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Effect of health education on birth preparedness and complication readiness on the use of maternal health services: A propensity score-matched analysis

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ABSTRACT

Objective: At 789 maternal deaths per 100,000 live births, South Sudan has one of the worst maternal mortality indicators in the world. Utilization of maternal health services namely antenatal care (ANC), skilled birth attendance (SBA), and early postnatal care (EPNC) is critical in reducing these deaths. We evaluated whether health education on birth preparedness and complication readiness (BPCR) has an impact on the utilization of skilled birth attendance and early postnatal care in Mundri East County, South Sudan.

Design: We used observational data collected from antenatal clinics in South Sudan to perform a propensity score matched analysis. Treatment effects in both unmatched and matched cohorts were estimated using modified Poisson regression analysis with robust standard errors in prevalence risk ratios (PR) and 95% confidence intervals.

Setting: 13 primary healthcare facilities.

Participants: 385 postpartum mothers.

Interventions: Health education on BPCR.

Measurements: Two outcomes were evaluated: (1) SBA measured as delivery in a health facility, and (2) EPNC use measured as use of postnatal care within 2–7 days of delivery.

Findings: Data on 243 (67.9%) mothers who attended antenatal care were analyzed. 92 participants who received BPCR health education were matched with 92 who had never. In unmatched adjusted analysis, health education on BPCR significantly increased SBA (Adjusted PR (APR), 1.99; 95% confidence interval (CI), 1.99–3.65) but not EPNC use (APR, 1.78; 95% CI, 0.73–4.35). In propensity score-matched analysis, SBA significantly improved (PR, 2.64; 95% CI, 1.91–3.66) while the increase in EPNC use was insignificant (PR, 1.14; 95% CI, 0.43–3.03).

Conclusions: Health education on BPCR improves SBA but not EPNC use among mothers in Mundri East County, South Sudan.

Implication for practice: South Sudan's health systems should design new strategies to enhance EPNC use in order to significantly reduce maternal and newborn deaths in the earlier days of the postpartum period. In addition, a qualitative study is needed to identify barriers to EPNC use.

Introduction

Globally, 830 women die daily from preventable causes related to pregnancy and childbirth, with 99% of the deaths occurring in developing countries (World Health Organization, 2018a). Despite a 44% drop in the maternal mortality ratio (MMR) between 1990 and

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2015, maternal deaths remain high (World Health Organization, 2018a). Consequently, between 2016 and 2030, the Sustainable Development Goals have set a target to reduce the global MMR to less than 70 per 100 000 live births (World Health Organization, 2018b). To achieve this goal, use of maternal health services is critical. Antenatal care (ANC), for instance, is critical in early detection and management of complications during pregnancy (World Health Organization, 2016), while skilled birth attendance reduces the risk of maternal mortality by 16–33% (Graham et al., 2001). In addition, use of postnatal care services decreases the risk of maternal and newborn deaths through early identification and appropriate management of postpartum complications (World Health Organization, 2014). In particular, the use of postnatal care within 2–7 days postdelivery (early postnatal care), a time when half of maternal and 40% of newborn deaths occur (World Health Organization, 2010), is crucial in averting maternal and newborn deaths.

In low income countries, maternal health services are underutilized despite the high incidence of maternal mortality. South Sudan in particular has one of the worst maternal mortality statistics in the world. Recent data indicate maternal mortality ratio of 789 per 100,000 live births (World Health Organization, 2018c), with significant regional variability. For example, in 2015, data from the Western Equatorial State of South Sudan showed that 2327 mothers died per 100,000 live births in the region (County Health Department Report, 2015), the highest rate in the country. Also, 87% of pregnant women deliver at home, often without a skilled birth attendant (a Medical Doctor, Nurse, or Midwife) (Frederick Hartman et al., 2013). More than half of pregnant mothers in Western Equatorial State do not attend ANC visits, and among those who attend, only 17% attend four or more visits (World Health Organization, 2015).

