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Abstract

Objective

To determine the met EmOC need in Torit County in South Sudan by calculating the proportion of women with direct obstetric complications in 2015 who were treated and to establish the nature of Obstetric complications and the associated interventions.

Design

This was a retrospective cross-sectional study.

Setting

Four primary health care centers (PHCCs) and one state hospital in three Payams (administrative areas that form a County) in Torit County, South Sudan.

Participants

All admissions in maternity wards (a total of 2,466 patient admission files) in 2015 in all the facilities designated to conduct deliveries in the study area were reviewed to identify obstetric complications.

Primary and secondary outcome measures

The proportion of all women with direct obstetric complications in the population treated in the facilities was calculated as a measure of the 'met need' for EmOC services. The frequencies of the appropriate interventions are reported as secondary outcomes.

Results

254 major obstetric complications were admitted in 2015 out of the 390 expected from 2602 pregnancies; representing 65.13% met EmOC need. The met need was highest for the urban areas (88%) compared to the rural areas and 98.8% of the complications were treated from the hospital while the four PHCCs treated only 1.2%. The commonest obstetric complications were abortions (45.7%), prolonged obstructed labor (23.2%) and hemorrhage (16.5%). Evacuation of the Uterus for retained products (42.5%), Cesarean sections (32.7%) and administration of Oxytocin for treatment of Post-partum hemorrhage (13.3%) were the commonest interventions.

Conclusion

The met need for EmOC services in Torit County is low with 35% of the women with major obstetric complications not accessing care and there is disparity with the urban areas having a higher met need compared to the rural areas. We suggest more support supervision to the PHCCs to increase access for the rural population.

Strengths and limitations of this study

- In this study we report the proportion of women with major obstetric complications treated in Torit County as a measure of the met EmOC need of the population in the study area.
- This study offers an opportunity to examine the health system performance and this is of public health interest as it strikes the balance between demand for services and access to these services.
- The tool used in this study for reviewing the cases of obstetric complications was pretested in a pilot study.
- There were limitations in this study, for example, the estimated population used to calculate the met EmOC need was a projection from the 2008 census with an assumption that there were no significant population movements.
- Another limitation was the retrospective nature in which the obstetric complications were identified as this only limited the researchers to what was indicated in the records without a chance to probe or validate information.

Introduction

Despite significant improvements in maternal health globally between 1990 and 2015, the targets of the millennium development goals 5 and 4 were missed, (1). There were 303,000 maternal deaths in the year 2015, 99% of these deaths occurred in the developing Countries with 1500 of them occurring in South Sudan alone,(2). Approximately 75% of all global maternal deaths in 2013 were due to direct obstetric complications, (3).

The major obstetric complications that threaten the lives of women include hemorrhage, obstructed labor, abortion complications, postpartum sepsis, pre-eclampsia/eclampsia, ruptured uterus and ectopic pregnancy, (4). However, timely access to quality Emergency Obstetric Care (EmOC) services by women who need them can avert most maternal and perinatal deaths, (5).

The World Health Organization (WHO) outlines seven process indicators to assess the availability, access and quality of EmOC services in a population among which is the proportion of women with obstetric complications treated in EmOC facilities which measures the 'met need' for EmOC services of the population; the target is to have 100% of women with obstetric complications treated in EmOC facilities, (6).

EmOC facilities are of two types: basic and comprehensive, (7). A facility is identified as a basic EmOC facility if it provides the following EmOC services: administration of parenteral antibiotics for treating sepsis, administration of parenteral oxytocic for treatment of postpartum hemorrhage, administration of parenteral anticonvulsants for treatment of severe pre-Eclampsia and Eclampsia, assisted vaginal delivery, manual removal of the placenta, removal of retained products of conception and newborn resuscitation. A facility is identified as a comprehensive EmOC facility if it provides all the basic functions above plus blood transfusion and caesarean section, (7).

South Sudan has been in civil war for more than two decades, (8) which has destroyed social community structures and health infrastructure, (9). With 81% of mothers delivering at their homes and only 10% of deliveries occurring under the care of skilled personnel, (10), access to EmOC services is poor in South Sudan. As in other developing Countries, this access is not only poor but also inequitable favoring those women in better social class, (2, 11-13). Women living in urban areas are twice more likely to receive any form of skilled assistance at delivery compared to those living in rural areas; women who are formally educated to at least secondary level are five times more likely to receive this assistance compared to their counter parts with no formal education while the richest ones have four

times more chance than the poorest in the wealth index, (14) . This polarized access to maternal health services does not seem to offer any good future to the Country as most of the population is disadvantaged with 51% living below the national poverty line of one dollar per day; 83% of the population is rural and 73% of men and 84 % of women are illiterate, (14).Health information management systems are currently under development and are not able to launch an effective monitoring and evaluation processes for maternal health indicators, (9). As such, evidence about met need for EmOC, nature of obstetric complications and associated interventions in Torit County are limited, hence affecting priority strategies for improving maternal and neonatal outcomes. Based on the focus of Sustainable Development Goals (SDGs) emphasizing equitable development, (15), this study aimed to estimate the 'met need' for EmOC services by calculating the proportion of women with direct obstetric complications in Torit County who accessed and got treatment in the EmOC facilities and disaggregate it by geographical location to help guide interventions by development partners who are currently implementing health services in the area under Health Pool Fund (HPF), (16)to improve maternal health.

Methods

Study design

We conducted a retrospective cross-sectional study of women who had been treated for obstetric complications from five EmOC facilities in Torit County in 2015.

Study setting

This study was conducted in health facilities located in three payams of Torit County in the former eastern Eastern Equatoria state, Republic of South Sudan: Kudo, Nyong and Himodonge; with a total projected population of 72,071 in 2015, (17). Payams in South Sudan are administrative areas that constitute a County which in turn constitute a state. Nyong Payam in which the state Capital, Torit, is located was the most populated with 47,071 inhabitants while Kudo Payam had 13,461 and Himodonge Payam had 11,357.

There are a total of 11 public health facilities in the three Payams including one hospital located in Nyong Payam which acts as a referral center. Out of the 11health facilities only5 including Torit State Hospital can conduct deliveries and are designated as EmOC facilities; four are basic EmOC facilities each with six beds capacity and 1- the hospital, is a comprehensive EmOC facility with 22 bed capacity dedicated to obstetric cases. The other 6 public facilities are Primary Health Care Units (PHCUs) and together with the private facilities, composed mainly of small clinics and drugs shops, do not conduct deliveries.

Sampling

The Population projection for 2015 in this study area was calculated from the 2008 census to be 72,071, (17). Using the crude birth rate for South Sudan of 36.1/1000 population,(18), a total of 2,602 pregnancies were estimated to have occurred in 2015 and 15% (390) were expected to get major obstetric complications, (7). Using OpenEpi version 3 for sample size calculation for the proportion who get EmOC services from the facilities and assuming Population size (for finite population correction factor) = 390, hypothesized met need for the population of 38.3%±5 assuming the results of an assessment in Yirol County, Lakes State of South Sudan, (19) and design effect (for cluster surveys-DEFF) = 1; allowing 10% for missing data, a sample size of 208 was enough for a 95% confidence level.

Inclusion and Exclusion Criteria

All admissions for major obstetric complications in all the facilities that conduct deliveries and are designated as EmOC facilities within the study area between January 1st and December 31st, 2015 were

included. The admissions for women who were not residents in the study areas were excluded as they were assumed to represent a demand for EmOC services from elsewhere.

Data collection

All the admission records in the maternity wards of the health facilities were reviewed for interventions and outcomes of patients treated for direct obstetric complications between January 1st and December 31st, 2015. The information collected included the date of admission, demographic data such as age, parity, tribe, and the Payam of residence. The direct obstetric complications for which the patient was admitted was recorded and according to WHO these complications include hemorrhage, prolonged or obstructed labor, abortion complications, postpartum sepsis, pre-eclampsia/eclampsia, ruptured uterus and ectopic pregnancy, (7). Information was also collected about the mode of end of pregnancy during that admission which included spontaneous vaginal delivery, instrumental vaginal delivery, cesarean section, complete abortion, evacuation of the uterus for retained products of conception, laparotomy for ruptured uterus, laparotomy for ectopic pregnancy and/or if woman died or was discharged or escaped from the facility while still pregnant. Maternal and neonatal outcomes during the admission were noted; whether dead or alive and for the neonate whether they required resuscitation at birth was also recorded. Information was further collected about the other interventions for the other obstetric complications such as administration of parenteral oxytocin, repair of genital tract tears and hysterectomy for postpartum hemorrhage, administration of Magnesium sulphate for severe pre-eclampsia and/or eclampsia, administration of parenteral antibiotics for puerperal sepsis, manual removal of the placenta and blood transfusion for severe hemorrhage.

Main outcome measures of study

The proportion of all women with direct obstetric complications in the population treated in the facilities was calculated as a measure of the 'met need' for EmOC services. The frequency of the different complications and the appropriate interventions determined as secondary outcomes.

Statistical Analysis

Data was checked, coded, entered and analyzed using SPSS version 21.

Frequency tables were used to present descriptive data, including the number of direct obstetric complications admitted from each Payam and treated in each facility, the interventions used for treating the complications, pregnancy outcomes after the admission as well as maternal and fetal outcome of

the complication. The crude birth rate for the population was used to calculate the expected number of deliveries in a year, 15% of these were assumed to have gotten major obstetric complications, (7). The proportion of the complications treated in the facilities was calculated to represent the met need for EmOC services and the 95% Confidence Intervals (CIs) were calculated using the formula for single population proportions, (20). The age and parity differences among the patients admitted with major Obstetric complications from the three Payams were compared using Analysis of Variance (ANOVA) test. The corresponding confidence intervals and p-values were presented in a table format.

