Functional recovery after cesarean delivery: a prospective cohort study in rural Rwanda

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Abstract

Background

Women who deliver via cesarean section (c-section) experience short- and long-term complications that may affect their physical health and their ability to function normally. While physical health outcomes are routinely assessed and monitored, postpartum functional outcomes are not well understood from a patient's perspective or characterized by clinicians. In Rwanda, 11% of rural women deliver via c-section. This study explores the functional recovery of rural Rwandan women after c-section and assesses factors that predict poor functionality at postoperative day (POD) 30.

Methods

Data were collected prospectively on POD 3, 11, and 30 from women delivering at Kirehe District Hospital between October 2019 and March 2020. Functionality was measured by self-reported overall health, energy level, mobility, self-care ability, and ability to perform usual activities. We computed composite mean scores with a maximum score of 4.0 and scores $\leq$ 2.0 reflected poor functionality. We assessed functionality with descriptive statistics and logistic regression.

Results

Of 617 patients, 54.0%, 25.9%, and 26.8% reported poor functional status at POD3, POD11, and POD30, respectively. At POD30, the most self-reported poor functionality dimensions were poor or very poor overall health (48.1%), and inability to perform usual activities (15.6%). In the adjusted model, women whose surgery lasted 30–45 minutes had higher odds of poor functionality (aOR = 1.85, p = 0.01), as did women who experienced intraoperative complications (aOR = 4.12, p = 0.037). High income patients had incrementally lower significant odds of poor functionality (aOR = 0.62 for every US$100 increase in monthly income, p = 0.04).

Conclusion

We found a high proportion of poor functionality 30 days post-c-section and while surgery lasting > 30 minutes and experiencing intra-operative complications was associated with poor functionality, a reported higher income status was associated with lower odds of poor functionality. Functional status assessments, monitoring and support should be included in post-partum care for women who delivered via c-section. Effective risk mitigating intervention should be implemented to recover functionality after c-section, particularly among low-income women and those undergoing longer surgical procedures or those with intraoperative complications.

Background

When medically indicated, cesarean sections (c-sections) are a life-saving mode of delivery for both mother and baby [1]. Recent years have seen a rapid increase in c-section delivery rates, both in high-income and low- to middle-income countries (LMICs) [2, 3]. C-section delivery itself is associated with short- and long-term changes in a woman's physical health, including altered functional status [4, 5]. Recovery after c-section may have a lengthy trajectory [6], and better understanding of postpartum functional outcomes is key to informing clinicians and designing relevant interventions. This is particularly important for women in rural and resource-constrained settings where poverty may necessitate women returning to work shortly after childbirth [7, 8].

The literature around post-c-section recovery has largely focused on postoperative clinical signs and symptoms complications, with little attention on functional abilities and the wellbeing of these women. Women delivering via c-section face physical discomfort for weeks, which may limit their functionality and mobility [9, 10]. In Sudan and China, women reported that pain after c-section affected their ability to care for their newborns [11]. A study in rural India found that women who delivered via a c-section reported minor to severe problems related to mobility, self-care, or ability to perform usual activities through the first postoperative month [12]. While there are no reported risk factors for poor post-c-section functional status, parity, duration of surgery, and preoperative depression have been shown to predict persistence of pain and to negatively affect recovery (13, 14].

In Rwanda, 17% of women nationally and 11% of rural women deliver via c-section [15]. While some studies have reported high rates of surgical site infections (SSIs) after c-section, ranging from 5%-17% [16, 17, 18], there is paucity of data assessing functional recovery among women who undergo c-section in rural Rwanda. This study reports functional status and predictors of poor functionality among rural Rwandan women through the first month post-cesarean delivery.

Methods

This study was conducted as part of a large prospective cohort study designed to evaluate the feasibility, acceptability, and diagnostic efficacy of photo-enhanced screening for SSI diagnosis following cesarean delivery, and included data collected on c-section patients at three different time points: day of discharge (approximately post-operative day (POD) 3), POD 11 (± 3days), and POD 30 (± 1 day).

Setting:

The parent study was conducted at Kirehe District Hospital (KDH), located in the Eastern Province of Rwanda. KDH encompasses 19 health centers and serves a population of over 360,000. Most Kirehe residents are insured through "*Mutuelle de Sante*" - a community-based health insurance scheme, which allows patients to pay only 10% of their healthcare cost. KDH is managed by the Rwandan Ministry of Health (MoH) and receives technical and financial support from Partners In Health/Inshuti Mu Buzima (PIH/IMB), a Boston-based non-governmental international organization. In Kirehe, like other rural areas

of Rwanda, labor is monitored at the local health center for normal delivery, while complicated deliveries, high-risk pregnancies, and women who need a c-section delivery are subsequently transferred to KDH for higher level management. C-sections at KDH are performed by general practitioners (GPs) and post-cesarean recovery is monitored by midwives or nurses. There is one obstetrician-gynecologist who assists GPs on more complicated cases and mentors them in the performance of emergency interventions. When there are no complications, a woman is hospitalized for three days after her c-section and is then discharged home to continue wound dressing changes and evaluation at her local health center.

