.6	43	5.3	122	14.9
Severe vaginal bleeding	30	3.7	14	1.7	3	0.4	46	5.6
Abdominal pain and severe bleeding			2	0.2	4	0.5	6	0.7
Fever			21	2.6	35	4.3	50	6.1
Leaking of fluid from vagina			52	6.4	60	7.4	94	11.5
Swollen extremities			69	8.4	248	30.5	266	32.4
Preterm premature rupture of membranes			1	0.1	9	1.1	9	1.1
Abdominal pain			90	11.0	96	11.8	140	17.1
Regular and painful uterine contractions			3	0.4	26	3.2	28	3.4

Course of labour and delivery and their background characteristics

Almost three quarters of pregnant women started labour spontaneously, 5% had induced labour. In total, 28.4% of all pregnant women delivered by CS including 19.7% who were delivered by CS before start of labour and 8.7% who underwent CS during labour (Table 3).

Table 3. Characteristics of labour and delivery

Variable	All participants		Participants with spontaneous labour[a]		Participants with induced labour[a]	
	N=817		n=594		n=40	
	n	%	n	%	N	%
Intake of traditional medicines during pregnancy[b]	**814**	**99.6**	**592**	**99.7**	**40**	**100**
Yes	163	20.0	130	22.0	9	22.5
No	651	80.0	462	78.0	31	77.5
Transferral from another health facility[b]	**815**	**99.8**	**592**	**99.7**	**40**	**100**
Yes	460	56.4	368	62.2	34	85.0
No	355	43.6	224	37.8	6	15.0
Reason for transfer from another health facility[b]	**460**	**56.4**	**594**	**100**	**40**	**100**
For caesarean section	60	7.4	28	4.7	2	0.5
For pre-eclampsia	1	0.1	1	0.2	0	0.0
For prolonged labour/dystocia	39	4.8	36	6.1	1	2.5

For fetal distress	13	1.6	11	1.9	0	0.0
For uterine rupture	1	0.1	1	0.2	0	0.0
For severe bleeding	7	0.9	6	1.0	0	0.0
For other reasons	339	41.4	285	48.0	35	87.5
Reason for transfer from another health facility[c]	**460**	**56.4**	**402**	**63.6**	**40**	**100**
For caesarean section	102	12.5	66	11.1	5	12.5
For pre-eclampsia	1	0.1	1	0.3	0	0.0
For placenta praevia	1	0.1	0	0.0	1	2.6
For prolonged labour/dystocia	46	5.6	40	10.6	2	5.3
For fetal distress	19	2.3	15	4.0	0	0.0
For uterine rupture	1	0.1	1	0.3	0	0.0
For prolapse of umbilical cord	1	0.1	1	0.3	0	0.0
For severe bleeding	3	0.4	3	0.8	0	0.0
For better management of pregnant woman	218	26.7	181	30.5	19	47.5
For "scarred uterus"	30	3.7	22	3.7	2	5.0
For post term	16	2.0	5	0.8	9	22.5
For other reasons	22	2.6	15	4.0	2	5.3
Period when transferred[c]	**460**	**56.4**	**366**	**61.6**	**38**	**95.0**
Transferred before labour started	179	38.9	106	29.0	32	84.2
Transferred during labour before delivery	281	61.1	260	71.0	6	15.8
Fetal presentation[c]	**747**	**91.4**	**582**	**98.0**	**40**	**100**
Cephalic	735	98.4	574	98.6	38	100
Breech	7	0.9	5	0.9	0	0.0
Face	2	0.3	2	0.3	0	0.0
Transverse	2	0.3	0	0.0	0	0.0
Other	1	0.1	1	0.2	0	0.0
Spontaneous rupture of membranes before arrival to the health facility[c]	**810**	**99.1**	**590**	**99.3**	**40**	**100**
Yes	202	24.9	186	31.5	10	25.0
No	608	75.1	404	68.5	30	75.0
Systolic blood pressure at arrival to health facility (mmHg) [c]	**792**	**96.9**	**579**	**97.5**	**35**	**87.5**
≥160	31	3.9	5	0.9	0	0.0
140-159	71	9.0	57	9.8	1	2.9
<140	690	87.1	517	89.3	34	97.1
Systolic blood pressure at 4 hours in health facility (mmHg) [c]	**147**	**18.0**	**137**	**23.1**	**31**	**22.5**
≥160	2	1.4	2	1.5	0	0.0
140-159	2	1.4	2	1.5	0	0.0
<140	143	97.3	133	97.1	9	100
Diastolic blood pressure at arrival to health facility (mmHg) [c]	**784**	**96.0**	**572**	**96.3**	**34**	**85.0**
≥95	55	7.0	14	2.4	1	2.9
90-94	38	4.8	19	3.3	1	2.9
<90	691	88.1	539	94.2	23	94.1
Diastolic blood pressure at 4 hours in health facility (mmHg) [c]	**147**	**18.0**	**137**	**23.1**	**31**	**22.5**
≥95	1	0.7	1	0.7	0	0.0
90-94	0	0.0	0	0.0	0	0.0
<90	146	99.3	136	99.3	9	100
Hypertension at arrival to health facility[c]	**817**	**100**	**594**	**100**	**40**	**100**
Yes	101	13.8	70	11.8	3	7.5
No	633	86.2	524	88.2	37	92.5

Labour[c]	**795**	**97.3**	**594**	**100**	**40**	**100**
Spontaneous start of labour	594	72.7	594	100		
Induction of labour	40	5.0			40	100
Caesarean section before start of labour	161	19.7				
Cervical dilation grade at arrival to the health facility[c]	**769**	**94.1**	**571**	**96.1**	**38**	**95.0**
≤3 cm	341	44.3	157	27.5	34	89.5
4-5 cm	169	20.7	161	28.2	2	5.3
≥6 cm	259	33.7	253	44.3	2	5.3
Cervical dilation grade at 4 hours in health facility[c]	**172**	**21.1**	**161**	**27.1**	**10**	**25.0**
≤3 cm	1	0.6	1	0.6	0	0
4-5 cm	9	5.2	8	5.0	1	10
≥6 cm	162	94.2	161	94.4	9	90
Number of contractions 10-minutes after arrival to the health facility[c]	**559**	**68.4**	**519**	**87.4**	**33**	**82.5**
0	4	0.7	2	0.4	2	6.1
1	28	5.0	21	4.0	5	15.2
2	247	44.2	230	44.3	16	48.5
3 or more	280	50.1	266	51.3	10	30.3
Number of contractions after 4 hours in health facility[c]	**174**	**21.3**	**165**	**27.8**	**28**	**70.0**
0	0	0.0	0	0.0	0	0.0
1	0	0.0	0	0.0	0	0.0
2	51	29.3	45	27.3	6	50
3 or more	123	70.7	120	72.7	6	50
Duration of contractions at arrival to the health facility[c]	**556**	**68.1**	**517**	**87.0**	**32**	**80.0**
≤20 seconds	70	12.6	62	12.0	6	18.8
21-40 seconds	485	87.2	454	87.8	26	81.3
>40 seconds	1	0.2	1	0.2	0	0.0
Duration of contractions after 4 hours in health facility[c]	**172**	**21.1**	**159**	**26.8**		
≤20 seconds	4	2.3	4	2.5	0	0.0
21-40 seconds	168	97.7	155	97.5	12	30.0
>40 seconds	0	0.0	0	0.0	0	0.0
Position of the head of the fetus at 4 hours in health facility[c]	**175**	**21.4**	**163**	**27.4**	**11**	**27.5**
5/5	2	1.1	2	1.2	0	0.0
4/5	18	10.3	17	10.4	1	9.1
3/5	50	28.6	47	28.8	3	27.3
2/5	31	17.7	29	17.8	2	18.2
1/5	24	13.7	24	14.7	0	0.0
0/5	50	28.6	44	27.0	5	45.5
Use of parthogram during labour[c]	**726**	**88.9**	**559**	**94.1**	**33**	**82.5**
Yes	555	76.4	519	92.8	32	97.0
No	171	23.6	40	7.2	1	3.0
Number of hours in maternity ward[c]	**740**	**90.6**	**527**	**88.7**	**39**	**97.5**
≤4	318	43.0	249	47.2	3	7.7
>4-8	123	16.6	112	21.3	3	7.7
>8-10	21	2.8	15	2.8	2	5.1
>10	10	37.6	151	28.7	31	79.5
Provision of pharmacological pain relief during labour[c]	**817**	**100**	**594**	**100**	**40**	**100**
Yes	10	1.2	10	1.7	0	0.0
No	807	98.8	584	98.3	40	100

Artificial augmentation of labour with oxytocin[c]	**817**	**100**	**594**	**100**	**40**	**100**
Yes	99	12.1	71	12.0	28	70
No	722	88.4	523	88.0	12	30
Reasons for artificial augmentation of labour with oxytocin[c]	**99**	**12.1**	**71**	**12.0**	**28**	**70.0**
Not enough uterine contractions	77	8.9	59	48.8	18	64.3
The cervix dilation was not progressing well	7	2.9	4	3.3	3	10.3
The fetus was not progressing well into pelvis	2	3.7	1	0.8	1	3.4
Other reasons	13	1.1	7	5.8	6	20.7
Artificial rupture of amnion done during labour[c]	**815**	**99.8**	**593**	**99.8**	**39**	**97.5**
Yes	215	26.2	202	34.1	13	33.3
No	601	73.7	391	65.9	26	66.7
Reasons for artificial rupture of amniotic membranes[c]	**215**	**26.2**	**202**	**34.1**	**13**	**33.3**
Not enough uterine contractions	54	6.6	54	21.9	5	31.3
The cervix dilation was not progressing well	8	2.2	8	3.2	1	6.3
The fetus was not progressing well into pelvis	9	3.7	9	3.6	2	12.5
The routine amniotomy	105	14.4	105	42.2	3	18.8
Completed cervix dilation	39	4.0	39	15.9	2	12.5
Episiotomy[c]	**817**	**100**	**594**	**100**	**40**	**100**
Yes	102	12.5	100	16.8	2	5.0
No	723	88.5	494	83.2	38	95.0
Reasons for episiotomy[c]	**102**	**12.5**	**100**	**16.8**	**2**	**5.0**
To protect the perineum	94	11.5	92	62.2	2	100
Routine episiotomy	5	0,6	5	3.4	0	0.0
Acute fetal distress	2	0.2	2	1.4	0	0.0
Other reasons	1	0.1	1	0.7	0	0.0
Vacuum extraction[c]	**817**	**100**	**594**	**100**	**40**	**100**
Yes	10	1.2	9	1.5	1	2.5
No	807	98.8	495	98.5	39	97.5
Forceps extraction[c]	**817**	**100**	**594**	**100**	**40**	**100**
Yes	3	0.4	3	0.5	0	0.0
No	814	99.6	591	99.5	40	100.0
Indication for performed caesarean section[c]	**170**	**20.8**	**70**	**11.8**	**10**	**25.0**
Pre-eclampsia/eclampsia	2	1.2	0	0.0	0	0.0
Placenta praevia/Abnormal placenta insertion	1	0.6	0	0.0	0	0.0
Prolonged labour/dystocia	49	28.8	43	61.4	6	60.0
Acute fetal distress	6	3.5	3	4.3	1	10.0
Twin pregnancy	1	0.6	1	0.2	0	0.0
Bad presentation (not cephalic)	5	2.9	4	5.7	0	0.0
Scarred uterus	78	45.9	18	25.7	2	10.0
Post term pregnancy	16	9.4	0	0.0	1	20.0
Generally retracted pelvis	5	2.9	1	1.4	0	0.0
Other reasons	7	4.1	0	0.0	0	0.0
Preeclampia/eclampsia[c]	**817**	**100**	**594**	**100**	**40**	**100**
Yes	8	1.0	4	0.7	0	0
No	809	99.0	630	99.3	40	100
Post-partum haemorrhage[c]	**817**	**100**	**643**	**100**	**40**	**100**
Yes	22	2.7	20	3.4	0	0.0
No	795	97.3	614	96.6	40	100

Post-partum haemorrhage [c]	**809**	**99.0**	**590**	**99.3**	**39**	97.5
<500ml	785	96.1	568	96.3	39	100.0
500-1000ml	17	2.1	16	2.7	0	0.0
>1000 ml	7	0.9	6	1.0	0	0.0
	Mean value	**SD**	**Mean value**	**SD**	**Mean value**	**SD**
Mean cervical dilation (cm) at arrival to the health facility[c]	4.21	3.22	5.38	2.38	1.26	1.8
Mean cervical dilation at 4 hours in health facility[c]	8.31	1.70	8.30	1.6	8.30	2.0
Mean number of hours in maternity ward[c]	10.38	14.19	8.63	11.97	27.49	24.14

[a]Women with spontaneous start of labour or with induced labour excluding those with elective caesarean section – Self-reported data

[b]Self-reported data

[c]Medical records data

For 69% of the women who underwent CS during labour (8.7%), prolonged labour/dystocia was the indication. In total, 56.4% of pregnant women were transferred from lower level to the higher level of health care and 61.1% of all transferred pregnant women were in labour. About 68% of all pregnant women who delivered in district hospitals or in referral hospitals were transferred from lower levels of care (Table 4).