All significance levels were set at $p \leq 0.05$.

Ethical issues

Written consent was obtained from the facility in-charges to review the facility records after giving them written information about the study. Ethical approval was sought from the state ministry of health, Eastern Equatoria state, South Sudan and from the University of Liverpool ethics committee and a waiver of consent for the medical record reviews obtained. Each complicated case reviewed was assigned a unique study number, the data collected on questionnaires was stored under lock and key, and these were entered into SPSS in a computer which was pass-word protected, only accessed by the researchers.

The Results

A total of 2,466 patient admissions were reviewed in all the facilities, 352 of these admissions were for major obstetric complications.

90 of the patients admitted with major obstetric complications in TSH were not residents of the study areas while information of residency was lacking for eight patients. These admissions were not included in the analysis as these represented demands for EmOC services from other population groups. A total of 254 admissions for major obstetric complications were therefore, included in the analysis to determine the met need for EmOC in the study. This was slightly more than the calculated sample size of 208 participants.

It is crucial to note here that several patients had more than one complication for which they received different interventions; so whereas only one, the primary complication, was recorded for each of these patients; all the interventions were taken note of. Therefore, the number of interventions was not equal to 254.

Descriptive information for Participants included in the analysis

Table 1 shows descriptive information for the cases of major Obstetric complications from Kudo, Nyong and Himodonge Payams treated in the facilities within these areas. The mean age of the women admitted with major obstetric complications was 24.8 ± 6.68 years and ranged between 15- 43 years and the mean parity was 2.6 ± 2.56 and ranged from 0- 10; the median parity was 2. Most of the cases were from Nyong Payam 227(89.4%); only 15(5.9%) were from Himodonge Payam while 12(4.7%) were from Kudo Payam.

The commonest obstetric complication leading to admission was complicated abortions (45.7%) followed by prolonged obstructed labor (23.2%) and hemorrhage (16.5%). Evacuation of the Uterus for retained products (42.5%), Cesarean sections (32.7%) and administration of Oxytocin for treatment of Post-partum hemorrhage (13.3%) were the commonest interventions for treating the complications.

Table 1: Frequency table for descriptive information on the participants to measure the met EmOC needs in three Payams in Torit County

	Factors	N (%)	Confidence intervals (CI)
1.	**Age (years)**		
	≤ 20	87 (34.3)	29.6- 41.3
	21- 30	120 (47.2)	42.1- 55.1
	>30	40 (15.7)	11.7- 21.1
	Missing	7 (2.8)	
	Mean age	24.8 (SD=6.68)	
	Range	15- 43	
2.	**Parity**		
	0- 1	107 (42.1)	37.1- 49.6
	2- 5	98 (38.6)	33.9- 46.0
	>5	43 (16.9)	12.9- 22.2
	Missing	6 (2.4)	
	Mean	2.6 (SD=2.56)	
	Range	0-10	
		N (%)	
3.	**Payam of Residence**		
	Nyong	227 (89.4)	85- 92.9
	Himodonge	15(5.9)	3.1- 9.1
	Kudo	12(4.7)	2.4- 7.5
4.	**Admissions per facility**		
	Torit state Hospital (TSH)	251(98.8)	97.1- 100

	Himodonge PHCC	3(1.2)	0.0-2.9
	Kudo PHCC	0(0)	
	Nyong PHCC	0(0)	
	Lowoi PHCC	0(0)	
5.	**The complication for which patient was admitted**		
	Hemorrhage	42(16.5)	12.4- 22.0
	Pre-eclampsia/Eclampsia	4 (1.6)	0.4- 3.7
	Sepsis	8 (3.1)	0.8- 4.6
	Prolonged or Obstructed labor	59 (23.2)	17.4- 28.2
	Ruptured uterus	3 (1.2)	0.0-2.9
	Ectopic pregnancy	3 (1.2)	0.0-2.9
	Complicated Abortion	116 (45.7)	37.8- 51.5
	Others	19 (7.6)	2.9- 8.7
6.	**The interventions for treatment of the complications (n ≠ 254)**		
	Caesarean section	83 (32.7)	
	Evacuation of uterus for retained products of conception	108 (42.5)	
	Laparotomy for ectopic pregnancy	2 (0.8)	
	Laparotomy for ruptured uterus plus hysterectomy	3 (1.2)	
	Manual removal of the placenta	8 (3.1)	
	Oxytocin for treatment of post-partum hemorrhage (PPH)	34(13.4)	
	Misoprostol for treatment of PPH	10 (3.9)	
	Genital tract repairs for tears	6 (2.4)	
	Magnesium sulphate	4 (1.6)	
	Blood transfusion	15 (5.9)	

	Parenteral antibiotics for sepsis	17 (6.7)	
7.	**Maternal out-come of the complications**		
	Alive	251 (98.8)	98.4- 100
	Dead	1 (0.4)	0.0-1.6
	Referred to a higher Centre	2 (0.8)	
8.	**Fetal outcomes**		
	Live births	112 (44.1)	38.2- 51.5
	Still births	17 (6.7)	4.1- 10.4
	Abortions	119 (46.9)	39.0- 52.3
	Unknown	6 (2.4)	0.8- 4.6
9.	**If the live newborn was resuscitated (n=112)**		
	Yes	50 (44.6)	
	No	55 (49.1)	
	Unknown	7 (6.3)	

The met EmOC need for the three Payams in Torit County

Table 2. shows the met need for EmOC services in the three Payams. Out of the 390 major obstetric complications expected in 2015 from the three Payams (including 61 from Himodonge Payam, 73 from Kudo Payam and 256 from Nyong Payam), 254 cases were admitted and treated giving a met EmOC need of 65.13% (95%CI: 60.40 -69.86) for thewhole population in the three Payams. The met EmOC need was highest for the population residing in Nyong Payam (88.67%; 95% CI: 85.01- 92.33) while it was only 24.59% (95%CI: 13.78- 35.40) and 16.44% (95%CI: 7.94- 24.94) for the populations of Himodonge and Kudo Payams respectively.

Table 2. Calculation of the met EmOC need for three Payams in Torit County

Payam of residence	Population in 2015	Total births expected in 2015 using a crude birth rate of 36.1/1000 population	Expected Obstetric complication (15% of expected births)	Obstetric complications actually treated in the facilities	The proportion of obstetric complications treated in the facilities (met need) (%)
Himodonge	13,461	410	61	15	24.59
Kudo	11,357	486	73	12	16.44
Nyong	47,253	1,706	256	227	88.67
Total	72,071	2,602	390	254	65.13

Comparison of the patients with major obstetric cases admitted from the three Payams representing met EmOC need

There was no statistical difference in the mean age of the patients admitted from the three payams with the 95% CIs for mean overlapping among the three groups using one way ANOVA test (p value= 0.818) (see Table 3). The same test applied on the mean parity also showed no significant difference among the three groups with the 95% CIs for mean overlapping as well (p value= 0.165).

In summary, the results shown here indicate a met EmOC service need of 65.13% for the population in the three Payams in Torit County. The met need for the population in Nyong Payam was significantly higher than the population in the other two Payams.

Table 3: Comparison of the major obstetric cases admitted from the three Payams by age and parity

		Nyong	Himodonge	Kudo	P-value
Age (years)					
	≤ 20	79	4	4	
	21 -30	108	5	7	
	>30	33	6	7	0.125
	Mean	24.65 ± 6.61	27.23 ± 7.24	24.08 ± 6.19	0.818
Parity					
	Prime para	95	5	7	
	2-5	89	6	3	
	>5	39	2	2	0.818
	Mean	2.50 ± 2.43	3.46 ± 3.20	2.67 ± 3.23	0.165

Discussion

In this study, the proportion of women with major obstetric complications in three payams in Torit County in 2015 who were treated in the health facilities in Torit County was calculated as the met EmOC need based on the United nations (UN) guidelines for process indicators for EmOC, (7). The study revealed for the first time in Torit County, a 65.13% met obstetric need for the three payams; Nyong Payam with the highest met need of 88.67% while Kudo and Himodonge had only 16.44% and 24.59 %respectively. The implication is that about 12%% of women with obstetric complications who needed emergency care in these settings did not access it and this figure was even higher in Kudo (83.56%) and Himodonge (75.41%) Payams. This is not to suggest that all those women who did not access care must have died but even if they survived, for them to do so without making contact with the healthcare system raises a big public health question.