Study population:

The parent study recruited women, regardless of age, who were permanently residing in Kirehe District and who had a c-section delivery at KDH between September 23rd, 2019 and February 28th, 2020. In our analysis, we excluded women who consented to the study before the start of data collection on functional outcome variables (October 23rd, 2019), women who enrolled after February 28th, 2020 as we were unable to complete follow-up due to COVID-19 restrictions, and participants missing functional data at all three data collection points. The parent study excluded women who resided outside the KDH's catchment area and women from Mahama Refugee Camp.

Primary data source and validation

At POD 1, experienced data collectors recruited patients, obtained consent, and administered a structured questionnaire to collect self-reported demographic data, including *Ubudehe* categories. *Ubudehe* is a four-tired socioeconomic rank system, with *Ubudehe* 1 being the poorest rank and 4 being the wealthiest.

At the time of discharge (approximately POD 3), data collectors administered self-report questions on functional status and extracted clinical data from patients' charts. We administered a second survey on functional status at POD 11 (± 3 days), when participants had returned to the outpatient clinic for follow-up and physical exam. At POD 30, study team members called mothers and administered a third functional status survey.

Using a validated quality of life questionnaire [19, 20], we assessed functional status using five dimensions: ability to move independently, ability to selfcare, ability to perform usual activities, level of energy, and overall health. All five dimensions were self-reported and included four levels with 1 representing poorest or lowest level of functionality for each dimension and 4 representing the best or highest level of functionality.

At each time point, data collectors entered data into a password protected electronic data collection application (REDCap) [21]. The study team lead regularly checked and confirmed the data quality. To maximize the response rate for the POD 30 phone call, we requested patients to provide multiple phone numbers (home phone, family member's phone, and neighbor's phone) on which they could be reached. We contacted a local community health worker to help trace participants who could not be reached on

designated phone numbers. If participants could not be reached on the first attempt, they were called two additional times on two different days.

Analysis and statistics:

We restricted data analysis to participants with data collected on at least one of the follow up time points. We summarized demographic and clinical characteristics of participants using frequencies and percentages for categorical data, and medians and interquartile ranges (IQR) for asymmetrically distributed continuous data. We described the five dimensions of functional status at POD 3, POD 11, and POD 30, using frequencies and percentages. We assessed overall functional status through a composite variable of overall function based on the mean scores of the five dimensions of functional status. Composite scores ranged from one to four with one representing the poorest level of functionality and 4 representing the highest level of functionality. We further dichotomized functionality into poor and good function, with scores of 2 or lower reflecting poor function and scores of greater than 2 representing good function. We assessed the association between demographic and clinical characteristics and poor functionality at POD 30 using Chi-square tests for categorical independent variables and Wilcoxon rank sum tests for continuous independent variables. Variables with a p-value < 0.2 in a bivariate analysis were considered for a multivariate analysis using logistic regression and were included in the full model. Subsequent reduced models were built by removing the least statistically significant variables one at the time. We assessed statistical significance in the multivariate analysis at the $\alpha = 0.05$ significance level. We used Stata/IC version 15.1(College Station, TX: StataCorp LP) for all statistical analyses.

Results

A total of 639 women were included in the study, with 511 (80.0%) having follow up at all three time points, 548 (85.8%) with follow up at two time points, and 602 (94.2%) with at least one follows up. Most women were between 20 and 34 years old (n = 477, 74.6%), with 56 (8.8%) under 20 years and 106 (16.6) over 34 years (Table 1). The majority of women lived with a partner (n = 536, 83.9%). Most (n = 543, 85%) were farmers and the median self-reported annual household income was US$1,624 ($1,133, $2,675), with 72 participants (11.3%) belonging to the lowest rank of *Ubudehe* categories. The median travel time from the woman's home to the health center was 30 minutes (IQR: 15, 60) and 40 minutes (IQR: 5, 60) from health center to the hospital. Primipara accounted for 40.4% (n = 258) of women, and 264 women (41.4%) had one or two previous births. Approximately 30% of women (n = 188) had a prior c-section delivery.