A qualitative study in Rumbek North County, South Sudan identified several barriers to using ANC namely: difficult access, limited resources, negative sociocultural contexts, misperceptions about benefits of ANC, low perceived risk of pregnancy complications, and incorrect perceptions about the quality of ANC (Wilunda et al., 2017). ANC is the first point of entry into maternal and child health services and is critical in providing information on successful care and nutrition of the newborn and identification of high-risk pregnancies (World Health Organization, 2016). In essence, ANC attendance ensures that pregnant women receive health education on birth preparedness and complication readiness (BPCR) (World Health Organization, 2010). In a systematic review on BPCR, increased skilled birth attendance was reported in 13 studies while the remaining 20 studies reported merely increase in knowledge on BPCR but not skilled birth attendance (Miltenburg et al., 2015). Birth preparedness information includes skilled attendant at birth and discussions to plan the place of delivery and availability of essential clean items for the mother and baby at delivery. Similarly, complication readiness information includes how to recognize warning signs of complications in pregnancy or childbirth, designating decision maker(s), how to access emergency funds for obstetric care, rapid referral, and transport to an emergency obstetric care site (Acharya et al., 2015).

Despite the hypothesized benefits of health education on BPCR during ANC visits, it remains unclear whether it actually translates into increased skilled birth attendance and early postnatal care use in Western Equatorial State, South Sudan. The purpose of this study was to evaluate whether there is a difference in use of skilled birth attendance and early postnatal care by mothers who received health education on BPCR compared to those who did not, in Mundri East County, a setting with the highest MMR in the Western Equatorial State, South Sudan.

The findings will inform interventions to improve maternal and child health services, thus contributing to reduction in maternal and newborn morbidity and mortality.

Methods

Data source

We analyzed data from a previous cross-sectional study on early postnatal care use in Mundri East County, described elsewhere (Izudi et al., 2017). In brief, the aforementioned study sampled postpartum mothers that had live births, were 15–49 years old but 8–14 days post-delivery, and had attended postnatal clinics (to receive immunization, contraception and growth monitoring services) between July 20, 2016 and September 18, 2016 across 13 primary healthcare facilities. The study included 385 postpartum mothers, an estimate based on 5% precision and 50% conservative proportion of early postnatal care use in the setting. The participants were proportionately divided across the 13 primary healthcare facilities. At each primary healthcare facility, the study used a systematic random sampling method to obtain a sampling interval by dividing the average number of postpartum mothers that had attended the postnatal clinic by the number of required participants from each of the primary healthcare facility. From the sampling interval, the study used a convenience sampling method to select participants. The study was approved by the Institutional Review Board (IRB) of the Faculty of Health Sciences, Uganda Christian University. Informed consent was obtained from all the study participants. This study was reviewed and approved by the same IRB. However, the need for informed consent was waived since secondary data was analyzed.

Study design

We used observational data from antenatal clinics in South Sudan to conduct a quasi-experimental study using propensity score matching, an analytical approach for ensuring study participants who are in the control and intervention groups are similar based on measured characteristics. Propensity score is the probability of receiving treatment by untreated participants based on observed covariates (West et al., 2015).

The analytical method reduces selection bias and offers an alternative for measuring treatment effects in observational studies, where it is impossible or unethical to randomize participants to treatment groups (Thavaneswaran 2008; Okoli et al., 2014). In doing so, propensity score matching approximates a randomized controlled trial by equally balancing participant characteristics across treatment and control groups. Essentially, the groups are the same, except for the treatment or intervention ensuring a less-biased estimate of treatment effects.

Intervention and study arms

The intervention, health education on BPCR, was defined according to the WHO guidelines (World Health Organization, 2006). Accordingly, birth preparedness was defined as: receipt of health education on defining a desired place of birth, preferred birth attendant, and location of the closest health facility during ANC visit(s). Complication readiness was defined as receipt of health education on availability of funds for any expenses, supplies and materials to bring to the health facility, an identified labor and birth companion, a support person to look after other children at home, transport to a health facility for birth or in case of complications, compatible blood donors if needed (World Health Organization, 2006). We categorized mothers who received and those who never received health education on BPCR to the intervention (treated) and counterfactual (untreated) arms, respectively (Fig. 1). The study used the terms treated and untreated groups to refer to intervention and control arms, respectively.