Table 4. Background factors and characteristics of labour in relation to level of health care. Test of difference between groups using Pearson's Chi-Square test and Holm-Bonferroni method (p-value)

Variable	Health centre		District hospital		Referral /Private hospital		Chi-Square p-value	Holm-Bonferroni p-value
Maternal age (years)	**n**	**%**	**n**	**%**	**n**	**%**		
<25	62	40.5	105	25.1	70	28.7		
25-34	70	45.8	252	60.1	149	61.1		
≥35	21	13.7	62	14.8	25	10.1	0.003	0.069
Marital status								
Married or cohabiting	138	90.8	368	87.8	225	92.6		
Unmarried/single/widow/separated	14	9.2	51	12.2	18	7.4	0.135	1
Woman's education								
Completed secondary school and reached university	11	7.2	126	30.1	67	27.6		
Completed primary level	133	86.9	280	66.8	169	69.5		
No education	9	5.9	13	3.1	7	2.7	**<0.001**	**<0.001[a]**
ANC attendance								
Yes	153	100	416	99.0	243	99.6		

No	0	0.0	4	1.0	1	0.4	0.386	1
Woman's employment								
Yes	143	93.5	357	28.2	191	82.0		
No	10	6.5	57	71.8	42	18.0	0.006	0.132
Health insurance								
Yes	153	100.	408	97.6	241	98.8		
No	0	0.0	10	2.4	3	1.2	0.182	1
Woman's height (m)								
<1.50	2	3.9	19	9.6	2	1.6		
≥1.50	49	96.1	178	90.4	125	98.4	0.010	0.200
Woman's weight before pregnancy (kg)								
<50	15	10.1	65	16.0	26	10.9		
≥50	133	89.9	341	84.0	213	89.1	0.080	1
Body mass index (BMI, kg/m²)								
<18.5	1	2.0	11	5.8	6	4.8		
18.5-24.9	39	76.5	121	63.4	80	64.0		
25-29.9	8	15.7	45	23.6	20	16.0		
≥30	3	5.9	14	7.3	14	15.2	0.098	1
Weight gained during pregnancy (kg)								
0 or weight decrease	9	6.5	18	4.6	16	7.0		
1-10	106	76.3	305	77.2	149	64.8		
10-20	23	16.5	67	17.0	62	27.0		
>20	1	0.7	5	1.3	5	1.3	0.035	0.630
Number of miscarriages								
0	136	88.9	376	89.5	220	90.2		
1	13	8.5	36	8.6	23	9.4		
2	3	2.0	7	1.7	0	0.0		
>2	1	0.7	1	0.2	1	0.4	0.538	1
Number of births (including the index child)								
Primiparity	54	35.3	177	42.1	103	42.4		
Multiparity	99	64.7	243	57.9	140	57.6	0.290	1
Number of children born at home								
0	134	87.6	387	92.1	234	95.9		
≥1	19	12.4	33	7.9	10	4.1	0.009	0.189
Hypertension during pregnancy								
No	148	96.7	391	93.1	235	96.3		
Yes	5	3.3	29	6.9	9	3.7	0.095	1
Anaemia during pregnancy								
No	124	81.0	361	86.0	210	86.1		
Yes	29	19.0	59	14.0	34	13.9	0.301	1
Transfer from other health facility								
Yes	6	3.9	287	68.3	167	68.4		
No	147	96.1	133	31.7	77	31.6	**<0.001**	**<0.001** [a]
Labour								
Spontaneous labour and vaginal delivery	148	96.7	221	52.6	164	67.2		
Spontaneous labour and delivery by caesarean section	0	0.0	44	10.5	17	7.0		
Induction of labour	2	1.3	27	6.4	11	4.5		
Caesarean section before labour	0	0.0	122	29.0	39	16.0	**<0.001**	**<0.001** [a]

Cervical dilation grade at arrival at health facility								
≤ 3cm	20	13.4	201	52.1	120	51.3		
4-5cm	49	32.9	71	18.4	49	20.9		
≥6cm	80	53.7	114	29.5	65	27.8	**<0.001**	**<0.001**[a]
Cervical dilation at 4 hours in the health facility								
≤3cm	0	0.0	1	1.0	0	0.0		
4-5cm	0	0.0	6	6.2	3	11.5		
≥6cm	49	100.	90	92.8	23	88.5	0.217	**1**
Duration of contractions at arrival in the health facility								
≤20 seconds	23	15.9	37	14.7	10	6.3		
21-40 seconds	122	84.1	213	84.9	150	93.8		
>40 seconds	0	0.0	1	0.4	0	0.0	0.048	0.816
Duration of contractions at 4 hours in the health facility								
≤20 seconds	2	4.0	1	1.0	1	3.8		
21-40 seconds	48	96.0	95	99.0	25	96.2		
>40 seconds	0	0.0	0	0.0	0	0.0	0.454	**1**
Use of partogram				67.4				
Yes	144	99.3	248	32.6	163	76.5		
No	1	0.7	120		50	23.5	**<0.001**	**<0.001**[a]
Pharmacological pain relief during labour				1.4				
Yes	2	1.3	6	98.6	2	0.8		
No	151	98.7	414		242	99.2	0.785	**1**
Caesarean section done during labour				11.9				
Yes	0	0.0	50	88.1	21	8.6		
No	153	100.	370		223	91.4	**<0.001**	**<0.001**[a]
Health provider assisting the delivery				6.0				
Nurse	125	84.5	25	41.0	3	1.2		
Midwife	23	15.5	170	53.0	130	53.3		
Doctor	0	0.0	220		111	45.5	**<0.001**	**0.002**[a]
Preeclampsia/eclampsia								
Yes	2	1.3	4	1.0	2	0.8		
No	151	98.7	416	99.0	242	99.2	0.888	1
Caesarean section due to prolonged labour								
Yes	0	0.0	19	4.5	24	9.8		
No	153	100	401	95.5	220	90.2	**<0.001**	**<0.001**[a]
Post-partum haemorrhage								
Yes	6	3.9	13	3.1	3	1.2		
No	147	96.1	407	96.9	241	98.8	0.209	1
Self-rated health before pregnancy[b]								
Good	138	90.2	375	89.5	234	95.9		
Poor	15	9.8	44	10.5	10	4.1	0.014	0.266
Self-rated health during pregnancy[b]								
Good	101	66.0	284	67.8	177	72.5		
Poor	52	34.0	135	32.2	67	27.5	0.309	1
Self-rated health postpartum[a]								
Good	136	88.9	366	87.1	201	82.4		
Poor	17	11.1	54	12.9	43	17.6	0.123	1

[a]Statistical significant p-value after correction with Holm-Bonferroni method.

[b]Poor-SRH (Poor self-rated health status) includes very poor and poor health status categories and Good-SRH (Good self-rated health status) includes very good and good health status categories.

The majority of transferred pregnant women (n=460; 62.4%) were transferred from health centres to a district hospital (Figure 1) with "CS" (12.5%) or scarred uterus (3.7%), or to ensure "better management" (26.7%) as the main reasons of transferral.

Table 3 presents background characteristics related to course of labour and delivery for all pregnant women who started labour spontaneously or whose labour was induced. A parthogram was used during labour for almost all women who delivered at health centres, but a parthogram was only used by 67% of the district hospitals (Table 4). Table 4 presents background characteristics related to course of labour and delivery in relation to the level of health care. In total, 44.3% of pregnant women arrived at a health facility with a cervical dilation grade ≤3 cm, 22% with cervical dilation grade between 4-5cm, and 31.7% with cervical dilation grade ≥6cm (Figure 1). Pregnant women who arrived at the a health facility with a cervical dilation grade ≤3 cm spent more hours in maternity ward (median value 9.25 hours; IQR: 3.33-18.50) compared to those who arrived with a cervical dilation grade of 4-5 cm (median value 5.42 hours; IQR: 1.17-15.00; p<0.001) and those who arrived with a cervical dilation grade of ≥6 cm (median value 2.92 hours; IQR: 1.00-6.17; p<0.001) (Figure 2).

Pregnant women who arrived at a health facility with a cervical dilation grade ≤3 cm, and who did not receive oxytocin during labour, spent more hours in a maternity ward compared to those who arrived with a cervical dilation grade ≤3 cm and who received oxytocin during labour (median value 14.17 hours; IQR: 5.42-19.58; p<0.001) (Figure 3). Pregnant women who arrived at a health facility with a cervical dilation grade between 4-5 cm, and who did not receive oxytocin during labour, spent more hours in

a maternity ward compared to those who arrived with a cervical dilation grade between 4-5 cm and received oxytocin during labour (median value 5.13 hours; IQR: 3.16-8.31; p=0.007). Pregnant women who arrived at a health facility with a cervical dilation grade ≥6 cm, and who did not receive oxytocin during labour, spent more hours in a maternity ward compared to those who arrived with a cervical dilation grade ≥6 cm and received oxytocin during labour (median value 1.45 hours; IQR: 0.50-3.67), p<0.001).

Prevalence of pregnancy-related complications

The prevalence of hypertension upon arrival to the health facility was 13.8%. The prevalence of eclampsia/pre-ecalmpsia, post-partum haemorrhage and CS due to prolonged/dystocia labour was 1%, 2.7%, and 5.4% of all pregnant women respectively, and prolonged/dystocia labour represented 28.8% of all indication for CS.

Factors associated with caesarean section due to prolonged labour/dystocia

In bivariable analysis, poor households with a monthly income of less than 36,000 RWF (i.e. approximately 45 USD), residence far from a health facility (distance from home to a health facility >1 km), and cervical dilation grade <6 cm upon arrival to a health facility, were statistically significant factors associated with CS due to prolonged labour/dystocia. In multivariable analysis, the same background factors and nulliparity were significantly associated with CS due to prolonged labour/dystocia (Table 5).

Table 5. Bivariable and multivariable logistic regression analyses with calculation of crude odds ratios (COR) and adjusted odds ratios and their 95% confidence intervals (CI) for caesarean section due to prolonged labour/dystocia in relation to specified background variables

Variable	Caesarean section due to prolonged labour/dystocia							
	Bivariable analysis						Multivariable analysis	
	Yes		No					
Maternal age (years)	**N**	**%**	**N**	**%**	**Crude OR**	**95% CI**	**Adjusted OR**	**95% CI**
<25	13	5.5	224	94.5	1		1	
25-34	28	5.9	443	94.1	0.91	0.46-1.80	0.67	0.30-1.48
≥35	2	1.9	106	98.1	0.29	0.70-1.27	0.40	0.09-1.80
Marital status								
Married or cohabiting	41	5.6	690	94.4	1			
Unmarried or single or widow or separated	2	2.4	81	97.6	0.41	0.09-1.75		
Women's education								
Completed secondary level or reached university level	13	6.4	191	93.6	1			
Completed primary level	29	5.0	553	95.0	0.77	0.92-1.51		
Never attended school	1	3.4	28	96.6	0.52	0.06-4.16		
Woman's employment								
Employed	37	5.4	654	94.6	1			
Not employed	6	5.5	102	94.5	1.03	0.42-2.50		
Number of births								
Multiparity	12	2.7	434	97.3	1		1	
Primiparity	1	2.9	34	97.1	1.03	0.13-8.18	**3.79**	**1.79-8.01**
Number of previous children delivered at home								
None	40	5.3	715	94.7	1			
1 or more	3	4.8	59	95.2	0.90	0.27-3.02		
History of miscarriages								
No	37	5.6	621	94.4				
Yes	5	6.6	71	93.4	1.18	0.45-3.10		
HIV status								
Negative	42	5.5	723	94.5	1			
Positive	1	1.9	51	98.1	2.96	0.40-		
Health Insurance								
Yes	42	5.2	760	94.8	1			
No	1	7.7	12	92.3	1.50	0.19-		
Household monthly income								
≥36,000 RWF	11	10.9	90	89.1	**1**		1	
<36,000RWF	32	4.8	641	95.2	**2.44**	**1.19-5.02**	**4.86**	**2.08-11.35**
Distance to the health facility								
≤1km	32	7.2	413	92.8	1		1	
>1km	11	3.0	358	97.0	**2.55**	**1.25-5.07**	**3.30**	**1.53-7.11**
Antenatal care visit								
Yes	41	5.3	737	94.7	1			
No	1	3.3	2996.		1.61	0.21-		
Anaemia during pregnancy								
No	39	5.6	656	94.4	1			

Yes	4	3.3	118	96.7	0.57	0.20-1.62		
Bad smelling during pregnancy								
No	42	5.8	683	94.2	1			
Yes	1	1.1	91	98.9	0.17	0.02-1.31		
Transfer from another health facility								
No	14	3.9	343	96.1	1			
Yes	29	6.3	431	93.7	1.64	0.85-3.16		
When transferred								
Before start of labour	7	3.9	172	96.1	1			
During labour before delivery	22	7.8	259	92.2	2.08	0.87-4.99		
Cervical dilation grade at arrival to health facility								
≤3cm	28	8.2	313	91.8	**4.54**	**1.73-**	**6.17**	**2.20-17.28**
4-5cm	10	5.9	159	94.1	**3.19**	**1.07-9.51**	**4.03**	**1.27-12.71**
≥6cm	5	1.9	254	98.1	1		1	
Woman's weight (kg)								
<50	5	4.7	101	95.3	1.11	0.42-2.91		
≥50	36	5.2	651	94.8	1			
Self-rated health before pregnancy[a]								
Good	42	5.6	705	94.4	1			
Poor	1	1.4	68	98.6	0.24	0-03-.82		
Self-rated health during pregnancy[a]								
Good	39	6.9	523	93.1	1		**1**	
Poor	4	1.6	250	98.4	**0.21**	**0.07-0.60**	**0.22**	**0.07-0.65**

[a]Poor-SRH (Poor self-rated health status) includes very poor and poor health status categories and Good-SRH (Good self-rated health status) includes very good and good health status categories.