Table 1
Demographic and clinical characteristics of women delivering via c-section at Kirehe District Hospital

Variable name	Frequency (n)	Percentage (%)
N	639	100%
DEMOGRAPHIC CHARACTERISTICS		
Age, in years		
< 20	56	8.8%
20–24	191	29.9%
25–29	175	27.4%
30–34	111	17.4%
>=35	106	16.6%
Parity		
0	258	40.4%
1–2	264	41.4%
3–4	73	11.4%
> 4	43	6.7%
Marital Status		
Single, separated, divorced/widow	103	16.1%
Legally married	237	37.1%
Cohabitating (common marriage)	299	46.8%
Level of education		
Less than primary	60	9.4%
Completed primary	431	67.5%
Completed secondary or more	148	23.1%
Has health insurance	636	99.5%
Ubudehe categories		
Ubudehe 1	72	11.3%
Ubudehe 2	334	52.4%
Ubudehe 3&4	231	36.3%
Occupation		

Variable name	Frequency (n)	Percentage (%)
Farmer	543	85.0%
Employed (self, government, etc.)	74	11.6%
Unemployed (including housewives and students)	22	3.4%
Travel time in minutes, HC to hospital, Median (IQR)	30	(15,60)
Travel time in minutes, HC to hospital, Median (IQR)	40	(5,60)
Annual Income in USD, Median (IQR)	$1,624	($1,133, $2675)
CLINICAL CHARACTERISTICS		
Had previous c-section	188	29.56%
Reasons for surgery (N = 630)		
Fetal factors, no maternal factors	213	33.8%
Maternal factors, no neonatal factors	177	28.1%
Previous c-section only	140	22.2%
Maternal and fetal factors	100	15.9%
Any intraoperative complication		
Yes	12	1.9%
Not documented	627	98.1%
Duration of c-section surgery (in minutes) (N = 623)		
<=30	189	30.3%
(30–45]	290	46.5%
(45–60]	79	12.68%
> 60	65	10.43%
Length of hospital stay post-c-section, in days (N = 601)		
<=3 days	240	39.9%
> 3 days	361	60.1%
Surgical c-section categories		
Emergent	38	6.0%
Urgent	562	88.1%
Elective	38	6.0%

Variable name	Frequency (n)	Percentage (%)
Neonatal outcomes at discharge (N = 631)		
Alive and discharged	553	87.6%
Alive and admitted to NICU	63	10.0%
Died	15	2.4%
*** Defined by any of the following: prior uterine scar, obstructed labor, contracted pelvis, hypertension, fever, hemorrhage, uterine rupture, placental abnormality**		
****Defined by any of the following: Fetal distress, mal presentation, malposition, macrosomia, multiple pregnancies, cord prolapse, intrauterine growth restriction**		
□ Converted using Rwanda purchasing power parity (PPP) for 2018		

Nearly all women (n = 600, 94.1%) had an urgent or emergency surgery. The indication for c-section was: fetal factors only (n = 213, 33.8%), maternal factors only (n = 177, 28.1%), prior c-section (n = 140, 22%) and combined fetal and maternal factors (n = 100, 15.9%). Nearly half of all women (n = 290, 46.5%) had surgery length ranging between 30 to 45 minutes, 189 (30.3%) had a surgery length of less than 30 minutes, and 65 (10.4%) had a surgery length of greater than an hour. Over 60% (n = 361) of participants had a hospital stay greater than three days (Table 1)

Table 2 summarizes the five dimensions of functional status of patients at POD 3, POD 11 and POD 30. The majority of women were able to move independently at the time of hospital discharge (83.3%, n = 518 of 622) at POD 11 (84.7%, n = 499 of 589) and at POD30 (91.0%, n = 500 of 549). Participants reported the lowest level of functionality in the dimension assessing ability to perform usual activities, with 50.8% (n = 316 of 622) of women reporting total inability to perform usual activities at hospital discharge and 15.6% (n = 86 of 551) at POD 30. At POD 30, 68.6% (n = 368 of 551) women reported needing help to perform usual activities, 48.6% (268 of 551) reported poor or very poor overall health status, and 80 14.5% (n = 80 of 551) reported needing help to self-care. The overall functional status was poor for 54.0% (n = 333 of 617) and 26.8% (n = 147 of 548) of women at POD 3 and POD 30, respectively. Of the 147 women with poor functional status documented at POD 30, 78 (53%) had reported poor functional status at POD 3, while 79 (47%) had good functional status at POD 3 and deteriorated over the following month.

