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Health facility service availability and readiness to provide basic emergency obstetric and newborn care in low-income countries: an evidence from Tanzania national survey

Deogratius Bintabara[1*], Alex Ernest[2], Bonaventura C.T Mpondo[3]

*Correspondence

Author email addresses:

DB:bintabaradeo@gmail.com

AE: ibolinga@gmail.com

BCM: boniempondo@gmail.com

ABSTRACT

Objective: This study aimed to assesse the availability of seven signal functions; readiness of the health facilities to provide basic emergency obstetrics and newborns care; and identifying its influential factors in low-income countries.

Design: Health facility-based cross-sectional survey

Setting: We analysed data for obstetric and newborn care services obtained from the 2014-2015 Tanzania Service Provision Assessment survey, using World Health Organization-Service Availability and Readiness Assessment tool.

Primary and secondary outcome measures: Availability of seven signal functions were measured based on the provision of "parental administration of antibiotic", "parental administration of oxytocic," "parental administration of anticonvulsants," "assisted vaginal delivery," "manual removal of placenta," "manual removal of retained products or conception," and 'neonatal resuscitation". Readiness was a composite variable measured based on the availability of supportive items categorized into three domains; staff training, equipment, and medicines.

Results: Out of 1, 188 facilities, 905 (76.2%) reported to provide obstetric and newborn care services and therefore were included in the analysis of the current study. Overall availability of seven signal functions and average readiness score were consistently higher among hospitals than health centers and dispensaries (P<0.001). Furthermore, the type of facility, performing quality assurance, regular reviewing of maternal and newborn deaths, reviewing clients' opinion, and a number of delivery beds per facility were significantly associated with higher readiness score.

Conclusion: The study found the variation in availability of seven signal functions and readiness to provide basic emergency obstetric and newborn care among health facilities. The study recommends that quality assurance measures, reviewing clients' opinion and maternal mortality audits should be strengthened to improve availability and readiness to provide basic emergency obstetric and newborns care.

Strengths and limitations of this study

- This is the first study in this region to identify factors assocated with readiness to provide basic emergency obstetric and newborn care using the recommended World Health Organization service readiness indicators, and data obtained from a nationally representative sample.
- Using a nationally representative sample nation suggest that our findings accurately reflect the current situation regarding availability and readiness to provide basic emergency obstetric and newborn care in low-income countries.
- The findings were adjusted for clustering effect and weighted to correct for complex sampling technique and non- response and disproportionate sampling respectively.
- Being a cross-sectional in nature, the causal relationship could not be assessed, therefore, the results should be interpreted with caution.

INTRODUCTION

Maternal mortality ratio (MMR) remains unacceptably high in developing countries.[1] Estimates show that 800 women die daily from maternal complications globally; 99% of all these deaths have been shown to occur in developing countries.[2] Direct obstetric causes are responsible for 73% of all maternal deaths with hemorrhage being the most common cause followed by hypertensive disorders and sepsis.[3] Despite the substantial decline in global maternal mortality estimates over the past 15 years,[4] recent reports showed a significant increase of MMR in Tanzania from 454 maternal deaths per 100,000 live births in 2010[5] to 556 maternal deaths per 100,000 live births in 2016.[6]

To reduce these deaths, World Health Organization (WHO) recommends access to skilled birth attendants and availability of emergency obstetric care (EmOC) services as strategies to avert maternal deaths.[2,7] Evidence suggests that provision of EmOC services is associated with the reduction in maternal mortality and morbidity[8], especially when provided by skilled birth attendants.[9,10] EmOC refers to interventions offered at health facilities aiming at treating direct obstetric emergencies which account for vast majority of the maternal deaths.[11] The guideline for EmOC services lists seven different items that constitute the basic emergency obstetric and neonatal care (BEmONC) services.[11] The seven items include; the ability of the facility to administer parenteral antibiotics, administer uterotonic drugs (parenteral oxytocin), parenteral anticonvulsants (e.g magnesium sulphate), perform manual removal of placenta, perform removal of retained products, perform assisted vaginal delivery and perform basic neonatal resuscitation. Based on these items, facilities are then classified as BEmONC based on their actual performance of the signal functions in three months. Several studies have been done to assess the met need for BEmONC, but, the majority of them found low rates of met needs for