List of figure

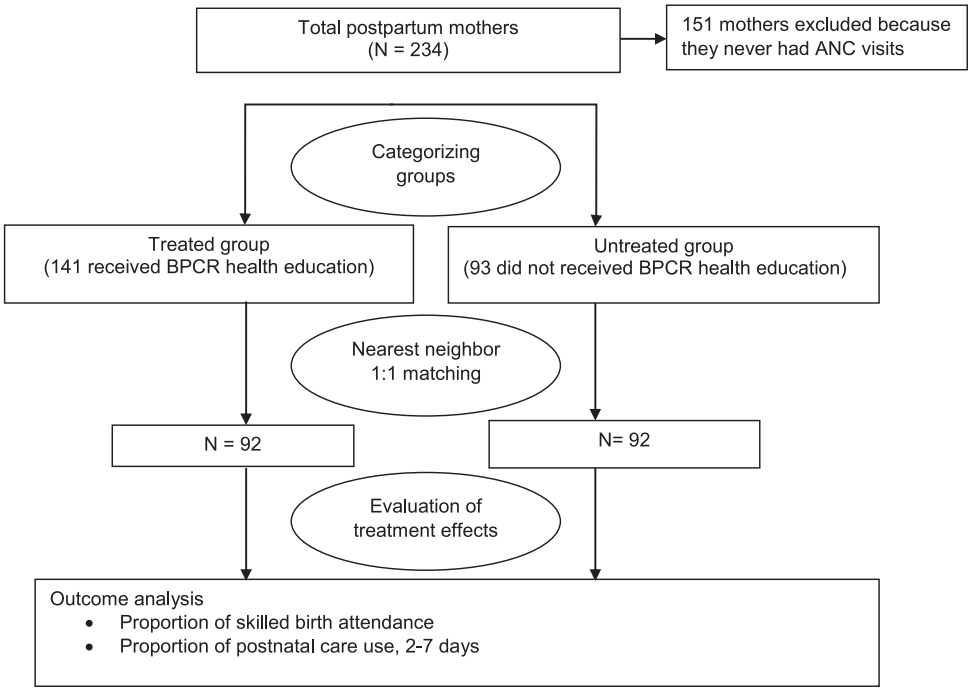

Fig. 1. Study profile showing the number of participants before and after propensity score matching, Mundri East County, South Sudan.

Covariates

We recognize that the selection of covariates in estimating propensity scores remains controversial and several approaches exists (Austin, 2011). The present study considered nine covariates that were theoretically and empirically related to both the treatment and the outcome (Starks and Garrido, 2004; Smith and Todd, 2005).

The nine covariates were: maternal age (≤30 years and >30 years), marital status (single or never married, married, and divorced), maternal educational level (none, primary, and secondary and over), maternal employment status (not employed and employed), paternal employment status (not employed and employed), ANC attendance in the recent pregnancy (<4 visits and ≥4 visits), number of hours spent to access a health facility (≤1 h and >1 h), reception offered by healthcare providers to mothers during ANC visits (not receptive and receptive), and the health facility ownership (public/government and private). We did not use stepwise algorithms for model selection or p-values because we were not building a parsimonious prediction model (Starks and Garrido, 2004).

Outcome measure

We studied two outcomes, namely skilled birth attendance in recent pregnancy (yes or no) and early postnatal care use (yes or no). We defined skilled birth attendance as the proportion of postpartum mothers who delivered in a primary healthcare facility, in the hands of a skilled healthcare provider during the recent pregnancy. In contrast, early postnatal care use was defined as the proportion of postpartum mothers who used postnatal care services within 2–7 days following delivery. In both cases, we used the ANC and postnatal care cards to verify the outcomes.

Statistical analysis

The analysis was performed in Stata version 15 (StataCorp, College Station, TX, USA) (StataCorp, 2017). We conducted a propensity score matched regression analysis (Pan and Bai, 2015), and adhered to the analysis and reporting of propensity score analysis (PSA) guidelines (Yao et al., 2017). To compare the distribution of observed participant baseline characteristics between the treated and untreated groups, we used the Student's *t*-test (for numerical data) and Chi-squared test (for categorical data) to test for associations at 5% significance level.

We estimated the propensity score in a logit model by regressing health education on BPCR on the nine selected covariates. We balanced the propensity score and the nine covariates across the treatment groups by splitting the sample into equally spaced intervals. Within each interval, we assessed significant differences in the average propensity score with *t*-test. Intervals that were significantly different were spilt further and re-tested with *t*-test until no further differences existed. We then checked the degree of overlap of propensity score and covariates between treatment groups using a propensity score graph.

After balancing propensity scores, we matched participants with similar propensity scores in the untreated (control) group with those in the treated (intervention) group using 1:1 nearest neighbor matching method without replacement. We then checked covariate balance across treatment groups with standardized mean difference between the treated and untreated arms, in both matched and unmatched cohorts. We considered a standardized mean difference less than or equal 0.1 as indicative of a good balance (Austin, 2009). We did not consider p-values to determine covariate balance because they are sample size dependent and are not recommended (Staffa and Zurakowski, 2018).