There are several factors that can affect the met EmOC need which may include community based factors such as education, poverty, transport, cultures and traditional beliefs, (21) as well as health system factors such as the availability and coverage of facilities that are able to offer EmOC services, health staff skills and attitudes, quality and cost of services, availability of the necessary equipment and supplies, governance and management of the health care system, (22). This current study was not designed to assess this whole range of factors but it has brought to light an important fact that should draw the attention of State government and its partners working in Torit County. Most obstetric complications in this study were from one particular Payam: Nyong Payam (89.4%) and the met need was therefore, highest in this Payam (88.13%). Torit town, the state capital, is located in Nyong Payam and the only hospital in this study area is also located in this Payam and so by the standards in this state, Nyong Payam is considered to be an urban area. With a population more than that of the other two Payams combined, perhaps it was not surprising that most of the obstetric complications were from Nyong Payam and were treated form Torit State Hospital. These findings are similar to those shown in a study from Uganda where maternal health care service utilization was more among the residents of the Capital city Kampala and reduced significantly among women living in the rural areas, (23). However, this Ugandan study used a Health and demographic survey data that had collected information on maternal health service utilization related to antenatal care attendance, facility delivery and postnatal care visit but not obstetric complications been assessed in the current study. There is evidence elsewhere indicating direct link between wealth and utilization of obstetric services. For example, a multi-country cross-sectional study to determine coverage, access and quality of EmOC services in Sub-Saharan Africa showed that both hospitals and health centers were utilized more by the women in the

highest wealth quintile than the poorest women, (11). In that study, 83% of women who had received EmOC services in Ethiopia were among the rich, this figure was 87% in Uganda and 77% in Tanzania. A population living in urban area is likely to be more educated and wealthier than that living in the rural areas. This current study shows a clear inequity between the different payams in terms of met obstetric need with Nyong Payam being the better of the three Payams which obviously requires further examination to assess the differences in socio-economic status of the populations in these Payams.

It is also important to note the very limited numbers of complications treated from the facilities located in the rural Payams in this study. Apart from Torit state Hospital (TSH) only Hileu PHCC admitted and treated three other cases, the rest of the other three facilities did not treat any obstetric complication in 2015. Some authors have criticized WHO's method of identifying EmOC facilities based on the signal functions offered in the previous three months before an assessment and advocated for extension of this period to six months to give chance to pick up those facilities with capacity to provide these signal functions but have low case load, (24-26). However, in this current study, facility records for a whole year were reviewed. The fact that no complications were treated in these facilities at all during this period requires critical examination beyond a purported 'no indication' explanation. Perhaps this raises issues of access but the quality of EmOC services and/or the capacity to offer one in the PHCCs in these areas has to be critically evaluated. Other than blood transfusion and cesarean section services almost all the other signal functions of EmOC need to be available in the PHCCs. In a qualitative study in rural Gambia while discussing the reasons for high maternal mortality, women reported reluctance to access health care because of unfavorable previous experience with the health care system such as inconsistent availability of services, poor understanding of how the system operates and sometimes poor attitudes of the health care providers, (27). Considering the lack of midwives and doctors in most facilities in South Sudan especially the PHCCs in rural areas, (28), there are doubts about the real availability of the skills required to offer these signal functions for EmOC in the PHCCs in this study; and the community would be justified not to seek care from these facilities. The undesirable impact of inequitable distribution of midwives among the facilities located in the rural areas on maternal and neonatal health has been discussed in previous cross sectional studies in similar Countries, (29-31).

Several data sources were used during the facility record reviews for obstetric complications admitted in the facilities. All the medical records for patients admitted in the obstetrics and Gynecology units of the facilities in 2015 were reviewed carefully to ensure all cases of obstetric complications were identified. Any missing information was cross checked in the registries on the wards and in the operating room. This has ensured the reliability of the data presented in this study. The analysis technique used here is

also a standard method advised by WHO for monitoring the progress in EmOC services in a community, (7).

This study had limitations. First the estimated population used to calculate the met need is a projection from the 2008 census with an assumption that there were no significant population movements. However, South Sudan has been a war zone with the most recent conflict that started in December, 2013 displacing several people, (8). It is likely that some residents of these areas may have left out of fear and presented their EmOC needs in another location or some populations may have moved into this study area from the conflict areas. There was an attempt however, to critically review several data sources in this study so as to identify and exclude cases from other locations. A second limitation was the retrospective nature in which the cases were identified as this only limited the researcher to what was indicated in the records without a chance to probe or validate information. This could have also affected the numbers of the cases especially if some cases were not recorded or records were lost thus affecting the reliability of the data. The lack of a qualitative arm in this study was another limitation as this would have provided insights into the socio-economic dimensions to access and community perceptions on poor utilization of the services in the facilities which seem to be available. However, the glaring gaps in the healthcare system have been clearly demonstrated in this study.

Conclusion

The key issues raised by this study are that there is low met need for EmOC services in Torit County and that the met need is much lower for the populations living in the rural Payams. Most major obstetric complications were admitted and treated only in TSH with no significant contribution of the PHCCs. The government partners working in these areas therefore, need to ear-mark the seven signal functions of EmOC for regular monitoring and evaluation to assess the performance and utilization of EmOC services in PHCCs in Torit, (7). This will offer an opportunity to identify gaps in the healthcare system and to intervene appropriately to address inequities that may exist in the distribution of EmOC services.

This study also set a basis for a more robust prospective study involving a larger setting that should examine all the seven process indicators for EmOC as well as a qualitative study to explore perceptions that might explain low met EmOC needs.

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Exclusive Licence

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

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	9
		(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	9
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	
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	12
		(*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	13
Discussion			14
Key results	18	Summarise key results with reference to study objectives	14
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	16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14
Generalisability	21	Discuss the generalisability (external validity) of the study results	15
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	N/A

*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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Estimating the met need for Emergency Obstetric care (EmOC) services in three Payams of Torit County, South Sudan; a facility based retrospective cross-sectional study.

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Abstract

Objective

To determine the 'met need' for EmOC in three Payams of Torit County in South Sudan in 2015 and to determine the frequency of each complication.

Design

This was a retrospective cross-sectional study.

Setting

Four primary health care centers (PHCCs) and one state hospital in three Payams (administrative areas that form a County) in Torit County, South Sudan.

Participants

All admissions in the Obstetrics and Gynecology wards (a total of 2,466 patient admission files) in 2015 in all the facilities designated to conduct deliveries in the study area were reviewed to identify obstetric complications.

Primary and secondary outcome measures

The primary outcome in this study was 'met need for EmOC' which was defined as the proportion of all women with direct major obstetric complications in 2015 treated in health facilities providing EmOC services. The frequency of each complication and the interventions for treatment were the secondary outcomes.

Results

Two hundred and fifty four (254) major obstetric complications were admitted in 2015 out of 390 expected from 2602 pregnancies; representing 65.13% 'met need'. The 'met need' was highest (88%) for Nyong Payam- an urban area, compared to the other two rural Payams and 98.8% of the complications were treated from the hospital while no complications were treated from three PHCCs. The commonest obstetric complications were abortions (45.7%), prolonged obstructed labor (23.2%) and hemorrhage (16.5%). Evacuation of the Uterus for retained

products (42.5%), Cesarean sections (32.7%) and administration of Oxytocin for treatment of Post-partum hemorrhage (13.3%) were the commonest interventions.

Conclusion

The 'met need' for EmOC in Torit County is low with 35% of the women with major obstetric complications not accessing care and there is disparity with Nyong Payam having a higher met need. We suggest more support supervision to the PHCCs to increase access for the rural population.

Strengths and limitations of this study

- In this study we reviewed all records of admissions in 2015 in Obstetrics and Gynecology wards of all EmOC health facilities in three Payams of Torit County, South Sudan, to identify women treated for major direct obstetric complications in that year and estimated the 'met need' for EmOC for the first time in a setting that has suffered several decades of civil conflict.
- The study offered an opportunity to examine the health system performance in delivering EmOC services which is of public health interest as it strikes the balance between demand for and access to these services.
- The tool used in this studyfor reviewing the cases of obstetric complications was pretested in a pilot study.
- There were limitations in this study, for example, the estimated population used to calculate the met EmOC need was a projection from the 2008 census with an assumption that there were no significant population movements. We also assumed the national crude birth rate to estimate the expected number of births in the study setting.
- The obstetric complications were identified retrospectively limiting the researchers to what was indicated in the records without a chance to probe or validate information.

Introduction

Timely access to quality Emergency Obstetric Care (EmOC) services by women who develop major direct obstetric complications can avert most maternal deaths, (1).These complications include hemorrhage (which can occur during antepartum, intrapartum or postpartum periods), prolonged obstructed labor, abortion complications, postpartum sepsis, severe pre-eclampsia/eclampsia, ruptured uterus and ectopic pregnancy, (2). The proportion of all women with major direct obstetric complications in a given population treated in EmOC facilities in a defined time period refers to the 'met need' for EmOC for that population, (3). The target is to have 100% of women with these complications treated in EmOC facilities, (4).

EmOC facilities are of two types: basic and comprehensive, (3). A health facility is identified as a basic EmOC facility if it provides the following EmOC services: administration of parenteral antibiotics for treating sepsis, administration of parenteral oxytocic for treatment of postpartum hemorrhage, administration of parenteral anticonvulsants for treatment of severe pre-Eclampsia and Eclampsia, assisted vaginal delivery, manual removal of the placenta, removal of retained products of conception and newborn resuscitation. A facility is identified as a comprehensive EmOC facility if it provides all the basic functions above plus blood transfusion and caesarean section and/or laparotomy, (3). This identification of facilities is important to define a clear continuum of care from primary health care centers to the secondary care facilities as this relates to the availability of medical commodities and staff with skills to manage the complications.

South Sudan has been in civil war for more than two decades, (5), which has destroyed social community structures and health infrastructure, (6). With 81% of mothers delivering at their homes and only 10% of deliveries occurring under the care of skilled personnel, (7), access to EmOC services is poor in South Sudan. As in other developing Countries, this access is not only poor but also inequitable favoring those women in better social class, (8-10). Women living in urban areas are twice more likely to receive any form of skilled assistance at delivery compared to those living in rural areas; women who are formally educated to at least secondary level are five times more likely to receive this assistance compared to their counter parts with no formal education while the richest ones have four times more chance than the poorest in the wealth index, (11). This polarized access to maternal health services is worrying as most of the population is disadvantaged with 51% living below the national poverty line of one dollar per

day; 83% of the population is rural and 73% of men and 84 % of women are illiterate, (11). Health information management systems are currently under development and are not able to launch an effective monitoring and evaluation processes for maternal health indicators, (6). As such, evidence about met need for EmOC, nature of obstetric complications and associated interventions in Torit County are lacking, hence affecting priority strategies for improving maternal and neonatal outcomes.