BEmONC.[8,12,13] Furthermore, an inverse correlation has been observed between BEmONC services rates and maternal mortality.[8]

BEmONC is among the strategies recommended to reduce MMR in low-income countries.[14] Despite the majority of these countries implemented BEmONC strategy yet this region still experience high MMR.[4,15] For example, Tanzania developed a number of policies and guidelines as a response from international and regional policies and agreements[16] targeting the reduction of maternal deaths, such as the Delhi Declaration of 2005 and Millennium Development Goal 5 and later Sustainable Development goal 3.[17] However, the country still reporting high MMR, additionally, there is a limited information regarding the status of the availability and readiness of health facilities to provide BEmONC. This study is therefore aimed at assessing the availability of BEmOC services among health facilities in Tanzania and their readiness to provide BEmONC services as well as its associated factors using WHO Service Availability and Readiness Assessment (SARA) tool.[18]

METHODS

Data source

The analyzed data of the current study were drawn from 2014-2015 Tanzania Service Provision assessment (TSPA) survey dataset. The 2014-2015 TSPA was undertaken by Tanzania's National Bureau of Statistics (NBS) in collaboration with the Office of the Chief Government Statistician (OCGS), Zanzibar, the Ministry of Health and Social Welfare (MoHSW), Tanzania Mainland, and the Ministry of Health (MOH), Zanzibar. Technical support for the survey was provided by ICF International under the Demographic and health survey (DHS) program. the survey assessed the facilities regarding availability and readiness of providing basic and essential health services, including maternal and newborn care and child health, family planning, reproductive health services, non-communicable diseases (NCDs), as well as services for certain infectious diseases (HIV/AIDS, STIs, malaria, and TB).

Sample and Sampling procedure

A multi-stage cluster sampling technique was used to select 1,200 health facilities out of a sampling frame containing all 7,102 formal sector health facilities in Tanzania. The sample was designed to provide nationally representative results according to facility type, managing authority and regionally representative results for both the Tanzania mainland and Zanzibar regions. The 2014-15 TSPA used four main types of data collection tools: a facility inventory questionnaire; a health provider interview questionnaire; observation protocols for antenatal care (ANC) family planning (FP) and sick child services; and exit interview questionnaires for ANC and FP clients and for caretakers of sick children whose consultations were observed. The current study analyzed data from the facility inventory file. For that reason, the unit of analysis remained at the facility level.

Measurement of variables

Based on our research questions; the current study identified two outcome variables which were "BEmONC services availability" and "BEmONC services readiness". These variables were measured by using the WHO methods of assessing facility service availability and readiness. Hence, "BEmOC services availability" were measured based on the provision of the seven services referred as "signal functions" which are "parental administration of antibiotic", "parental administration of oxytocic," "parental administration of anticonvulsants," "assisted vaginal delivery," "manual removal of placenta," "manual removal of retained products or conception," and 'neonatal resuscitation". "BEmONC services readiness" was measured based on the availability of supportive items categorized into three domains (groups) as follows; the first domain was staff training that had two indicators which were the presence of guidelines and at least one staff who had received refresher training in delivery and newborns care. The second domain was equipment which had eleven indicators i.e availability of "emergency transport," "sterilization equipment," "examination light," "delivery pack," "suction apparatus," "manual vacuum extractor," "vacuum aspirator or D&C kit," "neonatal bag and mask," "delivery bed," "Partograph," and "gloves". The third domain was medicine and commodities which had eleven indicators contains essential medicines for delivery and newborn i.e "injectable antibiotic," "injectable uterotonic"', "injectable magnesium sulfate", "injectable diazepam", "intravenous fluids," "skin disinfectant," "antibiotic eye ointment," "4% chlorhexidine," "injectable gentamicin," "injectable ceftriaxone," and "amoxicillin suspension". The BEmOC service readiness was then created as a composite score by adding the presence of each indicator, with equal weight given to each of the domains and each of the indicators within the domains. As the expected target was 100%, each domain accounted for 33.3% (100%/3) of the total score. The