Table 2
Description of dimensions used to define functional status of women at Kirehe district Hospital

	At discharge		POD11		POD30	
DIMENSION OF FUNCTION	**n**	**%**	**n**	**%**	**n**	%
Mobility/ Ability to move	**N = 622**		**N = 589**		**N = 549**	
I cannot move	1	0.2%	0	0.0%	2	0.4%
I need some help to move	30	4.8%	9	1.5%	28	5.1%
I need very little help to move	73	11.7%	81	13.8%	19	3.5%
I can move independently	518	83.3%	499	84.7%	500	91.0%
Level of Energy	**N = 622**		**N = 590**		**N = 551**	
Very low	11	1.8%	12	2.1%	21	3.8%
Low	175	28.1%	114	19.3%	107	19.4%
Moderate	421	67.7%	412	69.8%	364	66.1%
High	15	2.4%	52	8.8%	59	10.7%
Ability to perform usual activities	**N = 622**		**N = 588**		**N = 551**	
I cannot perform activities	316	50.8%	145	24.7%	86	15.6%
I need some help to perform activities	229	36.8%	165	28.1%	139	25.2%
I need little help performing activities	63	10.1%	148	25.2%	239	43.4%
I don't need help	14	2.3%	130	22.1%	87	15.8%
Ability to self-care	**N = 620**		**N = 590**		**N = 550**	
I cannot care for myself	11	1.8%	1	0.2%	8	1.5%
I need some help to care for myself	63	10.2%	14	2.4%	48	8.7%
I need little help care for myself	151	24.3%	82	13.9%	32	5.8%
I don't need help to care for myself	395	63.7%	493	83.6%	462	84.0%
Overall health status	**N = 623**		**N = 590**		**N = 551**	
Very poor	3	0.5%	3	0.5%	3	0.5%
Poor	394	63.2%	228	38.6%	265	48.1%
Good	218	35.0%	341	57.8%	242	43.9%
Very Good	8	1.3%	18	3.1%	41	7.4%

	At discharge		POD11		POD30	
MAIN OUTCOME						
Overall Functional Status *	**N = 617**		**N = 587**		**N = 548**	
Poor	333	54.0%	152	25.9%	147	26.8%
Good	284	46.0%	435	74.1%	401	73.2%
***Overall function status is a composite variable created by combining the above individual domains; scores 1–4 are generated and dichotomized into poor function status :1–2, good function satus:3–4, inclusive**						

Women who stayed in the hospital longer than three days after delivery were more likely to report poor functional status at POD 30 compared to those who stayed three days or fewer (p = 0.024, Table 3). Those with a poor functional status had a significantly lower monthly income [poor functional status: $37.6, IQR: ($28.3, $62.4); good functional status: $45.4, IQR: ($30.3, $70.6); p = 0.04)].

Table 3
Bivariate analysis of characteristics associated with poor functional status at POD30

Variable name		Poor function at pod30		P-value*
	N	n	%	
Number with poor functional outcome, overall	548	147	26.8%	
DEMOGRAPHIC CHARACTERISTICS				
Age, in years				0.25
< 20	43	7	16.3%	
20–24	158	43	27.2%	
25–29	153	36	23.5%	
30–34	99	31	31.3%	
>=35	95	30	31.6%	
Parity (N = 547)				0.43
0	217	51	23.5%	
1–2	229	64	28.0%	
3–4	63	19	30.2%	
> 4	38	13	34.2%	
Marital Status				0.80
Single, separated, divorced/widow	80	19	23.8%	
Legally married	231	58	27.5%	
Cohabitating (common marriage)	255	70	27.5%	
Level of education				0.13
Less than primary	54	13	24.1%	
Completed primary	359	106	29.5%	
Completed secondary or more	135	28	20.7%	
Has health insurance				0.18
No	3	2	66.7%	
Yes	545	145	26.1%	
Ubudehe **categories**				0.47

Variable name		Poor function at pod30		P-value*
Ubudehe 1	55	11	20.0%	
Ubudehe 2	289	80	27.7%	
Ubudehe 3&4	202	56	27.7%	
Occupation				0.09
Farmer	463	129	27.9%	
Employed (self, government, etc.)	67	17	25.4%	
Unemployed	18	1	5.6%	
Travel time in minutes, home to health center, Median (IQR) (N = 579)				0.18
Among those with poor function	134	30	(15,60)	
Among those with good function	361	30	(15,60)	
Travel time in minutes, HC to hospital, Median (IQR)(N = 579)				0.10
Among those with poor function	134	45	(10,60)	
Among those with good function	360	37.5	(5,60)	
Monthly Income in USD, Median (IQR)				
Among those with poor function	147	37.6	(28.3,62.4)	0.05
Among those with good function	370	45.4	(30.3,72.8)	
CLINICAL CHARACTERISTICS				
Had previous c-section (N = 636)	162	43	29.45%	0.95
Reasons for surgery (N = 630)				0.28
Fetal factors, no maternal factors	182	52	35.5%	
Maternal factors, no neonatal factors	154	33	22.6%	
Previous c-section only	119	33	22.6%	
Maternal and fetal factors	87	28	19.2%	
Duration of c-section surgery (in minutes)	534			0.07
<=30	163	33	20.2%	
(30–45]	247	78	31.6%	
(45–60)	70	20	28.6%	