This study aimed to estimate the 'met need' for EmOC services in three Payams of Torit County and to disaggregate it by geographical location to help guide interventions by development partners who are currently implementing health services in the area under Health Pool Fund (HPF) to improve maternal health, (12).

Methods

Study design

We conducted a retrospective cross-sectional study of women who had been treated for major direct obstetric complications from five EmOC facilities in three Payams of Torit County in 2015.

Study setting

This study was conducted in health facilities located in three payams of Torit County in the former eastern Eastern Equatoria state, Republic of South Sudan: Kudo, Nyong and Himodonge; with a total projected population of 72,071 in 2015, (13). Payams in South Sudan are administrative areas that constitute a County which in turn constitute a state. Nyong Payam (also called Torit Payam) in which the state Capital, Torit, is located was the most populated with 47,253 inhabitants while Kudo Payam had 13,461 and Himodonge Payam had 11,357.

There are a total of 11 public health facilities in the three Payams including one hospital located in Nyong Payam which acts as a referral center. Out of the 11health facilities only 5 including Torit State Hospital can conduct deliveries and are designated as EmOC facilities; four are basic EmOC facilities each with six beds capacity and one- the hospital, is a comprehensive EmOC facility with 22 bed capacity dedicated to obstetric cases. Health service delivery in these facilities is supported by implementing partners under the HPF grant; Save the Children International (SCI) for the PHCCs and Catholic Organization of Relief and Development Aid (CORDAID) for Torit state Hospital. These partners recruit the necessary human resource and procure the medical supplies while government does supportive supervision. The other 6 public facilities are Primary Health Care Units (PHCUs) and together with the private facilities, composed mainly of small clinics and drug shops neither conduct deliveries nor admit patients with major direct obstetric complications.

Study population

All women admitted with major direct obstetric complications in any of the five facilities in the study area between January 1st and December 31st 2015 were included in this study. The admissions for women who were not residents in the study areas were excluded as they were assumed to represent a demand for EmOC services from elsewhere.

Sampling

The Population projection for 2015 in this study area was calculated from the 2008 census to be 72,071,Assuming the same crude birth rate for South Sudan of 36.1/1000 population, (14),a total of 2,602births were expected in 2015. According the World Health Organization (WHO)an estimated 15% (390) of these were expected to get major obstetric complications, (3).Using OpenEpi version 3 for sample size calculation for the proportion who get EmOC services from the facilities and assuming Population size (for finite population correction factor) = 390, hypothesized met need for the population of 38.3%±5 assuming the results of an assessment in Yirol County, Lakes State of South Sudan, (15), and design effect (for cluster surveys-DEFF) = 1; allowing 10% for missing data, a sample size of 208 was enough for a 95% confidence level.

Data collection

All the admission records in theObstetrics and Gynecology wards of the health facilities between January 1st and December 31st 2015 were reviewedby one of the researchers (PB) to identify cases of major direct obstetric complications, the interventions used for treatment and the outcomes of treatment. All records had been kept in paper form and written in English. The information collected included the date of admission, demographic data such as age, parity, tribe, and the Payam of residence. The direct obstetric complications for which the patient was admitted was recorded and according to WHO these complications include hemorrhage, prolonged or obstructed labor, abortion complications, postpartum sepsis, pre-eclampsia/eclampsia, ruptured uterus and ectopic pregnancy, (3). Information was also collected about the pregnancy outcomes at the end of the admission which included spontaneous vaginal delivery, instrumental vaginal delivery, cesarean section, complete abortion, evacuation of the uterus for retained products of conception, laparotomy for ruptured uterus, laparotomy for ectopic pregnancy and/or if woman died or was discharged or escaped from the facility while still pregnant. Maternal and neonatal outcomes during the admission were noted; whether dead or alive and for the alive neonates whether they required resuscitation at birth. Information was further collected about the other interventions for the other obstetric complications such as administration of parenteral oxytocin, repair of genital tract tears and hysterectomy for postpartum hemorrhage, administration of Magnesium sulphate for severe pre-eclampsia and/or eclampsia, administration of parenteral antibiotics for puerperal sepsis, manual removal of the placenta and blood transfusion for severe hemorrhage.

Main outcome measures of study

The primary outcome in this study was the 'met need' for EmOC which was defined as the proportion of all women with major direct obstetric complications in the population treated in the health facilities between January 1st and December 31st 2015. The frequency of each complication and the appropriate interventions to treat them are reported as secondary outcomes.

Statistical Analysis

Data was checked, coded, entered and analyzed using SPSS version 21.

Frequency tables were used to present descriptive data, including the number of direct obstetric complications admitted from each Payam and treated in each facility, the interventions used for treating the complications, pregnancy outcomes after the admission as well as maternal and fetal outcome of the complication. The crude birth rate for the population was used to calculate the expected number of deliveries in a year, 15% of these were assumed to have gotten major obstetric complications, (3). The proportion of the complications treated in the facilities was calculated to represent the met need for EmOC services and the 95% Confidence Intervals (CIs) were calculated using the formula for single population proportions, (16). The age and parity differences among the patients admitted with major Obstetric complications from the three Payams were compared using Analysis of Variance (ANOVA) test. The corresponding confidence intervals and p-values were presented in a table format. All significance levels were set at $p \leq 0.05$.

Ethical issues

Written consent was obtained from the facility in-charges to review the facility records after giving them written information about the study. Ethical approval was sought from the state Ministry of Health, Eastern Equatoria state, South Sudan and from the University of Liverpool ethics committee and a waiver of consent for the medical record reviews obtained. Each complicated case reviewed was assigned a unique study number, the data collected on questionnaires was stored under lock and key, and these were entered into SPSS in a computer which was pass-word protected, only accessed by the researchers.

The Results

A total of 2,466 patient admissions were reviewed in all the facilities, 352 of these admissions were for major obstetric complications. Ninety (90) of the patients admitted with major obstetric complications in TSH were not residents of the study areas while information of residency was lacking for eight patients; these were excluded from the final analysis. A total of 254 admissions for major obstetric complications were therefore, included in the analysis to determine the met need for EmOC in the study. This was slightly more than the calculated sample size of 208 participants. It is crucial to note here that several patients had more than one complication for which they received different interventions; so whereas only one, the primary complication, was recorded for each of these patients; all the interventions were taken note of. Therefore, the number of interventions was not equal to 254.

Descriptive information for Participants included in the analysis

Table 1 shows descriptive information for the cases of major Obstetric complications from Kudo, Nyong and Himodonge Payams treated in the facilities within these areas. The mean age of the women admitted with major obstetric complications was 24.8 ± 6.68 years and ranged between 15- 43 years and the mean parity was 2.6 ± 2.56 and ranged from 0- 10; the median parity was 2. Most of the cases were from Nyong Payam 227(89.4%); only 15(5.9%) were from Himodonge Payam while 12(4.7%) were from Kudo Payam.

The commonest obstetric complication leading to admission was complicated abortions (45.7%) followed by prolonged obstructed labor (23.2%) and hemorrhage (16.5%). Evacuation of the Uterus for retained products (42.5%), Cesarean sections (32.7%) and administration of Oxytocin for treatment of Post-partum hemorrhage (13.3%) were the commonest interventions for treating the complications.

Table 1: Frequency table for descriptive information on the participants to measure the met EmOC needs in three Payams in Torit County

	Factors	N (%)	Confidence intervals (CI)
1.	**Age (years)**		
	≤ 20	87 (34.3)	29.6- 41.3
	21- 30	120 (47.2)	42.1- 55.1
	>30	40 (15.7)	11.7- 21.1
	Missing	7 (2.8)	
	Mean age	24.8 (SD=6.68)	
	Range	15- 43	
2.	**Parity**		
	0- 1	107 (42.1)	37.1- 49.6
	2- 5	98 (38.6)	33.9- 46.0
	>5	43 (16.9)	12.9- 22.2
	Missing	6 (2.4)	
	Mean	2.6 (SD=2.56)	
	Range	0-10	
		N (%)	
3.	**Payam of Residence**		
	Nyong	227 (89.4)	85- 92.9
	Himodonge	15(5.9)	3.1- 9.1
	Kudo	12(4.7)	2.4- 7.5
4.	**Admissions per facility**		

Torit state Hospital (TSH)	251(98.8)	97.1- 100
Himodonge PHCC	3(1.2)	0.0-2.9
Kudo PHCC	0(0)	
Nyong PHCC	0(0)	
Lowoi PHCC	0(0)	
5. **The complication for which patient was admitted**		
Hemorrhage	42(16.5)	12.4- 22.0
Pre-eclampsia/Eclampsia	4 (1.6)	0.4- 3.7
Sepsis	8 (3.1)	0.8- 4.6
Prolonged or Obstructed labor	59 (23.2)	17.4- 28.2
Ruptured uterus	3 (1.2)	0.0-2.9
Ectopic pregnancy	3 (1.2)	0.0-2.9
Complicated Abortion	116 (45.7)	37.8- 51.5
Others	19 (7.6)	2.9- 8.7
6. **The interventions for treatment of the complications (n ≠ 254)**		
Caesarean section	83 (32.7)	
Evacuation of uterus for retained products of conception	108 (42.5)	
Laparotomy for ectopic pregnancy	2 (0.8)	
Laparotomy for ruptured uterus plus hysterectomy	3 (1.2)	
Manual removal of the placenta	8 (3.1)	
Oxytocin for treatment of post-partum hemorrhage (PPH)	34(13.4)	
Misoprostol for treatment of PPH	10 (3.9)	