percent for each indicator within the domain was equal to 33.3% divided by the number of indicators in that domain. The BEmONC service readiness score for each facility was then calculated by adding the percentages. Facilities with high scores were considered to be better in readiness to provide BEmONC compared to those with low scores.

Explanatory variables; facility location was coded as "0" for urban and "1" for Rural. The facility type was coded as "0" for clinic or dispensary, "1" for a health center, and "2" for a Hospital. Managing authority was coded as "0" for a public facility and "1" for the private facility. Duty schedule for 24 hours was coded as "Yes" for facilities observed having a duty schedule or call list for 24 hours staff assignment and "No" for facilities that observed not having a duty schedule or call list for 24 hours staff assignment. Quality assurance was coded as "performed" for facilities reported routinely carry out quality assurance activities and "not performed" for facilities that reported not routinely carry out quality assurance activities. Maternal or newborn deaths were coded as "reviewed" for facilities that conducted regular reviews of maternal or newborn deaths or near-misses and "not reviewed" for facilities that not conducted regular reviews of maternal or newborn deaths or near-misses. Clients' opinions was coded as "reviewed" for facilities reported having a system of determining and reviewing clients' opinion and "not reviewed" for facilities reported not having a system of determining and reviewing clients' opinion. A number of staffs and number of beds per facility remained as discrete quantitative variables.

Statistical analysis

Data were analyzed using Stata 14 (StataCorp, College Texas). For all the analyses, the "svy" set command in Stata was used to adjust for the complex sampling design employed by TSPA survey. All estimates were weighted to correct for non- response and disproportionate sampling. In the descriptive analysis, continuous variables were summarized using either mean (SD) for normally distributed variables or median (IQR) for non-normal distributed variables. All categorical variables were summarized using proportions and then presented in tables and graphs. Bivariate and multivariate regression models were fitted to assess the existence of the association between the outcome variable (BEmONC service readiness) and the explanatory variables. Before the models fitted the skewness/kurtosis tests for normality was performed by using "sktest" commands in Stata. The insignificant test statistic obtained indicated that the prior stated null hypothesis that outcome variable is normally distributed cannot be rejected, hence the normality assumption was met. Also, multicollinearity, the term refers the condition when the explanatory variables are correlated to each other was assessed. Since in multiple regressions analysis, explanatory variables are required to be independent of each other, therefore any variable with the correlation coefficient of more than 0.3 with others was not included in the models. Then, all variables which met the previous criteria were subjected to bivariate analysis and those which were significant at P value < 0.05 were included in the multivariate analysis using the stepwise (backward elimination) method to test for the association of each explanatory variable with the outcome variable. A Pearson's chi-square (X^2) test was used to test for association and its corresponding P-value of less than 0.05 was considered statistically significant.

Ethics statement

This study was based on an analysis of existing public domain survey data sets that are freely available online with all identifier information detached. The survey was approved by the Ethics Committee of the ICF Macro at Calverton in the USA and by the National Institute of Medical Research Ethics Committee in Tanzania. Informed consent was requested and obtained from participants before the interview.