DISCUSSION

In this study, we found that the prevalence of health facility-based pre-eclampsia/eclampsia and post-partum haemorrhage were very low (1% and 2.7%, respectively). CS was the main reason for transfer of women from health centres to district hospitals, and dystocia/prolonged labour was the main indication for CS. Furthermore, risk factors for having a CS due to prolonged labour included living in a poor household, nulliparity, and residence far from a health facility.

The estimated prevalence of self-reported pregnancy-related health problems during pregnancy - i.e., anaemia, severe vaginal bleeding, hypertension, and diabetes mellitus - were comparable to results from other studies. Previously, self-reported anaemia for women of reproductive age in Rwanda have been found to be of a similar size as in

our study.[18] In addition, self-reported post-partum anaemia investigated in China is comparable to our findings,[28] and sub-Saharan African prevalence of gestational diabetes mellitus are also similar to the range found in our study.[11 29] The estimated prevalence of pregnancy-related complications preeclampsia/eclampsia and post-partum haemorrhage were very low compared to the prevalence in other countries in Africa.[9 10 30] For example, in other low and middle income sub-Saharan African countries the prevalence of pre-eclampia is estimated to be three times higher than our result.[10] However, one study reports the prevalence of preeclampsia/eclampsia in neighbouring countries of Rwanda, i.e Democratic Republic of Congo, Kenya and Uganda, that are similar to the results of our study.[12] In referral hospitals in Rwanda and Uganda, post-partum haemorrhage is three to ten times more common than estimated in our study.[8 9 30] Possible explanations for these differences may be due to misclassifications by health care providers. For example pre-eclampia may have been incorrectly classified as other hypertensive disorder during pregnancy, or received non-classification. Another explanation of these differences is that we only included survivors of pregnancy-related complications so we underestimated the true prevalence of a condition if a number of women actually died from these complications. In a tertiary care level hospital in Rwanda, post-partum heamorrhage and pre-eclampsia/eclampsia represent a case fatality rate of 22% and 16%, respectively.[9] Health providers may have underreported post-partum haemorrage cases after having managed to stabilise the woman because they mis-evalueted the quantity of blood loss. Other explanation may be that health care providers have not been able to evaluate total blood loss adequately because the woman was transferred from another health facility. Moreover, some physicians may not want to report postpatum haemorrage to avoid audit problems because in health centres and district

hospitals in Rwanda such cases are under high surveillance as the Ministry of Health has introduced maternal death audits.[31]

The majority of referred pregnant women were transferred from health centres to district hospitals. Most of the pregnant women who gave birth in district and referral hospitals were transferred women from a lower level of health care. These results are in the line with the pyramidal composition of the Rwandan health system where a large number of cases are managed at lower levels of health care (i.e. health centres), and only complicated cases are referred to the next level of health care.[25] In about one-third of cases a parthogram was not used to monitor labour in pregnant women delivering in district and in referral hospitals. This result is low compared to WHO recommendations of using parthograms for all women in labour monitoring, although it is comparable to the results obtained in Uganda.[32 33]

CS was the main reason for being transferred, and previous studies show that in sub-Saharan Africa transfer of pregnant women in labour is always associated with risk of delay due to lack of transportation and bad roads, a situation that increases the risk of additional complications such as maternal fistula or even foetal death.[34 35] Upgrading the capacity of health centres in management of pregnant women with special focus on management of prolonged labour/dystocia and performing CS may decrease the number of maternal transfers, prevent risks related to prolonged labour, and allow district hospitals to receive fewer cases, enabling the district hospitals to spend more time focusing on other pregnancy-related complications. The use of newly trained clinical officers in Rwandan health centres, a strategy used in other middle and low income sub-Saharan countries, may be of significance as it has been shown that there are few differences in clinical outcomes after CS performed by clinical officers or

physicians.[36 37] In this study, the CS rate was almost two times higher than the national rate and higher than the recommended WHO rate but the CS rates were in the range of CS rates in Kigali hospitals.[9 22 38]

Being a poor household located far from a health facility was a statistically significant factor associated with CS due to prolonged labour/dystocia. This finding is in agreement with previous studies reporting a statistical association between prolonged labour and low socio-economic level and being a pregnant woman living in a rural area.[39] Poor roads and long distance to a health facility are risk factors for prolonged labour/dystocia.[35] Arriving at a health facility with cervical dilation grade of less than 6 cm and being nulliparious were factors associated with CS due to prolonged labour/dystocia. It has been reported previously that less advanced cervical dilation grade at admission and nulliparity are risk factor for prolonged labour.[39 40]

Methodological considerations

One strength of this study is that all eligible women consented to participate. In Rwanda, all health-related studies that are conducted need both the ethical approval from the Rwandan National Ethics Committee (RNEC) and the Ministry of Health's authorization. Commonly, Ministry of Health is associated with these studies. This may contribute to the high participation rates that are seen in almost all studies done in Rwanda, since Rwandan people are known to be compliant to all activities conducted by the government.[18 41-43] Female professional interviewers with nursing and midwifery background, who were not working at the selected health facilities were employed because of their knowledge of the items included in the questionnaire as well as the terminology used in medical records. It was also a strategy to make female pregnant women feel comfortable while responding to questions. One

limitation is that this study only estimated the health facility prevalence of complications related to pregnancy. There may be underreporting of the prevalence of complications related to pregnancy, as for example in case of maternal deaths occurring in the community. Pregnancy-related complications are mainly managed at the district hospital level. However these hospitals are mainly staffed with general practitioners who may have generally high workload, limited knowledge about pregnancy-related complications and there is often lack of necessary equipment for management of complicated pregnancies.[44]. This may have led to underreporting of some cases by misinterpretation. There may have been some over-reporting of cases in relation to the population-based prevalence because of selection bias, since cases with complications are aggregated in hospitals for more advanced health care.

CONCLUSIONS

The hospital-based prevalence of preeclampsia/eclampsia, post-partum haemorrhage, and of CS due prolonged labour/dystocia was low in this sample from Rwanda. The estimated prevalences in this study were probably underestimated due to high workload and limited obstetric knowledge in physicians. The majority of pregnant women giving birth at district hospitals were transferred from health centres, and caesarean section was the main reason for transferral. Prolonged labour was the main indication of caesarean section during labour. Almost half of the women who were delivered at district hospitals, were assisted by a physician. Up-grading the capacity of Rwandan health centres by using clinical officers may decrease the number of maternal transferrals to higher level of health care, decrease risks of aggravation of

pregnancy-related complications during transferral, and improve maternal and fetal health.

COMPETING OF INTEREST

The authors declare no competing interests.

AUTHORS' CONTRIBUTIONS

JPSS participated in the design of the study and the development of the study tools, data collection in the field. JPSS performed the data analysis, wrote the manuscript and approved the final version of the manuscript.

GK participated in the design of the study and the development of the study tools, drafting of the manuscript, and approved the final version of the manuscript.

MN participated in the design of the study and the development of the study tools. He participated in data collection in the field, drafting of the manuscript, and approved the final version of the manuscript.

CM participated in the design of the study and the development of the study tools. He participated in data collection in the field, drafting of the manuscript, and approved the final version of the manuscript.

KE participated in the design of the study and the development of the study tools, drafting of the manuscript, and approved the final version of the manuscript.

IM participated in the design of the study and the development of the study tools. IM supervised the data analysis and the manuscript writing and approved the final version of the manuscript.

DATA AND MATERIALS SHARING

The datasets used and analyzed during the current study will be available from the corresponding author upon receiving a reasonable request.

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Tropical medicine & international health : TM & IH 2016;21(7):895-906. doi: 10.1111/tmi.12718 [published Online First: 2016/04/30]

FIGURE CAPTION LIST

Figure 1. Type of health facility where participants were transferred, cervical dilation grade upon arrival at health facility, and description of delivery

Figure 2. Type of health facilities where participants were transferred, cervical dilation grade at arrival at health facility and description of delivery

Figure 3. Frequency of participants in relation to the number of hours in the maternity ward until delivery and in relation to use (n=49) or non-use of oxytocin (n=292) for participants with cervical dilation grade of ≤3 cm upon arrival to the health facility

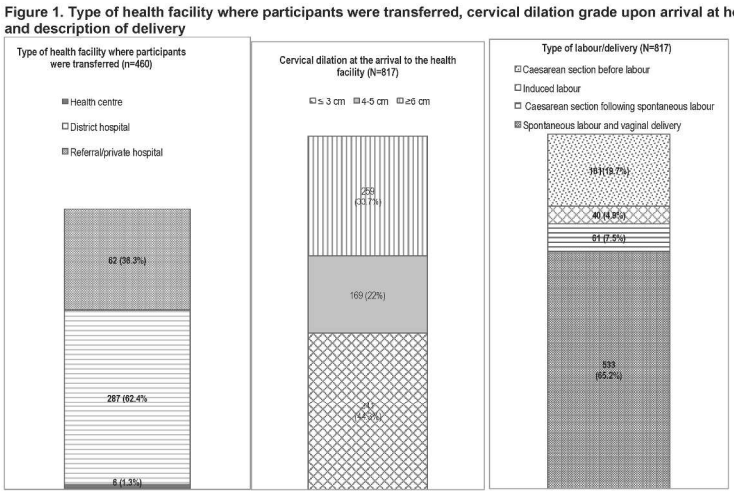

Figure 1. Type of health facility where participants were transferred, cervical dilation grade upon arrival at health facility, and description of delivery

297x209mm (300 x 300 DPI)

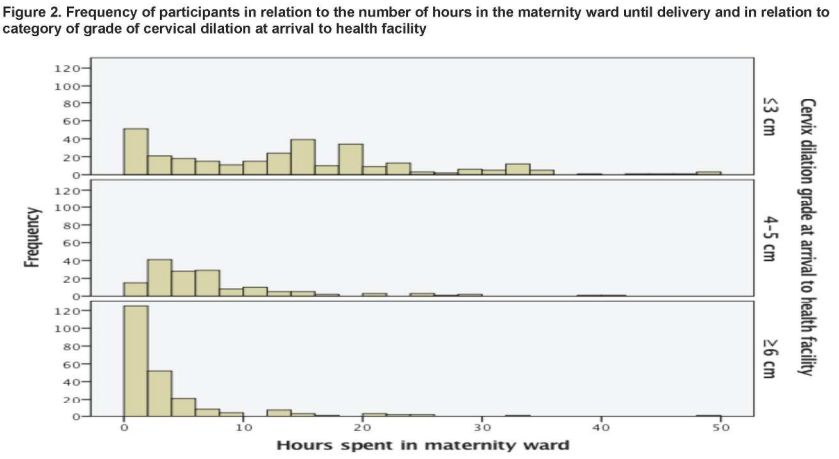

Figure 2. Type of health facilities where participants were transferred, cervical dilation grade at arrival at health facility and description of delivery

297x209mm (300 x 300 DPI)

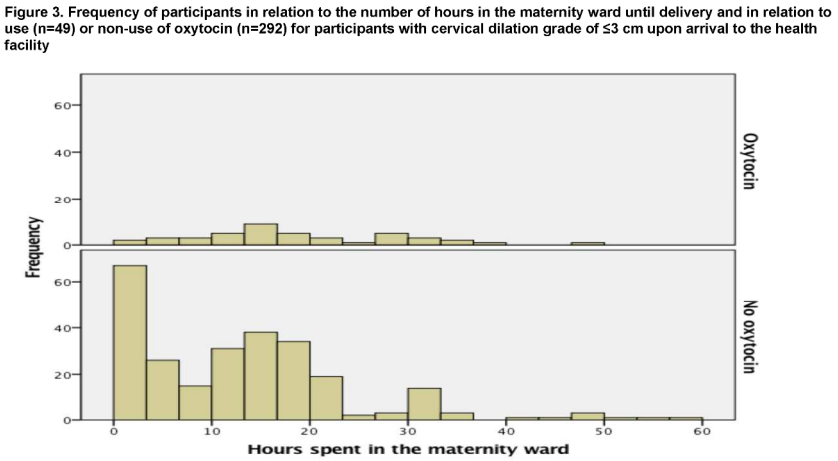

Figure 3. Frequency of participants in relation to the number of hours in the maternity ward until delivery and in relation to use (n=49) or non-use of oxytocin (n=292) for participants with cervical dilation grade of ≤3 cm upon arrival to the health facility

297x209mm (300 x 300 DPI)

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Health facility-based prevalence of pregnancy-related complications and course of labour of women who gave birth in selected health facilities in Rwanda