	Genital tract repairs for tears	6 (2.4)	
	Magnesium sulphate	4 (1.6)	
	Blood transfusion	15 (5.9)	
	Parenteral antibiotics for sepsis	17 (6.7)	
7.	**Maternal out-come of the complications**		
	Alive	251 (98.8)	98.4- 100
	Dead	1 (0.4)	0.0-1.6
	Referred to a higher Centre	2 (0.8)	
8.	**Fetal outcomes**		
	Live births	112 (44.1)	38.2- 51.5
	Still births	17 (6.7)	4.1- 10.4
	Abortions	119 (46.9)	39.0- 52.3
	Unknown	6 (2.4)	0.8- 4.6
9.	**If the live newborn was resuscitated (n=112)**		
	Yes	50 (44.6)	35.43- 53.85
	No	55 (49.1)	39.85- 58.37
	Unknown	7 (6.3)	1.77- 10.73

The met EmOC need for the three Payams in Torit County

Table 2 shows the met need for EmOC services in the three Payams. Out of the 390 major obstetric complications expected in 2015 from the three Payams (including 61 from Himodonge Payam, 73 from Kudo Payam and 256 from Nyong Payam), 254 cases were admitted and treated giving a met EmOC need of 65.13% (95%CI: 60.40 -69.86) for thewhole population in the three Payams. The met EmOC need was highest for the population residing in Nyong Payam (88.67%; 95% CI: 85.01- 92.33) while it was only 24.59% (95%CI: 13.78- 35.40) and 16.44% (95%CI: 7.94- 24.94) for the populations of Himodonge and Kudo Payams respectively.

Table 2: Calculation of the met EmOC need for three Payams in Torit County

Payam of residence	Population in 2015	Total births expected in 2015 using a crude birth rate of 36.1/1000 population	Expected Obstetric complication (15% of expected births)	Obstetric complications actually treated in the facilities	The proportion of obstetric complications treated in the facilities (met need) (%)
Himodonge	13,461	410	61	15	24.59
Kudo	11,357	486	73	12	16.44
Nyong	47,253	1,706	256	227	88.67
Total	72,071	2,602	390	254	65.13

Comparison of the characteristics of patients with major direct obstetric complications by the Payam of residence

There was no statistical difference in the mean age of the patients admitted from the three payams with the 95% CIs for mean overlapping among the three groups using one way ANOVA test (p value= 0.818) (see Table 3). The same test applied on the mean parity also showed no significant difference among the three groups with the 95% CIs for mean overlapping as well (p value= 0.165).

Table 3: Comparison of the Characteristics of patients with major direct obstetric complications treated byPayam of residence

		Nyong	Himodonge	Kudo	P-value
Age (years)					
	≤ 20	79	4	4	
	21 -30	108	5	7	
	>30	33	6	7	0.125
	Mean	24.65 ± 6.61	27.23 ± 7.24	24.08 ± 6.19	0.818
Parity					
	Prime para	95	5	7	
	2-5	89	6	3	
	>5	39	2	2	0.818
	Mean	2.50 ± 2.43	3.46 ± 3.20	2.67 ± 3.23	0.165

In summary, the results shown here indicate a met EmOC service need of 65.13% for the population in the three Payams in Torit County. The met need for the population in NyongPayam was significantly higher than the population in the other two Payams.

Discussion

In this study, the proportion of women with major obstetric complications in three payams in Torit County in 2015 who were treated in the health facilities in Torit County was calculated as the met EmOC need based on the United nations (UN) guidelines for process indicators for EmOC,(3). The study revealed for the first time in Torit County, a 65.13% met obstetric need for the three payams; NyongPayam with the highest met need of 88.67% while Kudo and Himodonge had only 16.44% and 24.59 %respectively. The implication is that about 12% of women with obstetric complications who needed emergency care in these settings did not access it and this figure was very high in Kudo (83.56%) and Himodonge (75.41%) Payams. This is not to suggest that all those women who did not access care must have died but even if they survived, for them to do so without making contact with the healthcare system raises an important public health question.

Our findings indicate a high 'met need' for EmOC in Torit compared to what has been reported previously in other parts of South Sudan. In 2005, Pearson and Shoo reported a 2.1% met need for EmOC in Yambio and 5% in Rumbek, (17). However, this study was more than a decade ago when South had not signed the Comprehensive peace agreement with Sudan, (18). At that time and as reported by the authors, the coverage of EmOC facilities was very low: less than one comprehensive EmOC center per 500,000 people and no basic EmOC centers in Yambio and only 0.5 per 500,000 people in Rumbek. Such a very low met need for EmOC was therefore, expected. Another study conducted in 2012 in Yirol County in South Sudan, just a year after South Sudan got independence, showed a much higher 'met need' for EmOC (38.3%), (15)but this was in an intervention study where an active hospital ambulance system was implemented. Although political conflict continues in South Sudan, our study was at a time when several humanitarian partners are in the Country to support the health system. Perhaps the higher 'met need' for EmOC in this study is as a result of these efforts, (19), but the very low figures for the two rural Payams (Kudo and Himodonge) still raises concerns. The met need for EmOc we obtained here for Nyong Payam is similar to what was reported for Malindi district in neighboring Kenya, (20) although that study only concentrated on comprehensive EmOC facilities and included only complications that required major surgical interventions.

There are several factors that can affect the met EmOC need which may include community based factors such as education, poverty, transport, cultures and traditional beliefs, (21), as well as health system factors such as the availability and coverage of facilities that are able to offer EmOC services, health staff skills and attitudes, quality and cost of services, availability of the necessary equipment and supplies, governance and management of the health care system, (22). This current study was not designed to assess this whole range of factors but it has brought to light an important fact that should draw the attention of State government and its partners working in Torit County. Most obstetric complications in this study were from one particular Payam: Nyong Payam (89.4%) and the 'met need'was therefore, highest in this Payam (88.13%). Torit town, the state capital is located in Nyong Payam and the only hospital in this study area is also located in this Payam and so by the standards in this state, Nyong Payam is considered to be an urban area. With a population more than that of the other two Payams combined, perhaps it was not surprising that most of the obstetric complications were from Nyong Payam and were treated from Torit State Hospital. These findings are similar to those shown in a study from Uganda where maternal health care service utilization was more among the residents of

the Capital city Kampala and reduced significantly among women living in the rural areas, (23).There is evidence elsewhere indicating direct link between wealth and utilization of obstetric services. For example, a multi-country cross-sectional study to determine coverage, access and quality of EmOC services in Sub-Saharan Africa showed that both hospitals and health centers were utilized more by the women in the highest wealth quintile than the poorest women, (8). In that study, 83% of women who had received EmOC services in Ethiopia were among the rich, this figure was 87% in Uganda and 77% in Tanzania. A population living in urban area is likely to be more educated and wealthier than that living in the rural areas. This current study shows a clear inequity between the different payams in terms of met obstetric need with Nyong Payam being the better of the three Payams which obviously requires further examination to assess the differences in socio-economic status of the populations in these Payams.

It is also important to note the very limited numbers of complications treated from the facilities located in the rural Payams in this study. Apart from Torit state Hospital (TSH) only Hileu PHCC admitted and treated three other cases, the rest of the other three facilities did not treat any obstetric complication in 2015. These facilities did not refer any patients to a higher center though, because of the short distance between Nyong PHCC and Torit state hospital, women from Nyong Payam may have preferred to seek care from the hospital directly. Some authors have criticized WHO's method of identifying EmOC facilities based on the signal functions offered in the previous three months before an assessment and advocated for extension of this period to six months to give chance to pick up those facilities with capacity to provide these signal functions but have low case load, (20, 24, 25). However, in this current study, facility records for a whole year were reviewed. The fact that no complications were treated in these facilities at all during this period requires critical examination beyond a purported 'no indication' explanation. Perhaps this raises issues of access but the quality of EmOC services and/or the capacity to offer one in the PHCCs in these areas have to be critically evaluated. Other than blood transfusion and cesarean section services almost all the other signal functions of EmOC need to be available in the PHCCs. In qualitative studies in other parts of South Sudan and in rural Gambia, women reported reluctance to access health care because of unfavorable previous experience with the health care system such as inconsistent availability of services, poor understanding of how the system operates and sometimes poor attitudes of the health care providers, (26-28). Considering the lack of midwives and doctors in most facilities in South

Sudan especially the PHCCs in rural areas, there are doubts about the real availability of the skills required to offer these signal functions for EmOC in the PHCCs in this study; and the community would be justified not to seek care from these facilities, (29). The undesirable impact of inequitable distribution of midwives among the facilities located in the rural areas on maternal and neonatal health has been discussed in previous cross sectional studies in similar Countries, (30-32).

Several data sources were used during the facility record reviews for obstetric complications admitted in the facilities. All the medical records for patients admitted in the obstetrics and Gynecology units of the facilities in 2015 were reviewed carefully to ensure all cases of obstetric complications were identified. Any missing information was cross checked in the registries on the wards and in the operating room. This has ensured the reliability of the data presented in this study. The analysis technique used here is also a standard method advised by WHO for monitoring the progress in EmOC services in a community, (3).