RESULTS

General characteristics of surveyed facilities

Out of 1, 188 facilities involved in the TSPA survey, 905 (76.18%) reported to provide delivery and newborns care services and therefore were included in the analysis of the current study. The majority (773, 85.42%) and (751, 83.07%) were from the rural location and were either dispensary or clinic type of facility respectively. Most of the facilities (756, 83.58%) were public facilities. A few (256, 28.27%) and (149, 16.42%) of facilities reported having a duty schedule of 24-hour staff available and routinely performing a quality assurance activities respectively. About one-fifth (182, 20.05%) and one-third (272, 30.03%) of facilities reported regular reviewing maternal, newborn deaths or "near-misses" and reviewing clients opinion about health facility or its services. Overall, the number of staffs and delivery beds per facility was low, with a median (IQR) of 3 (2, 6) and mean (SD) of 1.41 (1.02) respectively (Table 1).

Table 1 Percent distribution of surveyed facilities according to background characteristics, TSPA 2014-2015 (N=905).

Variable	Frequency (n=weighted)	Percentage (%=weighted)
Facility location		
Rural	773	85.42
Urban	132	14.58
Facility type		
Clinic & dispensary	751	83.07
Health center	110	12.10
Hospital	44	4.83
Managing authority		
Public	756	83.58
Private	149	16.42
Duty schedule for 24 hours		
Yes	256	28.27
No	649	71.73
Quality assurance		
Performed	149	16.42
Not performed	756	83.58
Maternal/newborn deaths		
Reviewed	182	20.05
Not reviewed	723	79.95
Clients' opinions		
Reviewed	272	30.03
Not reviewed	633	69.97
Number of staffs per facility		
Median (IQR)	3 (2,6)	
Number of delivery beds per facility		
Mean (SD)	1.41 (1.02)	

IQR: Interquartile range; SD: Standard deviation

Seven signal functions for BEmONC by type of facility and managing authority

Table 2, shows the distribution of the availability of seven signal function for BEmONC by type of facility and managing authority. Overall availability of these seven signal functions (parental administration of the antibiotic, parental administration of oxytocic, parental administration of anticonvulsant, asssisted vaginal delivery, manual removal of placenta, manual removal of retained products or conception, and neonatal resuscitation) were constitently higher among hospitals than health centers and dispensaries (P<0.001). Despite the fact that private facilities were consistently reported the higher availability of these seven signal functions compared to public facilities, only parental administration of the antibiotic, parental administration of anticonvulsants, and neonatal resuscitation were significant higher in private facilities (P<0.001). Regardless of facility type and managing authority, majority of the facilities reported high availability of parental administration of oxytocic (83.61%), assisted vaginal delivery (69.60%), and neonatal resuscitations (52.14%) while less than half of all facilities reported availailability of manual removal of retained products or conception (35.36%), parental administration of antibiotic (34.01%), manual removal of placenta (33.95%), and parental administration of anticonvulsants (13.35%).

Table 2 Percentage distribution of seven signal functions for basic emergency obstetric care services by type of facility and managing authority (N=905)

Variable	Facility type			Managing authority		
	Dispensary/ Clinic	Health center	Hospital	Public	Private	Overall National
Parental administration of antibiotic	27.32	60.01	83.95*	32.04	44.03*	34.01
Parental administration of oxytocin	81.77	90.94	96.86*	83.69	83.16	83.61
Parental administration of anticonvulsants	6.96	31.59	77.56*	10.93	25.63*	13.35
Assisted vaginal delivery	68.00	72.85	88.94*	69.50	70.11	69.60
Manual removal of placenta	30.22	45.34	69.66*	32.87	39.46	33.95
Manual removal of retained products of conception	31.10	51.35	68.56*	34.88	37.79	35.36
Neonatal resuscitation	46.78	73.05	92.03*	50.64	59.76*	52.14
Number of facilities providing normal delivery services	751	110	44	756	169	905

*** = *P*-value <0.001**

Availability of important supportive items for delivery and newborns care services

Human resources (staff training): Only (206, 22.75%) facilities reported having at least one staff who had received refresher training in delivery and newborns care. Also about one-third (270, 29.80%) of facilities reported having recommended guidelines related to delivery and newborn care.