Variable name		Poor function at pod30		P-value*
> 60	54	12	22.2%	
Any intraoperative complication				0.10
Not reported	538	142	26.4%	
Yes	10	5	50%	
Length of hospital stay, in days	534			0.024
<=3 days	163	33	20.3%	
> 3 days	371	110	29.7%	
Surgical c-section categories	547			0.74
Emergent	32	9	28.1%	
Urgent	481	127	26.4%	
Elective	34	11	32.4%	
Neonatal outcomes at discharge	542			0.31
Alive and discharged	487	127	26.1%	
Alive and admitted to NICU	41	15	36.6%	
Died	14	3	21.4%	

In the final reduced model (Table 4), surgery duration, intraoperative complications, and income remained the only significant factors. Patients whose surgery duration ranged between 30 to 45 minutes had 85% increased odds of reporting poor functional status at POD 30 compared to those with surgery duration of less than 30 minutes (aOR = 1.85, 95% CI: 1.15, 2.95). Women with any documented intraoperative complications had 3.12 times higher odds of poor function compared to women without complications (aOR = 4.12, 95% CI: 1.09, 15.57). For every US$100 increase in monthly income, there was a 38% decrease in the odds of reporting poor functional status at POD 30 (aOR = 0.62, 95% CI: 0.40, 0.96).

Table 4
Multivariate analysis of characteristics independently associated with poor functional status at POD30

	Full Model			Reduced Model		
Variable name	**OR**	**95% CI**	**p-value**	**OR**	**95% CI**	**p-value**
Level of education						
Less than primary	**Ref**					
Completed primary	1.3	(0.64, 2.72)	0.44			
Completed secondary or more	0.9	(0.38, 2.11)	0.80			
Has health insurance						
No	**Ref**					
Yes	0.19	(0.02,2.19)	0.18			
Occupation						
Farmer	**Ref**					
Employed (self, gov., etc)	1.2	(0.60,2.50)	0.58			
Unemployed	0.28	(0.03,2.21)	0.23			
Travel time in minutes, home to health center, Median (IQR)(N = 579)	0.99	(0.95, 1.04)	0.87			
Travel time in minutes, HC to hospital, Median (IQR)(N = 579)	1.02	(0.99,1.04)	0.21			
Monthly Income in USD, Median (IQR)	0.67	(0.42,1,06)	0.10	0.62	(0.40,0.96)	0.033
Any intraoperative complication						
Not reported	**Ref**					
Yes	5.39	(1.29,22.53)	0.021	4.12	(1.09,25.57)	0.037
Duration of c-section surgery (in minutes)						
<=30	**Ref**					
(30–45]	1.7	**(1.05,2.80)**	0.03	1.85	(1.15,2.95)	0.01
(45–60)	1.5	(0.76,2.91)	0.242	1.56	(0.82,2.99)	0.18
> 60	0.80	(0.35,1.82)	0.60	0.92	(0.42,2.03)	0.84
Length of hospital stay, in days						

	Full Model			Reduced Model
<=3 days	**Ref**			
> 3 days	0.76	(0.50,1.15)	0.20	

Discussion

Our study is one of a few assessing the overall functional status of c-section patients a month after surgery in LMICs. We found a high proportion of poor functionality at discharge, which was sustained through the first month, with approximately one in four women reporting poor function at POD 30. Surgery duration of between 30 to 45 minutes, report of any intraoperative complications and lower annual household income were significant independent predictors of poor functional status at POD30.

One comparable study included women from Malawi, Kenya, and Jamaica and reported 18% of women had poor function at six weeks postpartum [22]. It is important to note that that study used different tools to measure functionality and focused on difficulties in performing activities, while our study considered functional status as a multifaceted measure of mobility, level of energy, selfcare, performance of usual activities, and overall health.

In our study, mobility was the fastest dimension to improve after c-section, with over 83% of women reporting full mobility at POD 3 and rising to 91% at POD 30. This aligns with findings from other LMICs where 93–98% of c-section patients reported good mobility through the first month following surgery [12, 23]. Women who deliver via c-section are encouraged to mobilize a few hours post-surgery to avoid thromboembolism and to enhance early bonding with the infant [24]; clinical teams encouraging early mobility in this study population may have contributed to high rates of mobility one month after surgery. Despite high mobility, women reported poor ability to perform usual activities, with only 16% of women returning to full abilities by POD 30. Tiredness and fatigue are common post-c-section and may impede early resumption of activities in these patients [25, 26]. However, it is also possible that some activities, including farming activities or intensive housework including carrying water or older children; should not be immediately resumed as extreme physical activity or heavy lifting may impede safe recovery after cesarean delivery [27].