This study had limitations; first the estimated population used to calculate the met need is a projection from the 2008 census with an assumption that there were no significant population movements. However, South Sudan has been a war zone with the most recent conflict that started in December, 2013 displacing over 200,000 people internally and more than 40,000 into the neighboring Countries, (33). It is likely that some residents of these areas may have left out of fear and presented their EmOC needs in another location or some populations may have moved into this study area from the conflict areas. There was an attempt however, to critically review several data sources in this study so as to identify and exclude cases from other locations. Further still, the crude birth rate used in estimating the expected births in this study is for the entire Country which may be different for the local population in the study setting. A second limitation was the retrospective nature in which the cases were identified as this only limited the researcher to what was indicated in the records without a chance to probe or validate information. This could have also affected the numbers of the cases especially if some cases were not recorded or records were lost thus affecting the reliability of the data. The lack of a qualitative arm in this study was another limitation as this would have provided insights into the socio-economic dimensions to access and community perceptions on poor utilization of the services in the facilities which seem to be available. However, the glaring gaps in the healthcare system have been clearly demonstrated in this study.

Conclusion

The key issues raised by this study are that there is low met need for EmOC services in Torit County and that the met need is much lower for the populations living in the rural Payams. Most major obstetric complications were admitted and treated only inTorist state Hospital with no significant contribution of the PHCCs. The government partners working in these areas therefore, need to ear-mark the seven signal functions of EmOC for regular monitoring and evaluation to assess the performance and utilization of EmOC services in PHCCs in Torit. This will offer an opportunity to identify gaps in the healthcare system and to intervene appropriately to address inequities that may exist in the distribution of EmOC services.

This study also set a basis for a more robust prospective study involving a larger setting that should examine all the seven process indicators for EmOC and perhaps establish why the very high abortion rates as well as a qualitative study to explore perceptions that might explain low 'met need' for EmOC.

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

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	9
		(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	9
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	
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	12
		(*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	13
Discussion			14
Key results	18	Summarise key results with reference to study objectives	14
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	16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14
Generalisability	21	Discuss the generalisability (external validity) of the study results	15
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	N/A

*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

Estimating the met need for Emergency Obstetric care (EmOC) services in three Payams of Torit County, South Sudan; a facility based retrospective cross-sectional study.

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Estimating the met need for Emergency Obstetric care (EmOC) services in three Payams of Torit County, South Sudan; a facility based retrospective cross-sectional study

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Word count: 3,976

Abstract

Objective

To determine the met need for EmOC in three Payams of Torit County in South Sudan in 2015 and to determine the frequency of each major obstetric complication.

Design

This was a retrospective cross-sectional study.

Setting

Four primary health care centers (PHCCs) and one state hospital in three Payams (administrative areas that form a County) in Torit County, South Sudan.

Participants

All admissions in the Obstetrics and Gynecology wards (a total of 2,466 patient admission files) in 2015 in all the facilities designated to conduct deliveries in the study area were reviewed to identify obstetric complications.

Primary and secondary outcome measures

The primary outcome was met need for EmOC which was defined as the proportion of all women with direct major obstetric complications in 2015 treated in health facilities providing EmOC services. The frequency of each complication and the interventions for treatment were the secondary outcomes.

Results

Two hundred and fifty four (254) major obstetric complications were admitted in 2015 out of 390 expected from 2602 pregnancies; representing 65.13% met need. The met need was highest (88%) for Nyong Payam- an urban area, compared to the other two rural Payams and 98.8% of the complications were treated from the hospital while no complications were treated from three PHCCs. The most common obstetric complications were abortions (45.7%), prolonged obstructed labor (23.2%) and hemorrhage (16.5%). Evacuation of the Uterus for retained

products (42.5%), Cesarean sections (32.7%) and administration of oxytocin for treatment of post-partum hemorrhage (13.3%) were the most common interventions.

Conclusion

The met need for EmOC in Torit County is low with 35% of the women with major obstetric complications not accessing care and there is disparity with Nyong Payam having a higher met need. We suggest more support supervision to the PHCCs to increase access for the rural population.

Strengths and limitations of this study

- In this study, we reviewed all records of admissions in 2015 in Obstetrics and Gynecology wards of all EmOC health facilities in three Payams of Torit County, South Sudan, to identify women treated for major direct obstetric complications in that year and estimated the met need for EmOC for the first time in a setting that has suffered several decades of civil conflict.
- The study offered an opportunity to examine the health system performance in delivering EmOC services which is of public health interest as it strikes the balance between demand for, and access to these services.
- The tool used in this study for reviewing the cases of obstetric complications was pretested in a pilot study.
- There were limitations in this study, for example, the estimated population used to calculate the met EmOC need was a projection from the 2008 census with an assumption that there were no significant population movements. We also assumed the national crude birth rate to estimate the expected number of births in the study setting.
- The obstetric complications were identified retrospectively limiting the researchers to what was indicated in the records without a chance to probe or validate information.

Introduction

Timely access to quality Emergency Obstetric Care (EmOC) services by women who develop major direct obstetric complications can avert most maternal deaths (1).These complications include hemorrhage (which can occur during antepartum, intrapartum or postpartum periods), prolonged obstructed labor, abortion complications, postpartum sepsis, severe pre-eclampsia/eclampsia, ruptured uterus and ectopic pregnancy (2). The proportion of all women with major direct obstetric complications in a given population treated in EmOC facilities in a defined time period refers to the met need for EmOC for that population (3). The target is to have 100% of women with these complications treated in EmOC facilities (4).

EmOC facilities are of two types: basic and comprehensive (3). A health facility is identified as a basic EmOC facility if it provides the following EmOC services: administration of parenteral antibiotics for treating sepsis, administration of parenteral oxytocic for treatment of postpartum hemorrhage, administration of parenteral anticonvulsants for treatment of severe pre-Eclampsia and Eclampsia, assisted vaginal delivery, manual removal of the placenta, removal of retained products of conception and newborn resuscitation. A facility is identified as a comprehensive EmOC facility if it provides all the basic functions above plus blood transfusion and caesarean section and/or laparotomy (3). This identification of facilities is important to define a clear continuum of care from primary health care centers to the secondary care facilities as this relates to the availability of medical commodities and staff with skills to manage the complications.

South Sudan has been in civil war for more than two decades (5), which has destroyed social community structures and health infrastructure (6). With 81% of mothers delivering at their homes and only 10% of deliveries occurring under the care of skilled personnel (7), access to EmOC services is poor in South Sudan. As in other developing countries, this access is not only poor but also inequitable favoring those women in better social class (8-10). Women living in urban areas are twice more likely to receive any form of skilled assistance at delivery compared to those living in rural areas. Women who are formally educated to at least secondary level are five times more likely to receive this assistance compared to their counter parts with no formal education while the richest ones have four times more chance than the poorest in the wealth index (11). This polarized access to maternal health services is worrying as most of the population is disadvantaged with 51 % living below the national poverty line (one dollar per day;

83 % of the population is rural and 73 % of men and 84 % of women are illiterate (11). Health information management systems are currently under development and are not able to launch an effective monitoring and evaluation processes for maternal health indicators (6). Although it has been stated that at least 50 % of the population in Torit County live within 5 km of a public health facility and at least 50 % of the population are within one hour's walking time to the nearest public health facility, (12) it is not clear whether the people who really need the health care services are accessing it. As such, evidence about met need for EmOC, nature of obstetric complications and associated interventions in Torit County are lacking, hence affecting priority strategies for improving maternal and neonatal outcomes.

This study aimed to estimate the met need for EmOC services in three Payams of Torit County and to disaggregate it by geographical location to help guide interventions by development partners who are currently implementing health services in the area under Health Pool Fund (HPF) to improve maternal health (13).

Methods

Study design

We conducted a retrospective cross-sectional study of women who had been treated for major direct obstetric complications from five EmOC facilities in three Payams of Torit County in 2015.

Study setting

This study was conducted in health facilities located in three payams of Torit County in the former eastern Eastern Equatoria state, Republic of South Sudan: Kudo, Nyong and Himodonge; with a total projected population of 72,071 in 2015 (14). Payams in South Sudan are administrative areas that constitute a County which in turn constitute a state. Nyong Payam (also called Torit Payam) in which the state capital, Torit, is located was the most populated with 47,253 inhabitants while Kudo Payam had 13,461 and Himodonge Payam had 11,357.

The public health care system in South Sudan is structured into four levels: the primary health care units (PHCUs), the primary health care centers (PHCCs), the County Hospitals (CHs), the state hospitals (SHs) and the teaching hospitals (THs) (12). PHCUs are the lowest level facilities that provide preventive, promotional and curative services aimed to serve a population of 15,000 people while the primary health care centers (PHCCs) act as immediate referral points for the PHCUs and are aimed to serve a population of 50,000 people with all the services offered in a PHCU plus diagnostic laboratory, maternity and inpatient care services. The CHs aimed to serve 300,000 people and SHs to serve 500,000 people act as secondary care units while the THs provide tertiary care.

There are a total of 11 public health facilities in the study area including one state hospital located in Nyong Payam which acts as a referral center. Out of the 11 health facilities only 5 including Torit state hospital can conduct deliveries and are designated as EmOC facilities; four are basic EmOC facilities each with six beds capacity and one- the hospital, is a comprehensive EmOC facility with 22 beds capacity dedicated to obstetric cases. Health service delivery in these facilities is supported by implementing partners under the HPF grant; Save the Children International (SCI) for the PHCCs and Catholic Organization of Relief and Development Aid (CORDAID) for Torit state Hospital. These partners recruit the necessary human resource and provide the medical supplies while government does supportive supervision. The other 6 public facilities are Primary Health Care Units (PHCUs) and together with the private facilities

composed mainly of small clinics and drug shops neither conduct deliveries nor admit patients with major direct obstetric complications.