Table A. Correlation between reasons for transfer from medical records compared with reasons for transfer from self-reported data

Reasons for transfer medical records * Reasons for transfer self-reported data Cross-tabulation

			Reason for transfer self-reported data								
Reason for transfer medical records	Not transferred		Not transferred	Preeclampsia	Prolonged labor	Fetal distress	Uterine rupture	Severe bleeding	C section	Other reasons	Total
		Count	346	0	1	4	0	1	1	12	365
		Expected Count	160.8	.4	16.1	4.9	.4	3.1	22.3	156.8	365.0
		% within Reason for transfer medical records	94.8%	0.0%	0.3%	1.1%	0.0%	0.3%	0.3%	3.3%	100.0%
	Preeclampsia	Count	0	0	0	0	0	0	0	1	1
		Expected Count	.4	.0	.0	.0	.0	.0	.1	.4	1.0
		% within Reason for transfer medical records	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	100.0%
	Placenta praevia	Count	0	0	0	0	0	1	0	0	1
		Expected Count	.4	.0	.0	.0	.0	.0	.1	.4	1.0
		% within Reason for transfer medical records	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	100.0%
	Prolonged labor	Count	2	0	24	1	0	0	2	13	42
		Expected Count	18.5	.1	1.9	.6	.1	.4	2.6	18.0	42.0

		% within Reason for transfer medical records	4.8%	0.0%	57.1%	2.4%	0.0%	0.0%	4.8%	31.0%	100.0%
Reason for transfer medical records	Fetal distress	Count	0	0	3	2	0	0	0	9	14
		Expected Count	6.2	.0	.6	.2	.0	.1	.9	6.0	14.0
		% within Reason for transfer medical records	0.0%	0.0%	21.4%	14.3%	0.0%	0.0%	0.0%	64.3%	100.0%
	Uterine rupture	Count	0	0	0	0	1	0	0	0	1
		Expected Count	.4	.0	.0	.0	.0	.0	.1	.4	1.0
		% within Reason for transfer medical records	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%
	Prolapsus of the umbilical cord	Count	0	0	0	0	0	1	0	0	1
		Expected Count	.4	.0	.0	.0	.0	.0	.1	.4	1.0
		% within Reason for transfer medical records	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	100.0%
	Severe bleeding	Count	0	0	0	0	0	1	0	1	2
		Expected Count	.9	.0	.1	.0	.0	.0	.1	.9	2.0
		% within Reason for transfer medical records	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	0.0%	50.0%	100.0%
	C section	Count	3	1	2	0	0	0	31	35	72

		Expected Count	31.7	.1	3.2	1.0	.1	.6	4.4	30.9	72.0
		% within Reason for transfer medical records	4.2%	1.4%	2.8%	0.0%	0.0%	0.0%	43.1%	48.6%	100.0%
	Other reasons	Count	9	0	6	4	0	3	16	280	318
		Expected Count	140.1	.4	14.0	4.3	.4	2.7	19.5	136.6	318.0
		% within Reason for transfer medical records	2.8%	0.0%	1.9%	1.3%	0.0%	0.9%	5.0%	88.1%	100.0%
	Total	Count	360	1	36	11	1	7	50	351	817
		Expected Count	360.0	1.0	36.0	11.0	1.0	7.0	50.0	351.0	817.0
		% within Reason for transfer medical records	44.1%	0.1%	4.4%	1.3%	0.1%	0.9%	6.1%	43.0%	100.0%

Symmetric Measures

		Value	Asymptotic Standardized Error[a]	Approximate T[b]	Approximate Significance
Interval by Interval	Pearson's R	.893	.014	56.560	.000[c]
Ordinal by Ordinal	Spearman Correlation	.875	.015	51.566	.000[c]
Measure of Agreement	Kappa	.743	.019	29.983	.000
N of Valid Cases		817			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2 and 7
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6,7 and 8
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	8
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5, 9, 10 and 11
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	9,10 and 11
Bias	9	Describe any efforts to address potential sources of bias	*3 and 7*
Study size	10	Explain how the study size was arrived at	7 and 8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	11 and 12
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	11 and 12
		(*b*) Describe any methods used to examine subgroups and interactions	11 and 12
		(*c*) Explain how missing data were addressed	11 and 12
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	11 and 12
		(*e*) Describe any sensitivity analyses	11 and 12
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7 and 8
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	13-15
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	25-26
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	25-26
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	26-27
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	26-27
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	29
Generalisability	21	Discuss the generalisability (external validity) of the study results	29
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Prevalence of pregnancy-related complications and course of labour of surviving women who gave birth in selected health facilities in Rwanda: A health facility-based, cross-sectional study

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Prevalence of pregnancy-related complications and course of labour of surviving women who gave birth in selected health facilities in Rwanda: A health facility-based, cross-sectional study

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Abstract

Objectives

This study estimated health facility-based prevalence for pre-eclampsia/eclampsia, post-partum haemorrhage and caesarean section (CS) due to prolonged labour/dystocia. The background characteristics of Rwandan pregnant women, the course of labour and the level of health care were investigated in relation to pregnancy and delivery outcomes.

Methods

This is health facility-based study and data were collected in 2014–2015 through structured interviews and medical records (N=817) in Kigali and Northern Province, Rwanda. Frequencies and prevalence were used to describe participants' background factors, labour and delivery-related characteristics. Bivariable and multivariable logistic regression models were performed for different background factors and pregnancy/delivery outcomes.

Results

Pre-eclampsia/eclampsia, post-partum haemorrhage, and CS due to prolonged labour/dystocia represented 1%, 2.7% and 5.4% of all participants, respectively. In total, 56.4% of the participants were transferred from facilities with low levels to those with higher levels of health care, and the majority were transferred from health centres to district hospitals, with CS as the main reason for transfer. Participants who arrived at the health facility with cervical dilation grade of ≤3 cm spent more hours in maternity ward than those who arrived with cervical dilatation grade of ≥4 cm. Risk factors for CS due to prolonged labour or dystocia were poor households, nulliparity, and residence far from health facility.

Conclusions

The estimated health facility-based prevalence of pregnancy-related complications was relatively low in this sample from Rwanda. CS was the main reason for the transfer of pregnant women from health centres to district hospitals. Upgrading the capacity of health centres in the management of pregnant women in Rwanda may improve maternal and fetal health.

Keywords: Prevalence, health facility, pregnancy, pregnancy complications, labour, delivery, Rwanda

STRENGTHS AND LIMITATIONS OF THIS STUDY

- All the women eligible consented to participate in the study.
- Female professional interviewers with nursing and midwifery background who were not working at the selected health facilities were employed to make the pregnant women feel comfortable while responding to questions.
- There may also be underreporting of cases and physicians' diagnosis of pregnancy-related complications because of not following the pre-established guidelines. This can happen due to insufficient knowledge or misinterpretation or lack of time due to heavy workloads and lack of the equipment necessary for management of complicated pregnancies.
- Due to a lack of knowledge in seasonal variation of the investigated pregnancy-related complications in Rwanda, the study design did not take into account a possible seasonal variation in outcomes. This may be a potential limitation, because the outcomes during the study period may not be representative of a whole year.
- The study design focused on women who survived pregnancy and childbirth and did not take into account women who had died from pregnancy-related complications. This may have resulted in minor underestimation of cases.

BACKGROUND

Some pregnancies end tragically with maternal and/or fetal/child death or cause severe maternal and/or child impairment.[1] In 2013, about 300,000 maternal deaths occurred worldwide, and every year more than one and half million women suffer from pregnancy-related complications during pregnancy and delivery[2 3] The most common pregnancy-related complications are maternal haemorrhage, maternal sepsis, abortion, hypertensive disorders (pre-eclampsia, eclampsia, pregnancy-induced hypertension), and obstructed labour.[4 5] Maternal haemorrhage is the leading cause of maternal mortality, representing 33.9% of all maternal deaths in Africa. The prevalence of post-partum haemorrhage (PPH) in the world is approximately 6%.[5] In Uganda, between 2013–2014 the incidence of PPH was 9%, while the prevalence of maternal haemorrhage was estimated to be around 19.3% in Rwandan referral hospitals.[5-7] According to the World Health Organization (WHO), hypertensive disorders during pregnancy account for 9% of maternal mortality in Africa and Asia.[5] [8] Pre-eclampsia, characterised by hypertension and proteinuria, complicates 3–5% of pregnancies worldwide.[8] Pre-eclampsia can develop into eclampsia; characterized by the seizures that may be fatal for both mother and fetus.[9] In 2013, the prevalence of pre-eclampsia/eclampsia the East African region (i.e. Democratic Republic of Congo, Kenya and Uganda) was 1.02%, 2.27% and 1.15% respectively.[10]

Prolonged labour or obstructed labour occur when the fetus does not progress into the birth canal despite strong uterine contractions.[11] Obstructed labour represents 8% of maternal deaths globally.[1] In 2010, the incidence of obstructed labour was around 12.2% in Ethiopia and 3.7% in Rwanda in 2011.[12 13]

During the last decade, Rwanda has made significant improvements in maternal health.[14] In 2015, Rwanda reported a maternal mortality ratio of 210 per 100,000 live births and is one of few African countries that has managed to fulfil the 5th Millennium Development Goal (MDG5) of reducing maternal mortality by over 75% between 1990 and 2015.[15 16] A few studies that have investigated abortion and post-abortion care, antenatal care (ANC), use of community health workers, and rapid-SMS to promote ANC and childbirth attendance in Rwanda [14 17 18] However, the literature is limited on the course of labour and pregnancy-related complications.

This study aims to fill the knowledge gap in this area and to serve as documentation for policymakers.

Rwanda's national guidelines on the management of some obstetric and gynaecological common cases are very similar to those of the WHO and thus also similar to those used in many other countries. In these guidelines, pre-eclampsia is defined as blood pressure of ≥140/90 mm Hg after 20 weeks of gestation plus proteinuria of 300 mg per 24 hours or >2+ on a urine dipstick.[19] Furthermore, eclampsia is defined as the onset of convulsion/generalised seizures in a woman with pre-eclampsia that cannot be attributed to other causes.[19] PPH is defined as blood loss of more than 500 ml after vaginal delivery or 1,000 ml after caesarean delivery or excessive vaginal bleeding resulting in signs of hypovolemia or a 10% decline in post-partum haemoglobin concentration from antepartum levels.[19] Dystocia/prolonged labour is defined as difficult labour or an abnormally slow progression of labour.[19]

This study is part of the Maternal Health Research Programme (MaTHeR) undertaken by the University of Rwanda in collaboration with University of Gothenburg and Umeå University in Sweden.

AIMS

The study's overall aim was to determine the hospital-based prevalence of pregnancy-related complications (pre-eclampsia/eclampsia, post-partum haemorrhage and prolonged labour or obstructed labour or dystocia labour resulting in a caesarean section (CS) and to describe the course of labour and the background characteristics of women giving birth in selected Rwandan health facilities.

Specific aims were:

- To estimate the hospital-based prevalence of i) pre-eclampsia and eclampsia, ii) post-partum haemorrhage, and iii) prolonged labour or obstructed labour or dystocia labour resulting in a caesarean section.
- To describe the course of labour from the time of arrival at a health facility until delivery and the characteristics related to the course of labour and delivery in relation to the level of health care.
- To describe background characteristics of women who give birth in Rwandan health facilities and to describe these characteristics' associations with pregnancy outcomes.

METHODS

The study setting

The Rwandan public health system is composed of health posts, health centres, district hospitals, military hospitals, provincial hospitals, and referral hospitals.[20] A health centre, which provides the lowest level of health care, is where pregnant women with an uncomplicated pregnancy receive health care. Complicated cases are

referred to higher levels of health care, such as district, provincial and referral hospitals.[21] Health centres are mainly staffed by A2 nurses (registered nurses with secondary levels of education).[22] Private health care is available in Kigali and other large cities in the form of private dispensaries, private clinics, and private hospitals. Only the large private hospitals provide assisted delivery.[20] This study was conducted in the City of Kigali and Northern Province of Rwanda. It involved eight health centres, seven district hospitals, one provincial hospital, one referral hospital, and one private hospital.

This study used self-reported data from post-partum women and data from medical records.

This study used diagnoses made by physicians as noted in patients' medical records. The diagnoses were presumed to have been based on definitions and guidelines of pregnancy, labour, and delivery-related problems established by the Rwandan Ministry of Health.[19]

Study design and recruitment of study participants

This was a comprehensive cross-sectional, health facility-based study. During 2013, there were in total 67,077 vaginal deliveries in Kigali and Northern Province, and 28,786 of these (42%) occurred in Kigali city and 38,292 (58%) in Northern Province. Eighteen health facilities (10%) with a high number of vaginal deliveries were selected (eight health facilities in Kigali and ten in Northern Province). In Kigali and Northern Province, there are 11 public hospitals. The nine hospitals selected reported a high number of vaginal deliveries (more than 600) in the year 2013 and the non-selected two hospitals reported less than 600 vaginal deliveries in 2013. We also

selected eight health centres from all eight districts of Kigali and Northern Province that reported high number of deliveries in 2013 and included one private hospital. The sample size of 817 women was calculated based on the estimate of the prevalence of CS of 14.8% in Rwanda in 2013,[23] with an absolute precision of 5% and with about 10% of non-response. The target population were women who delivered in the selected health facilities during the data collection (2 December 2014 to 26 January 2015). The number of participants to be selected in each health facility was determined proportionally relative to the number of vaginal deliveries that had occurred in each facility in 2013 (i.e. the year before the data collection). This means that health facilities with high numbers of deliveries contributed with higher numbers of selected participants. The heads of the selected health facilities facilitated contact with the heads of their maternity wards. With the support of the heads of maternity wards, delivered women who were about to be discharged were invited to participate in the study. Before the individual interviews, information about the study was provided to the eligible participants. All the invited participants signed a written consent form before their participation in the study. Most of the time, data collection was performed on several occasions (i.e. on more than one day), in order to reach the quota of participants from each health facility.