We computed the effect of health education on BPCR on skilled birth attendance and early postnatal care use in both the unmatched and matched cohorts using the modified Poisson regres-

sion analysis because the outcome variables were prevalent (above 10%) (Thompson et al., 1998; Spiegelman and Hertzmark, 2005; Schmidt and Kohlmann, 2008; Lee et al., 2009). When an outcome is prevalent (large), the odds ratio overestimates the strength of association between independent and outcome variables, and is hence inappropriate (Thompson et al., 1998; Spiegelman and Hertzmark, 2005; Lee et al., 2009). Prevalence ratios (PR) are thus preferred (North Carolina Institute for Public Health, 2015; Tamhane et al., 2016).

In the analysis, we employed robust standard errors to control for mild violations of the underlying assumptions for Poisson regression analysis as recommended (Cameron and Trivedi, 1990). In the matched cohort, we considered the matched pairs as identities in the regression analysis and presented the results as prevalence risk ratios (PR) and 95% confidence intervals (CI).

Results

Study profile and balance of covariates

Our cohort consisted of 385 postpartum mothers, of whom 151 (39.2%) had never attended ANC while 234 (60.8%) attended ANC in recent pregnancy. The subsequent analysis considered the 234 participants who attended ANC visits during recent pregnancy (Fig. 1). Before propensity score matching, the results showed 141 (60.3%) participants had received health education on BPCR while 93 (39.7%) had not. When the 141 participants who received health education on BPCR (treated group) were matched to the 93 participants who never received health education on BPCR (untreated group) on propensity score, in 1:1 ratio, 184 participants were matched (92 in the treated group and 92 in the untreated group). The 184 participants were therefore considered in the propensity score matched analysis. Our matched pair analysis excluded 94 participants (93 in the treated group and one in the untreated group) because they lacked good matches on propensity scores. Results indicated in the unmatched cohort (Table 1), covariates differed substantially between the treated and untreated arms. However, a good balance (SMD < 0.10) was achieved in the propensity score matched cohort (Table 2).

Effect of health education on BPCR on skilled birth attendance before and after propensity score matched analysis

Before adjusting for covariates, unmatched analysis (Table 3) showed health education on BPCR significantly increased skilled birth attendance (PR, 2.55; 95% CI, 1.86–3.49). After adjusting for covariates in multivariable analysis, health education on BPCR was associated with significant increase in skilled birth attendance (Adjusted PR (APR), 2.69; 95% CI, 1.99–3.65). However, the effect estimate was more precise than in univariate and multivariable analyses. In propensity score matched analysis, health education on BPCR significantly increased skilled birth attendance (PR, 2.64; 95% CI, 1.91–3.66).

Effect of health education on BPCR on early postnatal care use; before and after propensity score matched analysis

Without adjusting for covariates (Table 3), unmatched analysis indicated health education on BPCR significantly increased early postnatal care use (PR, 2.92; 95% CI, 1.34–6.37). After adjusting for covariates in multivariable analysis (Table 3), health education on BPCR was not significantly associated with increase in early postnatal care use (Adjusted PR (APR), 1.78; 95% CI, 0.73–4.35). However, in propensity score matched analysis, health education on BPCR was again not statistically significantly associated with increased early postnatal care use (PR, 1.14; 95% CI, 0.43–3.03).

Discussion

The present study evaluated whether there was a difference in skilled birth attendance and early postnatal care use between mothers who received health education on BPCR compared to those who had not in Mundri East County, South Sudan. We found women who received health education on BPCR were more likely to have delivered in the presence of a skilled birth attendant. However, we did not find a difference in early postnatal care use between mothers who received health education on BPCR compared to those who did not. Our result is consistent with various studies (Becker et al., 1993; Addai, 2000; Chakraborty et al., 2003) where health education was reported to increase use of existing maternal and child health services.

The common acceptance is lack of knowledge on obstetric and postpartum complications contributes to none use of maternal and child health services among women. This means providing mothers with health information improves their knowledge and decision making ability regarding the health of their babies and their own. Our result is hence a confirmation of the benefits of providing pregnant mothers with health information on obstetric and postpartum complications. In addition, when women can recognize every pregnancy carries some risks of complications, their likelihood of skilled birth attendance increases. Our finding on skilled birth attendance conforms to results of a previous study in Burkina Faso where mothers who had birth preparedness plans had increased skilled birth attendance (Moran et al., 2006). In Bangladesh, a study on birth preparedness among postpartum mothers found well-prepared mothers had increased use of skilled birth attendance, clean cord care practice, and early postnatal care use (Moinuddin et al., 2017), a consistent with the present study results.