Study population

All women admitted with major direct obstetric complications in any of the five facilities in the study area between January 1st and December 31st 2015 were included in this study. The admissions for women who were not residents in the study areas were excluded as they were assumed to represent a demand for EmOC services from elsewhere.

Sampling

The Population projection for 2015 in this study area was calculated from the 2008 census to be 72,071. Assuming the same crude birth rate for South Sudan of 36.1/1000 population (15), a total of 2,602 births were expected in 2015. According to the World Health Organization (WHO) an estimated 15% (390) of these were expected to get major obstetric complications (3). Using OpenEpi version 3 for sample size calculation for the proportion who get EmOC services from the facilities and assuming population size (for finite population correction factor) of 390, hypothesized met need for the population of 38.3%±5 assuming the results of an assessment in Yirol County, Lakes State of South Sudan (16), and design effect (for cluster surveys-DEFF) = 1; allowing 10% for missing data, a sample size of 208 was enough for a 95% confidence level.

Data collection

All the admission records in the Obstetrics and Gynecology wards of the health facilities between January 1st and December 31st 2015 were reviewed by one of the researchers (PB) to identify cases of major direct obstetric complications, the interventions used for treatment and the outcomes of treatment. All records had been kept in paper form and written in English. The information collected included the date of admission, demographic data such as age, parity, ethnic group, and the Payam of residence. The direct obstetric complications for which the patient was admitted was recorded and according to WHO these complications include hemorrhage, prolonged or obstructed labor, abortion complications, postpartum sepsis, pre-eclampsia/eclampsia, ruptured uterus and ectopic pregnancy (3). Information was also collected about the pregnancy outcomes at the end of the admission which included spontaneous vaginal delivery, instrumental vaginal delivery, cesarean section, complete abortion, evacuation of the uterus for retained products of conception, laparotomy for ruptured uterus, laparotomy for ectopic pregnancy and/or if woman died or was discharged or escaped from the facility while

still pregnant. Maternal and neonatal outcomes during the admission were noted; whether dead or alive and for the alive neonates whether they required resuscitation at birth. Information was further collected about the other interventions for the other obstetric complications such as administration of parenteral oxytocin, repair of genital tract tears and hysterectomy for postpartum hemorrhage, administration of Magnesium sulphate for severe pre-eclampsia and/or eclampsia, administration of parenteral antibiotics for puerperal sepsis, manual removal of the placenta and blood transfusion for severe hemorrhage.

Main outcome measures of study

The primary outcome in this study was the met need for EmOC which was defined as the proportion of all women with major direct obstetric complications in the population treated in the health facilities between January 1st and December 31st 2015. The frequency of each complication and the appropriate interventions to treat them are reported as secondary outcomes.

Statistical Analysis

Data was checked, coded, entered and analyzed using SPSS version 21. Frequency tables were used to present descriptive statistics such as the number of direct obstetric complications admitted from each Payam and treated in each facility, the interventions used for treating the complications, pregnancy outcomes after the admission as well as maternal and fetal outcome of the complication.

The crude birth rate for the population was used to calculate the expected number of deliveries in a year, 15% of these were assumed to have gotten major obstetric complications (3). The proportion of the complications treated in the facilities was calculated to represent the met need for EmOC services and the 95% Confidence Intervals (CIs) were calculated using the formula for single population proportions (17). The age and parity differences among the patients admitted with major Obstetric complications from the three Payams were compared using Analysis of Variance (ANOVA) test. The corresponding confidence intervals and p-values were presented in a table format. All significance levels were set at $p \leq 0.05$.

Ethical issues

Ethical approval was sought from the state Ministry of Health, Eastern Equatoria state, South Sudan and from the University of Liverpool ethics committee. A waiver of consent for the

medical record reviews was also obtained. Written consent was obtained from the facility in-charges to review the facility records after giving them written information about the study.

Each complicated case reviewed was assigned a unique study number. The data collected on questionnaires was stored under lock and key and were entered into SPSS in a computer which was pass-word protected, only accessed by the researchers.

Results

A total of 2,466 patient admissions were reviewed in all the facilities; 352 of these admissions were for major obstetric complications. 90 of the patients admitted with major obstetric complications in TSH were not residents of the study areas while information of residency was lacking for eight patients; these were excluded from the final analysis. A total of 254 admissions for major obstetric complications were therefore included in the analysis to determine the met need for EmOC in the study. This was slightly more than the calculated sample size of 208 participants. It is important to note that several patients had more than one complication for which they received different interventions. However, only the primary complication was recorded for each of these patients while all the interventions were taken note of. Therefore, the number of interventions was not equal to 254.

Descriptive information for participants included in the analysis

Table 1 shows descriptive information for the cases of major Obstetric complications from Kudo, Nyong and Himodonge Payams treated in the facilities within these areas. The mean age of the women admitted with major obstetric complications was 24.8 ± 6.68 years and ranged between 15- 43 years. The mean parity was 2.6 ± 2.56 and ranged from 0- 10; the median parity was 2. Most of the cases were from Nyong Payam 227 (89.4%); only 15 (5.9%) were from Himodonge Payam while 12 (4.7%) were from Kudo Payam.

The most common obstetric complication leading to admission was complicated abortions (45.7%) followed by prolonged obstructed labor (23.2%) and hemorrhage (16.5%). Evacuation of the uterus for retained products (42.5%), Cesarean sections (32.7%) and administration of oxytocin for treatment of post-partum hemorrhage (13.3%) were the most common interventions for treating the complications.

Table 1: Frequency table for descriptive information on the participants to measure the met EmOC needs in three Payams in Torit County

	Factors	N (%)	Confidence intervals (CI)
1.	**Age (years)**		
	≤ 20	87 (34.3)	29.6- 41.3
	21- 30	120 (47.2)	42.1- 55.1
	>30	40 (15.7)	11.7- 21.1
	Missing	7 (2.8)	
	Mean age	24.8 (SD=6.68)	
	Range	15- 43	
2.	**Parity**		
	0- 1	107 (42.1)	37.1- 49.6
	2- 5	98 (38.6)	33.9- 46.0
	>5	43 (16.9)	12.9- 22.2
	Missing	6 (2.4)	
	Mean	2.6 (SD=2.56)	
	Range	0-10	
		N (%)	
3.	**Payam of Residence**		
	Nyong	227 (89.4)	85- 92.9
	Himodonge	15 (5.9)	3.1- 9.1
	Kudo	12 (4.7)	2.4- 7.5
4.	**Admissions per facility**		

Torit state Hospital (TSH)	251(98.8)	97.1- 100
Himodonge PHCC	3 (1.2)	0.0-2.9
Kudo PHCC	0 (0)	
Nyong PHCC	0 (0)	
Lowoi PHCC	0 (0)	
5. **The complication for which patient was admitted**		
Hemorrhage	42(16.5)	12.4- 22.0
Pre-eclampsia/Eclampsia	4 (1.6)	0.4- 3.7
Sepsis	8 (3.1)	0.8- 4.6
Prolonged or Obstructed labor	59 (23.2)	17.4- 28.2
Ruptured uterus	3 (1.2)	0.0-2.9
Ectopic pregnancy	3 (1.2)	0.0-2.9
Complicated Abortion	116 (45.7)	37.8- 51.5
Others	19 (7.6)	2.9- 8.7
6. **The interventions for treatment of the complications (n ≠ 254)**		
Caesarean section	83 (32.7)	
Evacuation of uterus for retained products of conception	108 (42.5)	
Laparotomy for ectopic pregnancy	2 (0.8)	
Laparotomy for ruptured uterus plus hysterectomy	3 (1.2)	
Manual removal of the placenta	8 (3.1)	
Oxytocin for treatment of post-partum hemorrhage (PPH)	34 (13.4)	
Misoprostol for treatment of PPH	10 (3.9)	

	Genital tract repairs for tears	6 (2.4)	
	Magnesium sulphate	4 (1.6)	
	Blood transfusion	15 (5.9)	
	Parenteral antibiotics for sepsis	17 (6.7)	
7.	**Maternal out-come of the complications**		
	Alive	251 (98.8)	98.4- 100
	Dead	1 (0.4)	0.0-1.6
	Referred to a higher Centre	2 (0.8)	
8.	**Fetal outcomes**		
	Live births	112 (44.1)	38.2- 51.5
	Still births	17 (6.7)	4.1- 10.4
	Abortions	119 (46.9)	39.0- 52.3
	Unknown	6 (2.4)	0.8- 4.6
9.	**If the live newborn was resuscitated (n=112)**		
	Yes	50 (44.6)	35.43- 53.85
	No	55 (49.1)	39.85- 58.37
	Unknown	7 (6.3)	1.77- 10.73

The met EmOC need for the three Payams in Torit County

Table 2 shows the met need for EmOC services in the three Payams. Out of the 390 major obstetric complications expected in 2015 from the three Payams (including 61 from Himodonge Payam, 73 from Kudo Payam and 256 from Nyong Payam), 254 cases were admitted and treated giving a met EmOC need of 65.13% (95%CI: 60.40 -69.86) for the whole population in the three Payams.