Women whose surgery duration was between 30 and 45 minutes had worse functional status at POD 30 compared to those whose surgery duration was equal to or less than 30 minutes. Surgery length varies by health providers and by intraoperative complications [28, 29, 30]. In this study, women who had intraoperative complications were four times as likely to report poor function at POD 30 than those with no intraoperative complications. Despite controlling for intraoperative complication, it is possible that surgeries with longer duration represented more complex cases of women with pre-existing medical co-morbidities, and these unmeasured factors have previously been linked to poor functional recovery after other types of surgeries [31–34]. Furthermore, the existing pathway where laboring women in Rwanda have to present at health centers before being referred to district hospitals for a c-section delivery could

result in further complexities of cases during transportation to district hospitals and inherent delays [35]. In our study, 94.1% of c-section were indicated as emergent or urgent. Improvement in referral systems and decentralizing obstetric emergency services to health centers to enhance timely access to c-sections for medically indicated cases could result in fewer complications and unnecessarily long c-section surgeries [36].

Women with lower annual household incomes had worse functional outcomes at POD 30. This association could be explained in the context of poor health outcomes previously reported among poor postpartum women. Poverty has been associated with poor postpartum nutritional status [37, 38], incidence of SSIs [17, 39], and poor post-natal care [40]. A study in Ethiopia reported that irrespective of mode of delivery, women with low income were almost half as likely to seek postpartum care[41], and a study in Iran found that rural women who did not received enhanced postpartum follow-up reported poor functional status at six weeks postpartum [41]. Financial hardship faced by poor women in our study could affect post-discharge follow-up and care, and in turn could impede their ability to recover fully. Specific interventions to increase post-cesarean follow-up care, in general and specifically targeting low-income women, should be considered.

This study had several limitations. There was no validated measurement for overall functional status; nevertheless, we used individual dimensions pulled from validated health-related quality of life tools. Secondly, a few recruited participants (8.6%) could not be reached by phone call on POD 30, although several attempts were made. We suspect that those lost to follow-up might be the poorest women with limited access to a telephone, or those with postoperative morbidities seeking care outside their community, and as such we may have underestimated the level of poor functional status at POD 30. Thirdly, we did not have a control group to ascertain whether the reported functional status was attributable to c-section specifically. Lastly, it is possible that women did not have clarity of which activities they should resume or not resume, during the first month after surgery because in Rwanda there is no protocol to assist c-section women with their post-cesarean recovery. However, we believe that this did not severely affect our results because functionality was measured as multidimensional outcome.

Conclusion

The present study provides evidence that a quarter of rural Rwandan women sustain poor functional status up to a month after cesarean delivery. Particularly, women from low income households, women who experience intraoperative complications, and women with longer surgeries were more vulnerable to poor functionality. Specific attention should be paid to these women during follow-up. Functional status assessments, monitoring and support should be included in post-partum care. We believe that these findings hold significance in other rural LMIC settings. Given rising global c-section rates, future research is needed to develop a validated measure of post-cesarean functionality. Further research into functional outcomes after c-section in other LMIC settings should be considered as well as research into peri-operative interventions that may improve and speed up return to normal functionality.

Abbreviations

POD
Post-Operative day
KDH
Kirehe District Hospital
aOR
adjusted Odds Ratio
LMICs
Low- to middle-income countries

Declarations

Ethical approval

The study had ethical approvals from the Harvard Medical School Institutional Review Board (IRB18-1033) andthe Rwanda National Ethics Committee (No.326/RNEC/2019). In addition, we had technical approvals from the Inshuti Mu Buzima Research Communityand the Rwanda Ministry of Health. The conduct of the parent study was in accordance with ethical principles of the Belmont report. All participants had provided voluntary informed consent before data collection. A voluntary assent from individuals less than 18 years was obtained, with signed consent from their parents or legal guardians.

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Availability of data

Data is available upon a reasonable request from corresponding author

Consent for publication

We did not disclos3 any personal details of participants in this paper. Thus, participants' consent for publication is not applicable.

Competing interests

The authors declare that there are no competing interests associated to this research.

Authors' contribution

AN, SG designed the study, led data analysis and wrote the first draft of the manuscript. BA, EM, BHG provided mentorship. ASG, TN designed data collection tools for the parent study. CM, SH, PN, FK, RR and AAB contributed to the interpretation of findings and to the refining of the manuscript. All authors revised the manuscript and approved the final version for submission to publication