Data collection procedures

A structured questionnaire, which the study team developed, included socio-demographic questions on age, marital status, educational level, previous pregnancies and the last pregnancy. It also asked for information on the outcomes of labour and delivery. The questionnaire was translated from English into Kinyarwanda. The questionnaire was piloted at one non-selected district hospital and its two health

centres located in Southern Province, Rwanda. After the pilot study, no major changes were made in the questionnaire; a few adjustments were made in wording to improve clarity. A group of eight experienced interviewers (nurses and midwives) collected data through individual structured interviews under the supervision of the supervisory team of this research (JPSS, MN and CM). These data collectors did not work as health professional at any of the selected health facilities during the data collection period. Data entry was performed by three skilled personnel. After the initial data entry, the first author re-registered 81 questionnaires, corresponding to approximately 10% of the total study sample, each including the 285 variables used in this study, to check the accuracy of the first data entry. The results of this re-registration showed 138 errors, corresponding to an error rate of 0.59% (138/23,085). The erroneous data were corrected.

Descriptions of variables

Variables related to pregnancy outcomes

Binary variables were *post-partum haemorrhage* and *pre-eclampsia*/eclampsia; the latter was a combination of the variables *pre-eclampsia before labour, eclampsia before labour, pre-eclampsia during labour, eclampsia during labour, pre-eclampsia post-partum, and eclampsia post-partum.* These variables were collected from medical records from diagnoses made by physicians. The dichotomised variable *caesarean section due to prolonged labour or dystocia* was created from the variable *what was the main indication of caesarean section*, and this was collected from medical records.

Variables related to socio-demographic factors

Maternal age, a continuous numerical variable, was divided into the following categories: <20 years, 20–24 years, 25–29 years, 30–34 years, 35–39 years and ≥40 years. *Maternal age* was also put into 3 categories, i.e. <25 years, 25–34 years and ≥35 years. *Marital status* included married, cohabiting, separated or divorced, widowed, and unmarried or single. *Marital status* was dichotomised into married or cohabitating where the single, divorced, or widowed were collectively categorised as the exposure category. *Education* included never attended school, primary level not completed, primary level completed, vocational training, secondary level not completed, secondary level completed, and tertiary level. Education was grouped into three categories: never attended school, completed primary level, completed secondary school, and reached tertiary university level. *Occupations* included student, unskilled worker, skilled worker, civil servant, not employed, and other employment; these were dichotomised as employed and non-employed. For each variable about the main health problems during pregnancy, data were collected for the first, second, and third trimesters. *First trimester* referred to the first three months of the pregnancy. *Second trimester* referred to four to six months of pregnancy. *Third trimester* referred to seven months or more. The data on the variables *anaemia* and *hypertension* during the first, second, and third trimester were combined as *anaemia during pregnancy* and *hypertension during pregnancy*. *Hypertension* was defined as blood pressure of ≥140/90 mm Hg [19].

Variables related to course of labour and delivery

The binary variables *intake of traditional medicines during pregnancy* and *transfer from another health facility* were the only labour and delivery self-reported variables.

Other variables were collected from the medical records. *Number of hours in maternity ward* was a variable calculated using *time of admission* at the maternity ward and *time of delivery*. It was categorised into ≤4 hours, >4–8 hours, >8–10 hours, and >10 hours. *Fetal presentation* included cephalic, breech, face, transverse, and others. *Period when transferred* included transferred before labour started and transferred during labour before delivery. *Cervical dilation grade at arrival to the hospital* and *cervical dilation grade at 4 hours in the hospital* were continuous numerical variables that were categorised into ≤3 cm, 4–5 cm, and ≥6 cm. *Number of contractions at arrival* and *number of contractions/ten minutes* after four hours in the hospital included 0, 1, 2, 3 or more contractions. *Duration of contractions/ten minutes at arrival to the hospital* and *duration of contractions at four hours in hospital* included ≤20 seconds, 21–40 and >40 seconds. Other binary variables were *spontaneous rupture of membranes*, *use of partogram during labour*, *provision of pharmacological pain relief during labour*, *artificial rupture of membranes*, *artificial augmentation of labour with oxytocin*, *episiotomy done*, *vacuum extraction,* and *forceps extraction*.

Statistical analysis

Frequency and prevalence (n and %) were used to describe the participants' socio-demographic and reproductive history characteristics, self-reported pregnancy-related problems, and delivery-related characteristics, including the features of the course of the labour. Cohen's kappa was calculated to assess agreement between responses from self-reported data and data from medical records.

Pearson's Chi-Squared test and Fisher's exact test were used for bivariable analyses. The adjustment for multiple comparisons was made using the Holm-Bonferroni

method.[24] The continuous variable 'number of hours in maternity ward' was not normally distributed, so the Wilcoxon test was used to compare medians of the number of hours spent in maternity wards for women who arrived at health facility with a cervical dilation grade of ≤3 cm, those who arrived with a cervical dilation of 4–5 cm, and those who arrived with a cervical dilation of ≥6 cm. This study identified the factors associated with CS due to prolonged labour/dystocia by using bivariable logistic regression analysis. Statistically significant variables that were associated with CS due to prolonged labour/dystocia were considered for the final logistic regression model. Then a multivariable logistic regression model was built that calculated odds ratios (OR) and their 95% confidence intervals (CI). In the multivariable model, forward stepwise regression was used, and all statistically significant variables in bivariable analyses were entered one at a time to identify factors associated with CS due to prolonged labour/dystocia. In the final model only factors were kept that were statistically significant ($p<0.05$). All multivariable models included parity and women's age for theoretical reasons as other studies have shown these variables to be associated with CS due to prolonged labour/dystocia.

Because no variable was highly correlated ($r\geq0.40$), no variable was excluded in the final model. Two dependent variables (PPH and pre-eclampsia/eclampsia) demonstrated a very low number of cases n=22 (2.7%) and n=8 (1.0%), respectively so no further analysis was possible.

ETHICAL CONSIDERATIONS

Participation in this study was voluntary. Before the interviews, the participants were verbally informed in detail about the aims of the study and the content of the questionnaire. They were ensured about the confidentiality of their responses, and

reminded that they could withdraw at any time during the interview or thereafter. To ensure confidentiality, the interview was conducted in privacy. All participants signed a written consent form before taking part in the study. This study was conducted according to the guidelines established by the Declaration of Helsinki.[25] The research protocol and the study questionnaire were approved by the University of Rwanda, College of Medicine and Health Sciences Institutional Review Board (Ref: 010/UR/CMHS/SPH/2014). Before the data collection, authorisation to conduct the study was obtained from the Ministry of Health in Rwanda (Ref: 20/4029/MCH/2014).

RESULTS

Socio-demographic and reproductive history characteristics

In total, 817 women (16 to 44 years old, with a mean age of 27.8 years) participated in the study. Married women represented 49.9% of participants, 40.0% were cohabiting, and 8.6% were single. The proportion of primiparous women was 41.1%, multiparous women with two to four births was 54.7%, and multiparous of more than five births was 4.3%. The frequencies and percentages of socio-demographic and reproductive history characteristics of participants are presented in Table 1.

Cohen's kappa was 0.74 for the agreement between the responses from self-reported data and data from medical records.

Table 1

Socio-demographic and reproductive history characteristics of participating women (N=817)

Participants (pregnant women)		
Variable	**Mean age (years)**	**SD[a]**
Mean maternal age	27.83	5.57
Woman's mean number of years of education	7.67	4.18
Partner mean age (years; SD)	32.77	6.52
Partner's mean number of years of education (years; SD)	8.97	4.23
	N	**%**
Maternal age in age group (years)	**816**	**99.0**
<20	46	5.6
20–24	191	23.4
25–29	250	30.6
30–34	221	27.1
35–39	90	11.0
≥40	18	2.2
BMI[b] calculated	**367**	**44.9**
<18.5	18	4.9
18.5–24.9	240	65.4
25-29.9	73	19.9
≥30	36	9.8
Woman's height (m)	**375**	**45.9**
<1.50	23	6.1
≥1.50	352	93.9
Woman's weight before pregnancy (kg)	**793**	**97.1**
<50	106	13.4
≥50	678	86.6
Marital status	**814**	**99.6**
Single or unmarried	70	8.6
Widowed	2	0.2
Separated or divorced	11	1.4
Cohabiting	326	40.0
Married	406	49.9

Religion	**814**	**99.6**
Catholic	220	27.0
Protestant	439	53.9
Adventist	92	11.3
Islam	25	3.1
Other	31	3.8
None	7	0.9
Education	**815**	**99.8**
None	29	3.6
Primary level, not completed	219	26.9
Primary level, completed	187	22.9
Secondary school, not completed	61	7.5
Secondary school, completed	115	14.1
Vocational training	83	10.2
Tertiary, university level	121	14.8
Occupation	**800**	**97.9**
Student	33	4.1
Non-skilled worker	470	58.8
Skilled worker	60	7.5
Civil servant	99	12.4
Not employed	109	13.6
Other employment	29	3.6
Number of births (including index birth)	**816**	**99.9**
1	335	41.1
2	213	26.1
3	155	19.0
4	78	9.6
≥5	35	4.3
Number of previous children delivered at home	**817**	**100**
0	756	92.5
1	33	4.0
2	15	1.8
3	8	1.0
≥4	5	0.6
Number of previous miscarriages	**817**	**100**
0	732	89.6
1	72	8.8
2	10	1.2
≥3	3	0.4
Woman's HIV status	**817**	**100**
Negative	765	93.6
Positive	52	6.4
ANC visits	**817**	**100**
Yes	812	99.4
No	5	0.6
Number of ANC visits	**812**	**99.4**
1 visit	67	8.3
2 visits	153	18.8

3 visits	259	31.9
4 visits	231	28.4
≥5	102	12.6
Partner to participant		
Partner's age in group (years)	**730**	**89.4**
<25	50	6.8
25–29	207	28.4
30–34	198	27.1
35–39	172	23.6
≥40	103	14.1
Partner's education	**728**	**89.1**
None	35	4.8
Primary level, not completed	119	16.3
Primary level, completed	144	19.8
Secondary school, not completed	44	6.0
Secondary school, completed	164	22.5
Vocational training	84	11.5
Tertiary, university level	138	19.0
Household information		
Health insurance	**814**	**99.6**
None	13	1.6
Community health-based insurance	650	79.9
Public insurance (RAMA, MMI, MIS/UR)[c]	135	16.6
Other private	16	2.0
Household income per month	**772**	**94.5**
<17,500 RWF	32	4.1
17,500–35,999 RWF	68	8.8
36,000–99,999 RWF	231	29.9
100,000–199,999 RWF	213	27.6
200,000–499,999 RWF	163	21.1
>500,000 RWF	65	8.4
Distance from home to the nearest health facility (km)	**814**	**99.6**
<1	445	54.7
2-5	289	35.5
6–10	64	7.9
≥10	16	2.0

[a]SD=Standard deviation
[b]BMI=Body Mass Index (kg/m^2)
[c]RAMA=La Rwandaise d'Assurance Maladie, MMI= Military Medical Insurance, MIS/UR= Medical Insurance of University of Rwanda

Self-reported health problems during pregnancy

The prevalence of anaemia, severe vaginal bleeding, hypertension, and diabetes mellitus during pregnancy was 14.9%, 5.6%, 5.3%, and 0.2%, respectively. The

prevalence of self-reported pregnancy-related health problems during pregnancy are presented in Table 2.

Table 2

Prevalence of self-reported pregnancy-related problems in 1st, 2nd, and 3rd trimesters[a] of pregnancy and the cumulative prevalence[b]

Variable	1st trimester		2nd trimester		3rd trimester		Cumulative prevalence	
	N	%	N	%	N	%	N	%
Hypertension	17	2.1	8	1.0	25	3.1	43	5.3
Convulsions	12	1.5	3	0.4	3	0.4	15	1.8
Diabetes mellitus	2	0.2	1	0.1	0	0	2	0.2
Bad smelling vaginal discharge	60	7.4	40	4.9	47	5.8	92	11.3
Anaemia	77	9.4	70	8.6	43	5.3	122	14.9
Severe vaginal bleeding	30	3.7	14	1.7	3	0.4	46	5.6
Abdominal pain and severe bleeding			2	0.2	4	0.5	6	0.7
Fever			21	2.6	35	4.3	50	6.1
Leaking of fluid from vagina			52	6.4	60	7.4	94	11.5
Swollen extremities			69	8.4	248	30.5	266	32.4
Preterm premature rupture of membranes			1	0.1	9	1.1	9	1.1
Abdominal pain			90	11.0	96	11.8	140	17.1
Regular and painful uterine contractions			3	0.4	26	3.2	28	3.4

[a]The first trimester represents the first 3 months of the pregnancy, the second trimester represents 4 to 6 months and the third trimester was defined as 7 months or more of pregnancy

[b]The third trimester do not include events or complications during delivery

Course of labour and delivery and their background characteristics

Almost three-quarters of the women started labour spontaneously; 5% had induced labour. In total, 28.4% of all pregnant women were delivered by CS, including 19.7% who were delivered by CS before start of labour and 8.7% who underwent CS during labour (Table 3). Table 3 presents the background characteristics related to course of labour and delivery for all the women who started labour spontaneously or whose labour was induced.