The inconsistency with respect to early use of postnatal care was not surprising because most healthcare systems in Africa and developing countries do not prioritize postnatal care (World Health Organization, 2014).

In fact, postnatal care is one of the most underutilized and weakest of all maternal and child health services (Sines et al., 2007). In previous study in Eastern Uganda, merely 15.4% of postpartum mothers attended postnatal care within 2–7 days (Izudi and Amongin, 2015). This finding agrees with the present result.

In general, our study results suggest health education on BPCR does not always result into achieving the intended goals. This is consistent with results of qualitative studies where preference for skilled birth attendance was favored (Furaha et al., 2015; Shifraw et al., 2016; Bhaumik, 2019), but not the actual use (Bhaumik, 2019). Similarly, a systematic review indicated increased knowledge of preparations for birth and complications but not the use of a skilled attendant at birth, (Solnes et al., 2015) an inconsistent result perhaps due to lack of meta-analysis to pool skilled birth attendance. Nonetheless, our findings underscore the importance of health education on BPCR in increasing skilled birth attendance. In practice, all pregnant women should hence receive appropriate and adequate health education on BPCR, and should be prepared to deal with such complications as and when they arise.

Study strengths and limitations

To the best of our knowledge, this study is the first to evaluate the effect of health education on BPCR on skilled birth attendance and early postnatal care use in Mundri East County, South Sudan. However, several factors should be considered when interpreting the results. By default, our study is designed to balance only observed but not unobserved covariates between treatment groups. The best design for achieving a balance in both observed and un-

Table 1
Participants characteristics before and after propensity score matching, Mundri East County, South Sudan.

	Before PS matching (original cohort)				After PS matching (matched cohort)			
	Untreated No. (%)	Treated No. (%)	Total	P value	Untreated No. (%)	Treated No. (%)	Total	*P* value
Age/years				0.157				0.455
≤30	42 (35.3)	77 (64.7)	119		41 (53.2)	36 (46.8)	77	
>30	51 (44.3)	64 (55.7)	115		51 (47.7)	56 (52.3)	107	
Marital status				0.016				0.044
Single	87 (42.6)	117 (57.4)	204		86 (50.3)	85 (49.7)	171	
married	1 (6.3)	15 (93.8)	16		1 (14.3)	6 (85.7)	7	
Divorced	5 (35.7)	9 (64.3)	14		5 (83.3)	1 (16.7)	6	
Maternal education				0.429				0.386
None	30 (39.5)	46 (60.5)	76		30 (46.2)	35 (53.8)	65	
Primary	52 (42.6)	70 (57.4)	122		52 (54.7)	43 (45.3)	95	
Secondary and over	11 (30.6)	25 (69.4)	36		10 (41.7)	14 (58.3)	24	
Mother employed				0.284				0.145
No	69 (37.9)	113 (62.1)	182		69 (47.3)	77 (52.7)	146	
Yes	24 (46.2)	28 (53.8)	52		23 (60.5)	15 (39.5)	38	
Spouse employed				0.677				0.145
No	67 (40.6)	98 (59.4)	165		67 (50.8)	65 (49.2)	132	
Yes	26 (37.7)	43 (62.3)	69		25 (48.1)	27 (51.9)	52	
At least four ANC visits				0.096				0.743
No	76 (37.6)	126 (62.4)	202		76 (48.4)	81 (51.6)	157	
Yes	17 (53.1)	15 (46.9)	32		16 (59.3)	11 (40.7)	27	
Access to health facility				0.011				0.298
<=1 h	34 (34.0)	66 (66.0)	100		34 (44.7)	42 (55.3)	76	
>1 h	59 (44.4)	74 (55.6)	133		58 (53.7)	50 (46.3)	108	
Healthcare workers receptive?				0.069				0.231
No	39 (47.6)	43 (52.4)	82		39 (48.1)	42 (51.9)	81	
Yes	53 (35.3)	97 (64.7)	150		53 (51.5)	50 (48.5)	103	
Health facility ownership				0.014				0.656
Public	8 (21.6)	29 (78.4)	37		8 (88.9)	1 (11.1)	9	
Private	85 (43.1)	112 (56.9)	197		84 (48.0)	91 (52.0)	175	
Total	93 (39.7)	141 (60.3)	234		92 (50.0)	92 (50.0)	184	

Table 2
Covariate balance before and after propensity score matching, Mundri East County, South Sudan.