References

1. World Health Organization. WHO Statement on Caesarean Section Rates. Genève, Switzerland; 2015
2. Betrán AP, Temmerman M, Kingdon C, Mohiddin A, Opiyo N, Torloni MR, et al. Interventions to reduce unnecessary caesarean sections in healthy women and babies. Lancet. 2018,392(10155):1358–1368.
3. Boatin, AA, Schlotheuber A, Betran AP, Moller,AB, Barros, A., Boerma T.,et al. Within country inequalities in caesarean section rates: observational study of 72 low- and middle-income countries. BMJ (Clinical research ed.).2018; 360, k55.
4. Bishop D, Dyer RA, Maswime S, Rodseth, RN, van Dyk D, Kluyts HL, et al. Maternal and neonatal outcomes after caesarean delivery in the African Surgical Outcomes Study: a 7-day prospective observational cohort study. Lancet Glob Health.2019,7(4):e513-e522.
5. Filippi V, Ganaba R, Calvert C, Murray SF, Storeng KT. After surgery: the effects of life-saving caesarean sections in Burkina Faso. BMC Pregnancy Childbirth. 2015;15:348.
6. Tulman L, Fawcett J(1990). Maternal employment following childbirth. Research in Nursing & health. 1990; 13(3):181–188.
7. Aktan NM. Functional status after childbirth and related concepts. Clin Nurs Res. 2010,19(2):165–80. doi: 10.1177/1054773810369372.
8. Horwood C, Hinton R, Haskins L, Luthuli S, Mapumulo S, Rollins N. 'I can no longer do my work like how I used to': a mixed methods longitudinal cohort study exploring how informal working mothers balance the requirements of livelihood and safe childcare in South Africa. BMC Womens Health. 2021;21(1):288.
9. Gjerdingen DK, Froberg DG, Chaloner KM, McGovern PM. Changes in Women's Physical Health During the First Postpartum Year.1990

10. Sousa L, Pitangui ACR, Gomes FA, Nakano AMS, Ferreira CHJ. Measurement and characteristics of post-cesarean section pain and the relationship to limitation of physical activities. Acta Paul Enferm. 2009;22(6):741–7.
11. Zhang F, Cheng J, Yan S, Wu H, Bai T. Early Feeding Behaviors and Breastfeeding Outcomes After Cesarean Section. Breastfeed Med. 2019;14(5):325–333.
12. Kohler S, Sidney Annerstedt K, Diwan V, Lindholm L, Randive B, Vora K, et al. Postpartum quality of life in Indian women after vaginal birth and cesarean section: a pilot study using the EQ-5D-5L descriptive system. BMC Pregnancy Childbirth. 2018;18(1):427.
13. Jin J, Peng L, Chen Q, Zhang D, Ren L, Qin P,et al. Prevalence and risk factors for chronic pain following cesarean section: a prospective study. BMC Anesthesiol. 2016;16(1):99.
14. Solehati T, Rustina Y. Benson Relaxation Technique in Reducing Pain Intensity in Women After Cesarean Section. Anesth Pain Med. 2015;5(3):e22236.
15. National Institute of Statistics of Rwanda, Ministry of Finance and Economic Planning/Rwanda, Ministry of Health/Rwanda, and ICF International. Rwanda Demographic and Health Survey 2014-15. Kigali, Rwanda: National Institute of Statistics of Rwanda, Ministry of Finance and Economic Planning/Rwanda, Ministry of Health/Rwanda, and ICF International;2015.
16. Nkurunziza T, Kateera F, Sonderman K, Gruendl M, Nihiwacu E, Ramadhan B, et al. Prevalence and predictors of surgical-site infection after caesarean section at a rural district hospital in Rwanda. Br J Surg. 2019;106(2): e121-e128.
17. Karemera P. High rate of post caesarean section infection in maternity ward in Rwamagana provincial hospital. Masters Thesis > University of Rwanda, College of Medicine and Health Sciences School of Health Sciences;2017.
18. Rwabizi D, Rulisa S, Findlater A, Small M. Maternal near miss and mortality due to postpartum infection: a cross-sectional analysis from Rwanda. BMC Pregnancy Childbirth. 2016;16(1):177.
19. Devlin NJ, Brooks R. EQ-5D and the EuroQol Group: Past, Present and Future. Appl Health Econ Health Policy. 2017;15(2):127–137.
20. Bruce B, Fries JF. The Health Assessment Questionnaire (HAQ). Clin Exp Rheumatol. 2005;23(5 Suppl 39):S14-8.
21. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)–a metadata-driven methodology and workflow process for providing translational research informatics support. J Biomed Inform. 2009;42(2):377–81.
22. Cresswell JA, Barbour KD, Chou D, McCaw-Binns A, Filippi V, Cecatti JG, et al. Measurement of maternal functioning during pregnancy and postpartum: findings from the cross-sectional WHO pilot study in Jamaica, Kenya, and Malawi. BMC Pregnancy Childbirth. 2020;20(1):518.
23. Ghaffari S, Dehghanpisheh L, Tavakkoli F, Mahmoudi H. The Effect of Spinal versus General Anesthesia on Quality of Life in Women Undergoing Cesarean Delivery on Maternal Request. Cureus. 2018;10(12):e3715. doi: 10.7759/cureus.3715.