Table 3

Characteristics of labour and delivery

Variable	All participants		Participants with spontaneous labour[a]		Participants with induced labour[a]	
	N=817		n=594		n=40	
	n	%	n	%	N	%
Intake of traditional medicines during pregnancy[b]	**814**	**99.6**	**592**	**99.7**	**40**	**100**
Yes	163	20.0	130	22.0	9	22.5
No	651	80.0	462	78.0	31	77.5
Transferred from another health facility[b]	**815**	**99.8**	**592**	**99.7**	**40**	**100**
Yes	460	56.4	368	62.2	34	85.0
No	355	43.6	224	37.8	6	15.0
Reason for transfer [b]	**460**	**56.4**	**594**	**100**	**40**	**100**
Caesarean section	60	7.4	28	4.7	2	0.5
Pre-eclampsia	1	0.1	1	0.2	0	0.0
Prolonged labour/dystocia	39	4.8	36	6.1	1	2.5
Fetal distress	13	1.6	11	1.9	0	0.0
Uterine rupture	1	0.1	1	0.2	0	0.0
Severe bleeding	7	0.9	6	1.0	0	0.0
Other	339	41.4	285	48.0	35	87.5
Reason for transfer from another health facility[C]	**460**	**56.4**	**402**	**63.6**	**40**	**100**
Caesarean section	102	12.5	66	11.1	5	12.5
Pre-eclampsia	1	0.1	1	0.3	0	0.0
Placenta praevia	1	0.1	0	0.0	1	2.6
Prolonged labour/dystocia	46	5.6	40	10.6	2	5.3
Fetal distress	19	2.3	15	4.0	0	0.0
Uterine rupture	1	0.1	1	0.3	0	0.0
Prolapse of umbilical cord	1	0.1	1	0.3	0	0.0
Severe bleeding	3	0.4	3	0.8	0	0.0
Better management of pregnant woman	218	26.7	181	30.5	19	47.5
'Scarred uterus'	30	3.7	22	3.7	2	5.0
Post term	16	2.0	5	0.8	9	22.5
Other	22	2.6	15	4.0	2	5.3
Period when transferred[c]	**460**	**56.4**	**366**	**61.6**	**38**	**95.0**
Before labour started	179	38.9	106	29.0	32	84.2
During labour before delivery	281	61.1	260	71.0	6	15.8
Fetal presentation[c]	**747**	**91.4**	**582**	**98.0**	**40**	**100**
Cephalic	735	98.4	574	98.6	38	100
Breech	7	0.9	5	0.9	0	0.0
Face	2	0.3	2	0.3	0	0.0
Transverse	2	0.3	0	0.0	0	0.0
Other	1	0.1	1	0.2	0	0.0
Spontaneous rupture of membranes before arrival at health facility[c]	**810**	**99.1**	**590**	**99.3**	**40**	**100**
Yes	202	24.9	186	31.5	10	25.0
No	608	75.1	404	68.5	30	75.0
Systolic blood pressure on arrival to health facility (mmHg) [c]	**792**	**96.9**	**579**	**97.5**	**35**	**87.5**
≥160	31	3.9	5	0.9	0	0.0

140–159	71	9.0	57	9.8	1	2.9
<140	690	87.1	517	89.3	34	97.1
Systolic blood pressure at 4 hours in health facility (mmHg) [c]	**147**	**18.0**	**137**	**23.1**	**31**	**22.5**
≥160	2	1.4	2	1.5	0	0.0
140–159	2	1.4	2	1.5	0	0.0
<140	143	97.3	133	97.1	9	100
Diastolic blood pressure at arrival to health facility (mmHg) [c]	**784**	**96.0**	**572**	**96.3**	**34**	**85.0**
≥95	55	7.0	14	2.4	1	2.9
90-94	38	4.8	19	3.3	1	2.9
<90	691	88.1	539	94.2	23	94.1
Diastolic blood pressure at 4 hours in health facility (mmHg) [c]	**147**	**18.0**	**137**	**23.1**	**31**	**22.5**
≥95	1	0.7	1	0.7	0	0.0
90–94	0	0.0	0	0.0	0	0.0
<90	146	99.3	136	99.3	9	100
Hypertension on arrival to health facility[c]	**817**	**100**	**594**	**100**	**40**	**100**
Yes	101	13.8	70	11.8	3	7.5
No	633	86.2	524	88.2	37	92.5
Labour[c]	**795**	**97.3**	**594**	**100**	**40**	**100**
Spontaneous start	594	72.7	594	100		
Induction	40	5.0			40	100
Caesarean section before start of labour	161	19.7				
Cervical dilation grade on arrival to the health facility[c]	**769**	**94.1**	**571**	**96.1**	**38**	**95.0**
≤3 cm	341	44.3	157	27.5	34	89.5
4–5 cm	169	20.7	161	28.2	2	5.3
≥6 cm	259	33.7	253	44.3	2	5.3
Cervical dilation grade at 4 hours in health facility[c]	**172**	**21.1**	**161**	**27.1**	**10**	**25.0**
≤3 cm	1	0.6	1	0.6	0	0
4–5 cm	9	5.2	8	5.0	1	10
≥6 cm	162	94.2	161	94.4	9	90
Number of contractions 10-minutes after arrival at the health facility[c]	**559**	**68.4**	**519**	**87.4**	**33**	**82.5**
0	4	0.7	2	0.4	2	6.1
1	28	5.0	21	4.0	5	15.2
2	247	44.2	230	44.3	16	48.5
3 or more	280	50.1	266	51.3	10	30.3
Number of contractions after 4 hours in health facility[c]	**174**	**21.3**	**165**	**27.8**	**28**	**70.0**
0	0	0.0	0	0.0	0	0.0
1	0	0.0	0	0.0	0	0.0
2	51	29.3	45	27.3	6	50
3 or more	123	70.7	120	72.7	6	50
Duration of contractions on arrival to the health facility[c]	**556**	**68.1**	**517**	**87.0**	**32**	**80.0**
≤20 seconds	70	12.6	62	12.0	6	18.8
21–40 seconds	485	87.2	454	87.8	26	81.3
>40 seconds	1	0.2	1	0.2	0	0.0
Duration of contractions after 4 hours in health facility[c]	**172**	**21.1**	**159**	**26.8**		
≤20 seconds	4	2.3	4	2.5	0	0.0
21–40 seconds	168	97.7	155	97.5	12	30.0

>40 seconds	0	0.0	0	0.0	0	0.0
Position of the head of the fetus at 4 hours in health facility[c]	**175**	**21.4**	**163**	**27.4**	**11**	**27.5**
5/5	2	1.1	2	1.2	0	0.0
4/5	18	10.3	17	10.4	1	9.1
3/5	50	28.6	47	28.8	3	27.3
2/5	31	17.7	29	17.8	2	18.2
1/5	24	13.7	24	14.7	0	0.0
0/5	50	28.6	44	27.0	5	45.5
Use of partogram during labour[c]	**726**	**88.9**	**559**	**94.1**	**33**	**82.5**
Yes	555	76.4	519	92.8	32	97.0
No	171	23.6	40	7.2	1	3.0
Number of hours in maternity ward[c]	**740**	**90.6**	**527**	**88.7**	**39**	**97.5**
≤4	318	43.0	249	47.2	3	7.7
>4-8	123	16.6	112	21.3	3	7.7
>8-10	21	2.8	15	2.8	2	5.1
>10	10	37.6	151	28.7	31	79.5
Provision of pharmacological pain relief during labour[c]	**817**	**100**	**594**	**100**	**40**	**100**
Yes	10	1.2	10	1.7	0	0.0
No	807	98.8	584	98.3	40	100
Artificial augmentation of labour with oxytocin[c]	**817**	**100**	**594**	**100**	**40**	**100**
Yes	99	12.1	71	12.0	28	70
No	722	88.4	523	88.0	12	30
Reasons for artificial augmentation of labour with oxytocin[c]	**99**	**12.1**	**71**	**12.0**	**28**	**70.0**
Not enough uterine contractions	77	8.9	59	48.8	18	64.3
Cervix dilation was not progressing well	7	2.9	4	3.3	3	10.3
Fetus was not progressing well into pelvis	2	3.7	1	0.8	1	3.4
Other reasons	13	1.1	7	5.8	6	20.7
Artificial rupture of amnion done during labour[c]	**815**	**99.8**	**593**	**99.8**	**39**	**97.5**
Yes	215	26.2	202	34.1	13	33.3
No	601	73.7	391	65.9	26	66.7
Reasons for artificial rupture of amniotic membranes[c]	**215**	**26.2**	**202**	**34.1**	**13**	**33.3**
Not enough uterine contractions	54	6.6	54	21.9	5	31.3
Cervix dilation was not progressing well	8	2.2	8	3.2	1	6.3
Fetus was not progressing well into pelvis	9	3.7	9	3.6	2	12.5
Routine amniotomy	105	14.4	105	42.2	3	18.8
Completed cervix dilation	39	4.0	39	15.9	2	12.5
Episiotomy[c]	**817**	**100**	**594**	**100**	**40**	**100**
Yes	102	12.5	100	16.8	2	5.0
No	723	88.5	494	83.2	38	95.0
Reasons for episiotomy[c]	**102**	**12.5**	**100**	**16.8**	**2**	**5.0**
Protect the perineum	94	11.5	92	62.2	2	100
Routine episiotomy	5	0,6	5	3.4	0	0.0
Acute fetal distress	2	0.2	2	1.4	0	0.0
Other	1	0.1	1	0.7	0	0.0
Vacuum extraction[c]	**817**	**100**	**594**	**100**	**40**	**100**
Yes	10	1.2	9	1.5	1	2.5
No	807	98.8	495	98.5	39	97.5

Forceps extraction[c]	**817**	**100**	**594**	**100**	**40**	**100**
Yes	3	0.4	3	0.5	0	0.0
No	814	99.6	591	99.5	40	100.0
Indication for performed caesarean section[c]	**170**	**20.8**	**70**	**11.8**	**10**	**25.0**
Pre-eclampsia/eclampsia	2	1.2	0	0.0	0	0.0
Placenta praevia/Abnormal placenta insertion	1	0.6	0	0.0	0	0.0
Prolonged labour/dystocia	49	28.8	43	61.4	6	60.0
Acute fetal distress	6	3.5	3	4.3	1	10.0
Twin pregnancy	1	0.6	1	0.2	0	0.0
Bad presentation (not cephalic)	5	2.9	4	5.7	0	0.0
Scarred uterus	78	45.9	18	25.7	2	10.0
Post term pregnancy	16	9.4	0	0.0	1	20.0
Generally retracted pelvis	5	2.9	1	1.4	0	0.0
Other	7	4.1	0	0.0	0	0.0
Preeclampia/eclampsia[c]	**817**	**100**	**594**	**100**	**40**	**100**
Yes	8	1.0	4	0.7	0	0
No	809	99.0	630	99.3	40	100
Post-partum haemorrhage[c]	**817**	**100**	**643**	**100**	**40**	**100**
Yes	22	2.7	20	3.4	0	0.0
No	795	97.3	614	96.6	40	100
Post-partum haemorrhage [c]	**809**	**99.0**	**590**	**99.3**	**39**	97.5
<500ml	785	96.1	568	96.3	39	100.0
500–1000ml	17	2.1	16	2.7	0	0.0
>1000 ml	7	0.9	6	1.0	0	0.0
	Mean value	**SD**	**Mean value**	**SD**	**Mean value**	**SD**
Mean cervical dilation (cm) on arrival to the health facility[c]	4.21	3.22	5.38	2.38	1.26	1.8
Mean cervical dilation at 4 hours in health facility[c]	8.31	1.70	8.30	1.6	8.30	2.0
Mean number of hours in maternity ward[c]	10.38	14.19	8.63	11.97	27.49	24.14

[a]Women with spontaneous start of labour or with induced labour excluding those with elective CS (Self-reported data)
[b]Self-reported data
[c]Medical records data

For 69% of the women who underwent CS during labour (8.7%), prolonged labour/dystocia was the indication. In total, 56.4% of the women were transferred from a lower level to a higher level of health care and 61.1% of all the transferred women were in labour. About 68% of all women who delivered in district hospitals or in referral hospitals were transferred from facilities providing lower levels of care (Table 4).