Covariates	Before matching			After matching		
	Mean in treated group	Mean in untreated group	SMD	Mean in treated group	Mean in untreated group	SMD
Age in years	0.46	0.55	−0.194	0.61	0.55	0.110
Marital status	1.24	1.12	0.226	1009	1.12	−0.082
Maternal education	1.84	1.78	0.091	1.77	1.78	−0.016
Maternal employment	1.19	1.25	−0.137	1.16	1.25	−0.215
Paternal employment	1.3	1.27	0.062	1.29	1.27	0.048
Attended at least 4 ANC visits	0.11	0.17	−0.192	0.12	0.17	−0.153
Access to health facility	0.53	0.63	−0.207	0.54	0.63	−0.176
Receptiveness of healthcare providers	1.69	1.58	0.243	1.54	1.58	−0.065
Health facility ownership	1.79	1.91	−0.343	1.99	1.91	0.356

Table 3
Effect of health education on BPCR on skilled birth attendance and early postnatal care use before and after propensity score matched analysis, Mundri East County, South Sudan.

	None PSM cohort		PSM cohort
Outcome	Univariate analysis (PR, 95% CI)	Multivariate analysis (Adjusted PR, 95% CI)	Propensity score matched analysis (PR, 95% CI)
Skilled birth attendance	2.55***(1.86,3.49)	2.69*** 1.99,3.65)	2.64*** (1.91,3.66)
Early postnatal care use	2.92**(1.34,6.37)	1.78(0.73,4.35)	1.14(0.43,3.03)
Sample size	234	234	184

*$p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$; 95% confidence intervals in brackets; APR: Adjusted Prevalence Ratio; PR: Unadjusted Prevalence Ratio; PSM: Propensity Score Matched; RC: Reference category.

observed covariates is a randomized controlled trial, which in our circumstance was neither practical nor ethical. For that reason, we selected the best alternative, a quasi-experimental study, created using propensity score matching to mimic a randomized controlled trial.

Second, we did not qualitatively explore the reasons that could explain the low skilled birth attendance or early postnatal care use observed in the present study. A qualitative data would have provided better insights in explaining the results into detail. However, this was impossible because we conducted secondary analysis on existing data. Third, our sample size was relatively small and it reduced further when certain participants failed to match on propensity scores. Fourth, we did not measure the timing and the frequency of health education on BPCR required to cause a percentage increase in skilled birth attendance or early postnatal care use. We recommend prospective studies should examine these nu-

ances of maternal education. Lastly, our study population consisted of women who attended postnatal care clinics, and they may not be representative of those who never sought postnatal care services.

Despite these limitations, we have demonstrated the effect of health education on BPCR in improving maternal and child health outcomes via skilled birth attendance and early postnatal care in Mundri East County, South Sudan. Our evidence can be used by healthcare practitioners and managers, researchers, and policy makers in improving maternal and child health programs in South Sudan.

Conclusion and recommendations

Our study indicates health education on BPCR improves skilled birth attendance but not early postnatal care use in Mundri East County, South Sudan. This suggests healthcare providers engaged in maternal and child health services provision should routinely provide pregnant mothers with correct and consistent information on birth and complications. In particular, emphasis should be on the unpredictable nature of pregnancy and postpartum to improve use of existing maternal and child health services. Since health education on BPCR did not improve early postnatal care use, we recommend a qualitative study to identify barriers to early postnatal care use among mothers in Mundri East County, South Sudan.

Ethical approval

Study was approved by the Institutional Review Board of Uganda Christian University, Uganda.

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Declaration of Competing Interest

None declared/ not applicable.

CRediT authorship contribution statement

Jonathan Izudi: Conceptualization, Data curation, Formal analysis, Writing - original draft, Supervision, Writing - review & editing. **Denise Grace Akwang:** Conceptualization, Data curation, Writing - review & editing. **Sandra I. McCoy:** Formal analysis, Writing - original draft, Supervision, Writing - review & editing. **Francis Bajunirwe:** Conceptualization, Formal analysis, Writing - original draft, Supervision, Writing - review & editing. **Damazo T. Kadengye:** Conceptualization, Formal analysis, Writing - original draft, Writing - review & editing.

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