The met EmOC need was highest for the population residing in Nyong Payam (88.67%; 95% CI: 85.01- 92.33) while it was only 24.59% (95%CI: 13.78- 35.40) and 16.44% (95% CI: 7.94- 24.94) for the populations of Himodonge and Kudo Payams respectively.

Table 2: Calculation of the met EmOC need for three Payams in Torit County

Payam of residence	Population in 2015	Total births expected in 2015 using a crude birth rate of 36.1/1000 population	Expected Obstetric complication (15% of expected births)	Obstetric complications actually treated in the facilities	The proportion of obstetric complications treated in the facilities (met need) (%)
Himodonge	13,461	410	61	15	24.59
Kudo	11,357	486	73	12	16.44
Nyong	47,253	1,706	256	227	88.67
Total	72,071	2,602	390	254	65.13

Comparison of the characteristics of patients with major direct obstetric complications by the Payam of residence

There was no statistical difference in the mean age of the patients admitted from the three payams with the 95% CIs for mean overlapping among the three groups using one way ANOVA test (p value= 0.818) (see Table 3). The same test applied on the mean parity also showed no significant difference among the three groups with the 95% CIs for mean overlapping as well (p value= 0.165).

Table 3: Comparison of the Characteristics of patients with major direct obstetric complications treated by Payam of residence

		Nyong	Himodonge	Kudo	P-value
Age (years)					
	≤ 20	79	4	4	
	21 -30	108	5	7	
	>30	33	6	7	0.125
	Mean	24.65 ± 6.61	27.23 ± 7.24	24.08 ± 6.19	0.818
Parity					
	Prime para	95	5	7	
	2-5	89	6	3	
	>5	39	2	2	0.818
	Mean	2.50 ± 2.43	3.46 ± 3.20	2.67 ± 3.23	0.165

In summary, the results indicated a met EmOC service need of 65.13% for the population in the three Payams in Torit County. The met need for the population in Nyong Payam was significantly higher than the population in the other two Payams.

Discussion

In this study, the proportion of women with major obstetric complications in three payams in Torit County in 2015 who were treated in the health facilities in the study area was calculated as the met EmOC need based on the United Nations (UN) guidelines for process indicators for EmOC (3). The study revealed a 65.13% met need for EmOC in the three payams; Nyong Payam with the highest met need of 88.67% while Kudo and Himodonge had only 16.44% and 24.59 % respectively. It means that about 35% of women with obstetric complications who needed emergency care in these settings did not access it and this figure was high in Kudo (83.56%) and Himodonge (75.41%) Payams.

Our findings indicate a high met need for EmOC in Torit compared to what has been reported previously in other parts of South Sudan. In 2005, Pearson and Shoo reported a 2.1% met need for EmOC in Yambio and 5% in Rumbek (18). However, this study was more than a decade ago

when South Sudan had not signed the Comprehensive peace agreement with Sudan (19). At that time and as reported by the authors, the coverage of EmOC facilities was very low: less than one comprehensive EmOC center per 500,000 people and no basic EmOC center in Yambio and only 0.5 per 500,000 people in Rumbek. Such a low met need for EmOC was therefore expected. Another study conducted in 2012 in Yirol County just a year after South Sudan got independence, showed a much higher met need for EmOC (38.3%). However, this study was an intervention study where an active hospital ambulance system was implemented (16). Our study was conducted at a time when several humanitarian partners are in the Country to support the health system. Perhaps the higher met need for EmOC in this study is as a result of these efforts. (20), but the low figures for the two rural Payams (Kudo and Himodonge) still raise concerns. The met need for EmOC obtained here for Nyong Payam is similar to what was reported for Malindi district in neighboring Kenya although that study only concentrated on comprehensive EmOC facilities and included only complications that required major surgical interventions (21).

This current study was not designed to assess the various factors that may affect the met need for EmOC (22, 23), but it has brought to light important facts that should draw the attention of State government and its partners working in Torit County. First, most cases of obstetric complications in this study were from one particular Payam: Nyong Payam (89.4%) and the met need was therefore highest in this Payam (88.13%). Torit town, the state capital is located in Nyong Payam and the only hospital in this study area is also located in this Payam and by the standards in this state, Nyong Payam is considered to be an urban area. With a population more than that of the other two Payams combined, perhaps it was not surprising that most of the obstetric complications were from Nyong Payam and were treated from Torit State Hospital. These findings are similar to those shown in a study from Uganda where maternal health care service utilization was more among the residents of the Capital city Kampala and reduced significantly among women living in the rural areas (24). There is evidence elsewhere indicating a direct link between wealth and utilization of obstetric services. For example, a multi-country cross-sectional study to determine the coverage, access and quality of EmOC services in Sub-Saharan Africa showed that both hospitals and health centers were utilized more by the women in the highest wealth quintile than the poorest women (8). In that study, 83% of women who had received EmOC services in Ethiopia were among the rich, this figure was 87% in Uganda and 77% in Tanzania (8). A population living in urban area is likely to be more educated and

wealthier than that living in the rural areas. This current study shows a clear inequity between the different payams in terms of met obstetric need with Nyong Payam being the better of the three Payams which obviously requires further examination to assess the differences in socio-economic status of the populations in these Payams.

Secondly, there were very limited numbers of complications treated from the facilities located in the rural Payams in this study. Apart from Torit state Hospital (TSH) only Hileu PHCC admitted and treated three other cases, the rest of the other three facilities did not treat any obstetric complication in 2015. These facilities did not refer any patients to a higher center either. Perhaps because of the short distance between Nyong PHCC and Torit state hospital, women from Nyong Payam might have preferred to seek care from the hospital directly. Some authors have criticized WHO's method of identifying EmOC facilities based on the signal functions offered in the previous three months before an assessment and advocated for extension of this period to six months to give chance to pick up those facilities with capacity to provide these signal functions but have low case load (21, 25, 26). However, in this current study, facility records for a whole year were reviewed. The fact that no complications were treated in these facilities during this period requires a critical examination beyond a purported 'no indication' explanation. Perhaps this raises issues of access but the quality of EmOC services and/or the capacity to offer one in the PHCCs in these areas have to be critically evaluated. Other than blood transfusion and cesarean section services almost all the other signal functions of EmOC need to be available in the PHCCs. In qualitative studies in other parts of South Sudan and in rural Gambia, women reported reluctance to access health care because of unfavorable previous experience with the health care system such as inconsistent availability of services, poor understanding of how the system operates and sometimes poor attitudes of the health care providers (27-29). Considering the lack of midwives and doctors in most facilities in South Sudan especially the PHCCs in rural areas, there are doubts about the real availability of the skills required to offer these signal functions for EmOC in the PHCCs in this study; and the community would be justified not to seek care from these facilities (30). The undesirable impact of inequitable distribution of midwives among the facilities located in the rural areas on maternal and neonatal health has been discussed in previous cross -sectional studies in similar countries (31-33).

In this study, several data sources were used during the facility record reviews for obstetric complications admitted in the facilities. All the medical records for patients admitted in the obstetrics and gynecology units of the facilities in 2015 were reviewed carefully to ensure all cases of obstetric complications were identified. Any missing information was cross checked in the registries on the wards and in the operating room. This has ensured the reliability of the data presented in this study. The analysis technique used here is also a standard method advised by WHO for monitoring the progress in EmOC services in a community (3). Since all admissions were reviewed and all major obstetric complications were included in the final analysis, this study had a heterogeneous population sample of participants minimizing selection bias and further increasing the external validity of the results.

However, there were limitations in this study; first the estimated population used to calculate the met need is a projection from the 2008 census with an assumption that there were no significant population movements. However, South Sudan has been a war zone with the most recent conflict that started in December 2013 displacing over 200,000 people internally and more than 40,000 into the neighboring Countries (34). It is likely that some residents of these areas may have left out of fear and presented their EmOC needs in another location or some populations may have moved into this study area from the conflict areas. There was an attempt however, to critically review several data sources in this study so as to identify and exclude cases from other locations. Further still, the crude birth rate used in estimating the expected births in this study is for the entire country which may be different for the local population in the study setting. A second limitation was the retrospective nature in which the cases were identified as this only limited the researchers to what was indicated in the records without a chance to probe or validate information. This could have also affected the numbers of the cases especially if some cases were not recorded or records were lost thus affecting the reliability of the data. The lack of a qualitative arm in this study was another limitation as this would have provided insights into the socio-economic dimensions to access of healthcare services and community perceptions on poor utilization of the services in the facilities which seem to be available. However, the glaring gaps in the healthcare system have been clearly demonstrated in this study.

Conclusion

The key issues raised by this study are that there is low met need for EmOC services in Torit County and that the met need is much lower for the populations living in the rural Payams. Most major obstetric complications were admitted and treated only in Torit state hospital with no significant contribution of the PHCCs. The government partners working in these areas therefore, need to ear-mark the seven signal functions of EmOC for regular monitoring and evaluation to assess the performance and utilization of EmOC services in PHCCs in Torit. This will offer an opportunity to identify gaps in the healthcare system and to intervene appropriately to address inequities that may exist in the distribution of EmOC services.

This study also set a basis for a more robust prospective study involving a larger setting that should examine all the seven process indicators for EmOC and perhaps establish why there is very high abortion rate. It also establishes the need for a qualitative study to explore perceptions that might explain the low met need for EmOC.

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

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	9
		(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	9
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	
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	12
		(*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	13
Discussion			14
Key results	18	Summarise key results with reference to study objectives	14
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	16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14
Generalisability	21	Discuss the generalisability (external validity) of the study results	15
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	N/A

*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.