Table 4

Background factors and characteristics of labour in relation to level of health care. Test of difference between groups using Pearson's Chi-Square test and Holm-Bonferroni method (p-value)

Variable	Health centre		District hospital		Referral /Private hospital		Chi-Square p-value	Holm-Bonferroni p-value
Maternal age (years)	**n**	**%**	**n**	**%**	**n**	**%**		
<25	62	40.5	105	25.1	70	28.7		
25-34	70	45.8	252	60.1	149	61.1		
≥35	21	13.7	62	14.8	25	10.1	0.003	0.069
Marital status								
Married or cohabiting	138	90.8	368	87.8	225	92.6		
Unmarried/single/widow/separated	14	9.2	51	12.2	18	7.4	0.135	**1**
Woman's education								
Completed secondary school and reached university	11	7.2	126	30.1	67	27.6		
Completed primary level	133	86.9	280	66.8	169	69.5		
None	9	5.9	13	3.1	7	2.7	**<0.001**	**<0.001[a]**
ANC attendance								
Yes	153	100	416	99.0	243	99.6		
No	0	0.0	4	1.0	1	0.4	0.386	1
Woman's employment								
Yes	143	93.5	357	28.2	191	82.0		
No	10	6.5	57	71.8	42	18.0	0.006	0.132
Health insurance								
Yes	153	100.	408	97.6	241	98.8		
No	0	0.0	10	2.4	3	1.2	0.182	1
Woman's height (m)								
<1.50	2	3.9	19	9.6	2	1.6		
≥1.50	49	96.1	178	90.4	125	98.4	0.010	0.200
Woman's weight before pregnancy (kg)								
<50	15	10.1	65	16.0	26	10.9		
≥50	133	89.9	341	84.0	213	89.1	0.080	1
Body mass index (BMI, kg/m^2)								
<18.5	1	2.0	11	5.8	6	4.8		
18.5–24.9	39	76.5	121	63.4	80	64.0		
25–29.9	8	15.7	45	23.6	20	16.0		
≥30	3	5.9	14	7.3	14	15.2	0.098	1
Weight gained during pregnancy (kg)								
0 or weight decrease	9	6.5	18	4.6	16	7.0		
1–10	106	76.3	305	77.2	149	64.8		
10–20	23	16.5	67	17.0	62	27.0		
>20	1	0.7	5	1.3	5	1.3	0.035	0.630
Number of miscarriages								
0	136	88.9	376	89.5	220	90.2		
1	13	8.5	36	8.6	23	9.4		
2	3	2.0	7	1.7	0	0.0		

>2	1	0.7	1	0.2	1	0.4	0.538	1
Number of births (including the index child)								
Primiparity	54	35.3	177	42.1	103	42.4		
Multiparity	99	64.7	243	57.9	140	57.6	0.290	1
Number of children born at home								
0	134	87.6	387	92.1	234	95.9		
≥1	19	12.4	33	7.9	10	4.1	0.009	0.189
Hypertension during pregnancy								
No	148	96.7	391	93.1	235	96.3		
Yes	5	3.3	29	6.9	9	3.7	0.095	1
Anaemia during pregnancy								
No	124	81.0	361	86.0	210	86.1		
Yes	29	19.0	59	14.0	34	13.9	0.301	1
Transfer from other health facility								
Yes	6	3.9	287	68.3	167	68.4		
No	147	96.1	133	31.7	77	31.6	**<0.001**	**<0.001** [a]
Labour								
Spontaneous labour and vaginal delivery	148	96.7	221	52.6	164	67.2		
Spontaneous labour and delivery by caesarean section	0	0.0	44	10.5	17	7.0		
Induction of labour	2	1.3	27	6.4	11	4.5		
Caesarean section before labour	0	0.0	122	29.0	39	16.0	**<0.001**	**<0.001** [a]
Cervical dilation grade on arrival at health facility								
≤ 3 cm	20	13.4	201	52.1	120	51.3		
4-5 cm	49	32.9	71	18.4	49	20.9		
≥6 cm	80	53.7	114	29.5	65	27.8	**<0.001**	**<0.001** [a]
Cervical dilation at 4 hours in the health facility								
≤3 cm	0	0.0	1	1.0	0	0.0		
4–5 cm	0	0.0	6	6.2	3	11.5		
≥6 cm	49	100.	90	92.8	23	88.5	0.217	**1**
Duration of contractions at arrival in the health facility								
≤20 seconds	23	15.9	37	14.7	10	6.3		
21–40 seconds	122	84.1	213	84.9	150	93.8		
>40 seconds	0	0.0	1	0.4	0	0.0	0.048	0.816
Duration of contractions at 4 hours in the health facility								
≤20 seconds	2	4.0	1	1.0	1	3.8		
21–40 seconds	48	96.0	95	99.0	25	96.2		
>40 seconds	0	0.0	0	0.0	0	0.0	0.454	**1**
Use of partogram				67.4				
Yes	144	99.3	248	32.6	163	76.5		
No	1	0.7	120		50	23.5	**<0.001**	**<0.001** [a]
Pharmacological pain relief during labour				1.4				
Yes	2	1.3	6	98.6	2	0.8		
No	151	98.7	414		242	99.2	0.785	**1**
Caesarean section done during labour				11.9				
Yes	0	0.0	50	88.1	21	8.6		
No	153	100.	370		223	91.4	**<0.001**	**<0.001** [a]

Health provider assisting the delivery				6.0				
Nurse	125	84.5	25	41.0	3	1.2		
Midwife	23	15.5	170	53.0	130	53.3		
Doctor	0	0.0	220		111	45.5	**<0.001**	**0.002**[a]
Pre-eclampsia/eclampsia								
Yes	2	1.3	4	1.0	2	0.8		
No	151	98.7	416	99.0	242	99.2	0.888	1
Caesarean section due to prolonged labour								
Yes	0	0.0	19	4.5	24	9.8		
No	153	100	401	95.5	220	90.2	**<0.001**	**<0.001**[a]
Post-partum haemorrhage								
Yes	6	3.9	13	3.1	3	1.2		
No	147	96.1	407	96.9	241	98.8	0.209	1
Self-rated health before pregnancy[b]								
Good	138	90.2	375	89.5	234	95.9		
Poor	15	9.8	44	10.5	10	4.1	0.014	0.266
Self-rated health during pregnancy[b]								
Good	101	66.0	284	67.8	177	72.5		
Poor	52	34.0	135	32.2	67	27.5	0.309	1
Self-rated health postpartum[b]								
Good	136	88.9	366	87.1	201	82.4		
Poor	17	11.1	54	12.9	43	17.6	0.123	1

[a]Statistical significant p-value after correction with Holm-Bonferroni method.
[b]Poor-SRH (Poor self-rated health status) includes very poor and poor health status categories and Good-SRH (Good self-rated health status) includes very good and good health status categories.

The majority of transferred women (n=460; 62.4%) were moved from health centres to a district hospital (Figure 1) with 'CS' (12.5%), or a scarred uterus (3.7%), or to ensure 'better management' (26.7%) as the main reasons for transferral. A partogram was used during labour for almost all the women who delivered at health centres, but was only used by 67% of the district hospitals (Table 4). Table 4, presents background characteristics related to course of labour and delivery in relation to the level of health care. In total, 44.3% of pregnant women arrived at a health facility with a cervical dilation grade ≤3 cm, 22% with cervical dilation grade between 4–5 cm, and 31.7% with cervical dilation grade ≥6 cm (Figure 1). Pregnant women who arrived at a health facility with a cervical dilation grade ≤3 cm spent more hours in maternity ward (median value 9.25 hours; IQR: 3.33-18.50) compared to those who arrived with a cervical dilation grade of 4–5 cm (median value 5.42 hours; IQR: 1.17-15.00;

p<0.001) and those who arrived with a cervical dilation grade of ≥6 cm (median value 2.92 hours; IQR: 1.00-6.17; p<0.001) (Figure 2).

Pregnant women who arrived at a health facility with a cervical dilation grade ≤3 cm, and who did not receive oxytocin during labour, spent more hours in a maternity ward compared to those who arrived with a cervical dilation grade ≤3 cm and who received oxytocin during labour (median value 14.17 hours; IQR: 5.42-19.58; p<0.001) (Figure 3). Pregnant women who arrived at a health facility with a cervical dilation grade between 4–5 cm and who did not receive oxytocin during labour spent more hours in a maternity ward compared to those who arrived with a cervical dilation grade between 4–5 cm and received oxytocin during labour (median value 5.13 hours; IQR: 3.16-8.31; p=0.007). Those who arrived at a health facility with a cervical dilation grade ≥6 cm and did not receive oxytocin during labour spent more hours in a maternity ward compared to those who arrived with a cervical dilation grade ≥6 cm and received oxytocin during labour (median value 1.45 hours; IQR: 0.50-3.67), p<0.001).

Prevalence of pregnancy-related complications

The prevalence of hypertension upon arrival to the health facility was 13.8%. The prevalence of eclampsia/pre-eclampsia, PPH, and CS due to prolonged/dystocia labour was 1%, 2.7%, and 5.4% of all pregnant women respectively. Prolonged/dystocia labour comprised 28.8% of all indications for CS.

Factors associated with caesarean section due to prolonged labour/dystocia

In the bivariable analysis, the following were statistically significant factors associated with CS due to prolonged labour/dystocia: poor households with a monthly

income of less than 36,000 RWF (i.e. approximately 45 USD), residence far from a health facility (distance from home to a health facility >1 km), and cervical dilation grade <6 cm upon arrival to a health facility. In the multivariable analysis, the same background factors and nulliparity were significantly associated with CS due to prolonged labour/dystocia (Table 5).

Table 5

Bivariable and multivariable logistic regression analyses with calculation of crude odds ratios and adjusted odds ratios and their 95% confidence intervals (CI) for CS due to prolonged labour/dystocia in relation to specified background variables

Variable	Caesarean section due to prolonged labour/dystocia							
	Bivariable analysis						Multivariable analysis	
	Yes		No					
Maternal age (years)	**N**	**%**	**N**	**%**	**Crude OR**	**95% CI**	**Adjusted OR**	**95% CI**
<25	13	5.5	224	94.5	1		1	
25–34	28	5.9	443	94.1	0.91	0.46–1.80	0.67	0.30–1.48
≥35	2	1.9	106	98.1	0.29	0.70–1.27	0.40	0.09-1.80
Marital status								
Married or cohabiting	41	5.6	690	94.4	1			
Unmarried or single or widow or separated	2	2.4	81	97.6	0.41	0.09–1.75		
Women's education								
Completed secondary level or reached university level	13	6.4	191	93.6	1			
Completed primary level	29	5.0	553	95.0	0.77	0.92—1.51		
Never attended school	1	3.4	28	96.6	0.52	0.06—4.16		
Woman's employment								
Employed	37	5.4	654	94.6	1			
Not employed	6	5.5	102	94.5	1.03	0.42—2.50		
Number of births								
Multiparity	12	2.7	434	97.3	1		1	
Primiparity	1	2.9	34	97.1	1.03	0.13–8.18	**3.79**	**1.79–8.01**
Number of previous children delivered at home								
None	40	5.3	715	94.7	1			
1 or more	3	4.8	59	95.2	0.90	0.27–3.02		
History of miscarriages								
No	37	5.6	621	94.4				
Yes	5	6.6	71	93.4	1.18	0.45-3.10		
HIV status								
Negative	42	5.5	723	94.5	1			
Positive	1	1.9	51	98.1	2.96	0.40–21.96		
Health Insurance								

Yes	42	5.2	760	94.8	1			
No	1	7.7	12	92.3	1.50	0.19–11.87		
Household monthly income								
≥36,000 RWF	11	10.9	90	89.1	**1**		1	
<36,000 RWF	32	4.8	641	95.2	**2.44**	**1.19–5.02**	**4.86**	**2.08–11.35**
Distance to the health facility								
≤1 km	32	7.2	413	92.8	1		1	
>1 km	11	3.0	358	97.0	**2.55**	**1.25–5.07**	**3.30**	**1.53–7.11**
Antenatal care visit								
Yes	41	5.3	737	94.7	1			
No	1	3.3	2996.		1.61	0.21–12.13		
Anaemia during pregnancy								
No	39	5.6	656	94.4	1			
Yes	4	3.3	118	96.7	0.57	0.20–1.62		
Bad smell during pregnancy								
No	42	5.8	683	94.2	1			
Yes	1	1.1	91	98.9	0.17	0.02–1.31		
Transfer from another health facility								
No	14	3.9	343	96.1	1			
Yes	29	6.3	431	93.7	1.64	0.85–3.16		
When transferred								
Before start of labour	7	3.9	172	96.1	1			
During labour before delivery	22	7.8	259	92.2	2.08	0.87–4.99		
Cervical dilation grade on arrival to health facility								
≤3 cm	28	8.2	313	91.8	**4.54**	**1.73–11.93**	**6.17**	**2.20–17.28**
4-5 cm	10	5.9	159	94.1	**3.19**	**1.07–9.51**	**4.03**	**1.27–12.71**
≥6 cm	5	1.9	254	98.1	1		1	
Woman's weight (kg)								
<50	5	4.7	101	95.3	1.11	0.42–2.91		
≥50	36	5.2	651	94.8	1			
Self-rated health before pregnancy[a]								
Good	42	5.6	705	94.4	1			
Poor	1	1.4	68	98.6	0.24	0-03–.82		
Self-rated health during pregnancy[a]								
Good	39	6.9	523	93.1	1		**1**	
Poor	4	1.6	250	98.4	**0.21**	**0.07–0.60**	**0.22**	**0.07–0.65**

[a]Poor-SRH (Poor self-rated health status) includes very poor and poor health status categories and Good-SRH (Good self-rated health status) includes very good and good health status categories.