24. Karaca I, Ozturk M, Alay I, Ince O, Karaca SY, Erdogan VS,et al. Influence of Abdominal Binder Usage after Cesarean Delivery on Postoperative Mobilization, Pain and Distress: A Randomized Controlled Trial. Eurasian J Med. 2019;51(3):214–218.
25. McQueen A, Mander R.Tiredness and fatigue in the postnatal period. J Adv Nurs. 2003;42(5):463–9.
26. Glazener CM, Abdalla M, Stroud P, Naji S, Templeton A, Russell IT. Postnatal maternal morbidity: extent, causes, prevention and treatment. Br J Obstet Gynaecol. 1995;102(4):282–7.
27. Ghanabari H. What to expect after cesarean section. Hghanbarimd.2020,
28. Cheng H, Clymer JW, Po-Han Chen B, Sadeghirad B, Ferko NC, Cameron CG, et al. Prolonged operative duration is associated with complications: a systematic review and meta-analysis. J Surg Res. 2018;229:134–144.
29. Wong TC, Lau CQ, Tan EL, Kanagalingam D. Decision-to-delivery intervals and total duration of surgery for Caesarean sections in a tertiary general hospital. Singapore Med J. 2017;58(6):332–337.
30. Nayak G B, Saha PK, Bagga R, Joshi B, Rohilla M, Gainder S, et al. Wound complication among different skin closure techniques in the emergency cesarean section: a randomized control trial. Obstet Gynecol Sci. 2020;63(1):27–34.
31. Yoon S H, Kim BR, Lee SY, Beom J, Choi JH, Lim JY. Influence of comorbidities on functional outcomes in patients with surgically treated fragility hip fractures: a retrospective cohort study. BMC Geriatr. 2021;283 (2021)
32. Beloosesky Y, Grinblat J, Epelboym B, Weiss A, Grosman B, Hendel D. Functional gain of hip fracture patients in different cognitive and functional groups. Clin Rehabil. 2002;16(3):321–8.
33. Finlayson E, Zhao S, Boscardin WJ, Fries BE, Landefeld CS, Dudley RA. Functional status after colon cancer surgery in elderly nursing home residents. Journal of the American Geriatrics Society. 2012;60(5):967–973.
34. Greer JA, Harvie HS, Andy UU, Smith AL, Northington GM, Arya LA. Short-term postoperative functional outcomes in older women undergoing prolapse surgery. Obstet Gynecol. 2015;125(3):551–558.
35. Powell BL, Nkurunziza T, Kateera F, Dusabe L, Kubwimana M, Koch R, et al. Synthesizing postpartum care pathways, facilitators, and barriers for women after cesarean section: a qualitative analysis from rural Rwanda. Journal of Global Health Reports. 2021;5:e2021043.
36. Niyitegeka J, Nshimirimana G, Silverstein A, Odhiambo J, Lin Y, Nkurunziza Tet al. Longer travel time to district hospital worsens neonatal outcomes: a retrospective cross-sectional study of the effect of delays in receiving emergency cesarean section in Rwanda. BMC Pregnancy Childbirth. 2017;17(1):242.
37. Bodnar ML, Cogswell EM, Scanlon SK. Low Income postpartusk of iron deficiency. The journal of nutrition. 2002;132(8):2298–2302.
38. Nkonwa I,Mugyenyi G, Ssalongo GMW,Ngonzi J,Masembe S, Lubega A. Incidence and Factors Associated with Postpartum Anemia at Mbarara Regional Referral Hospital.. Journal of Health, Medicine and Nursing.2016;23(2016)

39. Mukantwari J, Gatete JDD, Miranda E,Niyigena A,Kateera F,Riviello R, et al. Predictors for Persistent Perioperative Symptoms after a Cesarean Section at a Hospital in Rural Rwanda. JACS. 2020.
40. Langlois ÉV, Miszkurka M, Zunzunegui MV, Ghaffar A, Ziegler D, Karp I. Inequities in postnatal care in low- and middle-income countries: a systematic review and meta-analysis. Bull World Health Organ. 2015;93(4):259-270G.
41. Ayele B, Woldu M, Gebrehiwot H, Wellaym T, Hadgu T, Gebretnsae H, et al. Do mothers who delivered at health facilities return to health facilities for postnatal care follow-up? A multilevel analysis of the 2016 Ethiopian Demographic and Health Survey. PloS one. 2021, 16(4), p.e0249793.
42. Bagherinia M, Mirghafourvand M, Shafaie FS. The effect of educational package on functional status and maternal self-confidence of primiparous women in postpartum period: a randomized controlled clinical trial. J Matern Fetal Neonatal Med. 2017,30(20):2469–2475.