DISCUSSION

In this study, we found that the prevalence of health facility-based pre-eclampsia/eclampsia and PPH were very low (1% and 2.7%, respectively). CS was the main reason for transfer of women from health centres to district hospitals, and dystocia/prolonged labour was the main indication for CS. Furthermore, risk factors

for having a CS due to prolonged labour included living in a poor household, nulliparity, and residence far from a health facility.

The estimated prevalence of self-reported pregnancy-related health problems during pregnancy - i.e., anaemia, severe vaginal bleeding, hypertension, and diabetes mellitus - were comparable to results from other studies. Previously, the prevalence for self-reported anaemia for women of reproductive age in Rwanda has been found to be similar to that in our study.[16] In addition, self-reported post-partum anaemia investigated in China is comparable to our findings[26]; Sub-Saharan African prevalence of gestational diabetes mellitus is also similar to the range found in our study.[9 27] The estimated prevalence of pregnancy-related complications pre-eclampsia/eclampsia and PPH was very low compared to the prevalence in other countries in Africa.[7 8 28] For example, in other low and middle income sub-Saharan African countries, the prevalence of pre-eclampsia is estimated to be three times higher than our result.[8] However, one study reported the prevalence of pre-eclampsia/eclampsia in neighbouring countries of Rwanda (Democratic Republic of Congo, Kenya, and Uganda) as being similar to the results of our study.[10] In referral hospitals in Rwanda and Uganda, PPH is three to ten times more common than estimated in our study.[6 7 28] Possible explanations for these differences may be misclassifications by health care providers. For example, pre-eclampsia may have been incorrectly classified as other hypertensive disorder during pregnancy or not been classified. Another explanation for these differences is that we only included survivors of pregnancy-related complications so we underestimated the true prevalence of the condition because a number of women actually died from these complications. In a tertiary care hospital in Rwanda, post-partum haemorrhage and pre-eclampsia/eclampsia represented a case fatality rate of 22% and 16%,

respectively.[7] Health providers may have underreported PPH cases after having managed to stabilise the woman because they misevaluated the quantity of blood loss. Another explanation may be that the health care providers were not able to adequately evaluate total blood loss because the woman had been transferred from another health facility. Moreover, some physicians may not want to report post-partum haemorrhage to avoid audit problems because the Ministry of Health has introduced maternal death audits in health centres and district hospitals for such cases.[29]

The majority of women referred were transferred from health centres to district hospitals. Most of the women who gave birth in district and referral hospitals were transferred from a facility providing a lower level of health care. These results are in the line with the pyramidal composition of the Rwandan health system in which a large number of cases are managed at lower levels of health care, and only complicated cases are referred to the next level of health care.[23] In about one-third of cases, a partogram was not used to monitor labour in pregnant women delivering in district and referral hospitals. This result is low compared to WHO recommendations of using partograms for all women in monitoring labour, although it is comparable to results obtained in Uganda.[30, 31]

CS was the main reason for being transferred, and previous studies show that in sub-Saharan Africa transfer of pregnant women in labour is always associated with a risk of delay due to lack of transportation and bad roads, a situation that increases the risk of additional complications such as maternal fistula or even fetal death.[32 33] Upgrading the capacity of health centres in the management of pregnant women with special focus on the management of prolonged labour/dystocia and performing CS may decrease the number of maternal transfers, prevent risks related to prolonged labour,

and allow district hospitals to receive fewer cases. This would enable the district hospitals to spend more time on other pregnancy-related complications. Since 2012, clinical officers in Rwanda have been trained and two cohorts of clinical officers have been graduated but are not yet engaged in the Rwandan health system.[34] The use of these newly trained clinical officers in Rwandan health centres, a strategy used in other middle and low income sub-Saharan countries, may be of significance as it has been shown that there are few differences in clinical outcomes after CS performed by clinical officers or physicians.[34 35] In this study, the CS rate was almost two times higher than the national rate and higher than the recommended WHO rate but the CS rates were in the range of those in Kigali hospitals.[7 20 36]

Being in a poor household located far from a health facility was a statistically significant factor associated with CS due to prolonged labour/dystocia. This finding is in agreement with previous studies reporting a statistical association between prolonged labour and low socio-economic level and being a pregnant woman living in a rural area.[37] Poor roads and long distances to a health facility are risk factors for prolonged labour/dystocia.[33] Arriving at a health facility with cervical dilation grade of less than 6 cm and being nulliparious were factors associated with CS due to prolonged labour/dystocia. It has been reported previously that less advanced cervical dilation grade at admission and nulliparity are risk factors for prolonged labour.[37 38]

Methodological considerations

One strength of this study is that all the women eligible consented to participate. In Rwanda, all health-related studies that are conducted need both ethical approval from the Rwandan National Ethics Committee (RNEC) and authorisation from the Ministry of Health. Commonly, the Ministry of Health is associated with these studies. This

may contribute to the high participation rates seen in almost all studies done in Rwanda, since Rwandan people are known to comply with all activities conducted by the government.[16 39-41] Female professional interviewers with nursing and midwifery backgrounds, who were not working at the selected health facilities, were employed because of their knowledge of the items in the questionnaire and the terminology used in medical records. The strategy was also used to make the women feel comfortable while responding to questions. One limitation is that this study estimated only the health facility prevalence of complications related to pregnancy. There may be underreporting of the prevalence of complications related to pregnancy, as, for example, in the case of maternal deaths occurring in the community. Pregnancy-related complications are mainly managed at the district hospital level. However, these hospitals are mainly staffed with general practitioners who may have high workloads and limited knowledge of pregnancy-related complications. In addition, the hospitals often lack the equipment necessary for management of complicated pregnancies.[42] This may have led to underreporting of some cases by misinterpretation. There may have been some overreporting of cases in relation to the population-based prevalence because of selection bias, since cases with complications are aggregated in hospitals for more advanced health care.

CONCLUSIONS

The health facility-based prevalence of pre-eclampsia/eclampsia, PPH, and CS due to prolonged labour/dystocia was low in this sample from Rwanda. The estimated prevalences in this study were probably underestimated due to the high workload and limited obstetric knowledge of physicians. The majority of pregnant women giving

birth at district hospitals were transferred from health centres, and CS was the main reason for transfer. Prolonged labour was the main indication of CS during labour. Almost half of the women who were delivered at district hospitals were assisted by a physician. Upgrading the capacity of Rwandan health centres by using clinical officers may decrease the number of maternal transferrals to facilities with higher level of health care, decrease risks of aggravation of pregnancy-related complications during transferral, and improve maternal and fetal health.

COMPETING OF INTEREST

The authors declare no competing interests.

AUTHORS' CONTRIBUTIONS

JPSS participated in the design of the study and the development of the study tools, data collection in the field. JPSS performed the data analysis, wrote the manuscript, and approved the final version of the manuscript.

GK participated in the design of the study and the development of the study tools, drafting of the manuscript and approved the final version of the manuscript.

MN participated in the design of the study and the development of the study tools. He participated in data collection in the field, drafting of the manuscript and approved the final version of the manuscript.

CM participated in the design of the study and the development of the study tools. He participated in data collection in the field, drafting of the manuscript and approved the final version of the manuscript.

KE participated in the design of the study and the development of the study tools, drafting of the manuscript and approved the final version of the manuscript.

IM participated in the design of the study and the development of the study tools. IM supervised the data analysis and the manuscript writing and approved the final version of the manuscript.

DATA AND MATERIALS SHARING

The datasets used and analysed during the current study will be available from the corresponding author upon receiving a reasonable request.

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FIGURE CAPTION LIST

Figure 1. Type of health facility where participants were transferred, cervical dilation grade upon arrival at health facility, and description of delivery

Figure 2. Type of health facilities where participants were transferred, cervical dilation grade at arrival at health facility and description of delivery

Figure 3. Frequency of participants in relation to the number of hours in the maternity ward until delivery and in relation to use (n=49) or non-use of oxytocin (n=292) for participants with cervical dilation grade of ≤3 cm upon arrival to the health facility

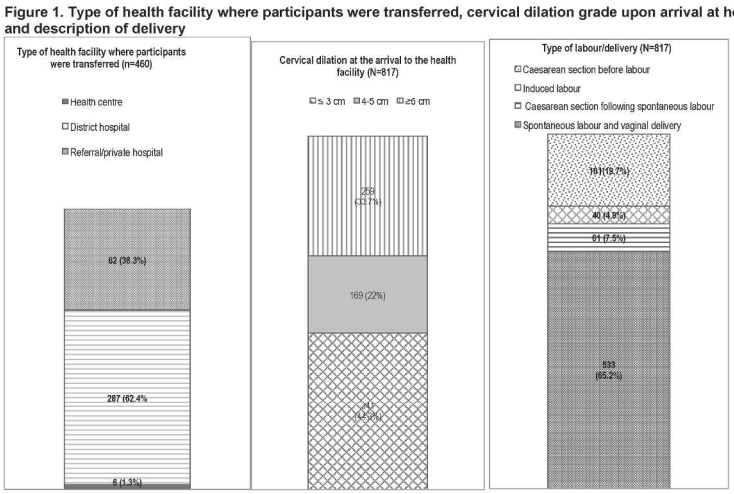


Figure 1. Type of health facility where participants were transferred, cervical dilation grade upon arrival at health facility, and description of delivery

297x209mm (300 x 300 DPI)

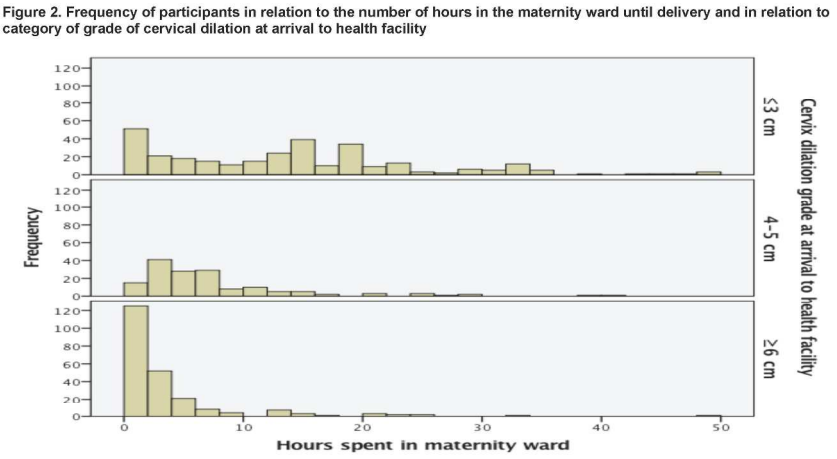
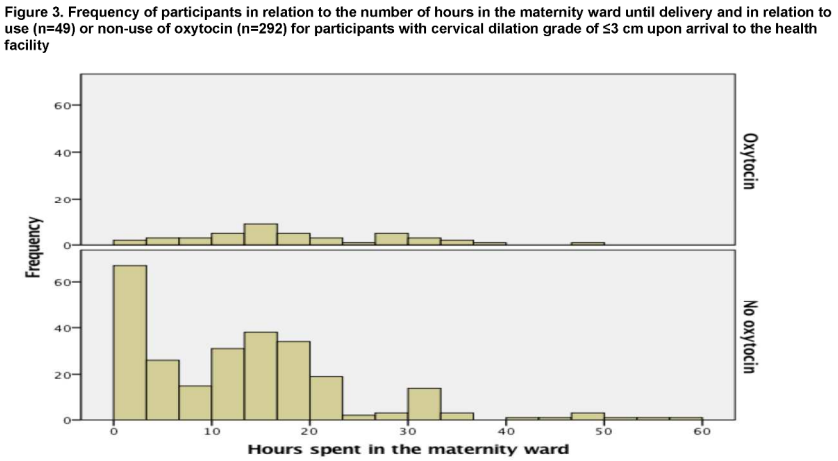


Figure 2. Type of health facilities where participants were transferred, cervical dilation grade at arrival at health facility and description of delivery

297x209mm (300 x 300 DPI)



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297x209mm (300 x 300 DPI)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2 and 7
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6,7 and 8
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	8
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5, 9, 10 and 11
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	9,10 and 11
Bias	9	Describe any efforts to address potential sources of bias	*3 and 7*
Study size	10	Explain how the study size was arrived at	7 and 8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	11 and 12
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	11 and 12
		(*b*) Describe any methods used to examine subgroups and interactions	11 and 12
		(*c*) Explain how missing data were addressed	11 and 12
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	11 and 12
		(*e*) Describe any sensitivity analyses	11 and 12
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7 and 8
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	13-15
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	25-26
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	25-26
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	26-27
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	26-27
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	29
Generalisability	21	Discuss the generalisability (external validity) of the study results	29
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.