Essential equipment and supplies: Overall, the majority (890, 98.35%) of facilities reported dedicating at least one bed for delivery purposes, (780, 86.24%) having sterile gloves, (760, 84.05%) having delivery packs, and (692, 76.48%) having a neonatal bags and masks. However, less than a quarter of facilities reported having suction apparatus (23.14%), sterilization equipment (20.75%), examination light (14.37%), vacuum aspirator or Dilatation and Curettage D&C kit (7.51%), and manual vacuum extractor (5.31%).

Medicines and commodities: Regarding availability of essential medicines for delivery, injectable uterotonic (78.81%), skin disinfectant (61.10%), and injectable diazepam (55.23%) were highly reported. While intravenous fluids (48.15%), injectable magnesium sulfate (40.77%), injectable antibiotic (32.11%) were poorly reported. On the other hand, regarding essential medicines for newborn care, more than half of facilities reported availability of amoxicillin suspension (62.90%) and injectable ceftriaxone (56.69%) while less than one-third of facilities reported availability of injectable gentamicin (29.54%), antibiotic eye ointment (28.05%), and 4% chlorhexidine (11.95%) (Table 3).

Table 3 Percentage distribution of readiness indicators for providing basic obstetric and newborn care services (N=905)

Variable	Frequency (n=weighted)	Percentage (%=weighted)
Staff and training		
Presence of guidelines	270	29.80
Availability of trained staff	206	22.75
Equipment and supplies		
Emergency transport	567	62.54
Sterilization equipment	188	20.75
Examination light	130	14.37
Delivery pack	760	84.05
Suction apparatus	209	23.14
Manual vacuum extractor	48	5.31
Vacuum aspirator or D&C kit	68	7.51
Neonatal bag and mask	692	76.48
Delivery bed	890	98.35
Partograph	520	57.51
Gloves	780	86.24
Medicines and commodities		
Essential medicines for delivery		
Injectable antibiotic	291	32.11
Injectable uterotonic	713	78.81
Injectable magnesium sulfate	368	40.77
Injectable diazepam	500	55.23
Intravenous fluids	436	48.15
Skin disinfectant	553	61.10
Essential medicines for newborns		
Antibiotic eye ointment	254	28.05
4% chlorhexidine	108	11.95
Injectable gentamicin	267	29.54
Injectable ceftriaxone	513	56.69
Amoxicillin suspension	569	62.90

Facility readiness for delivery and newborn care services

Figure 1 shows the average percentage score corresponding to the three domains and the overall index of facility readiness to provide delivery and newborn care services. None of the three domains score more than 50% based on the indicators suggested by WHO-SARA manual. Therefore, overall calculated facility readiness score was low, with the mean (SD) of 40.3 (17.6).

Overall readiness score according to type of facility and managing authority

The overall readiness score was found to differ significantly according to the type of facility, with a higher score at hospitals level than at dispensaries (P<0.001). However, there was no difference in the overall readiness score according to the managing authority at each level of facility type (P>0.05) (Figure 2).

Factors associated with facility readiness for providing BEmONC

Table 3 shows results of the bivariate and multivariate analysis, in the bivariate analysis all explanatory variables show significant association with outcome variable "BEmONC service readiness" therefore qualified to be included in multivariate analysis. The results of multivariate analysis show that the readiness for providing BEmONC was higher at health centers (11.54 percentage points better than dispensary and clinics), at facilities which performed quality assurance (5.45 percentage points better than those not performed), at facilities reported regular reviewing maternal, newborn deaths or "near-misses" (6.49 percentage points better than those not reviewed), at facilities that reviewed clients opinion about heath facility or its services (4.29 percentage points better than those not reviewed clients opinions), and facility with more delivery beds (2.44 percentage points for each doubling of bed per facility) (Table 4).

DISCUSSION

This study used a representative data from Tanzania national survey as an example of low resource countries to assess the availability and readiness of health facilities to provide BEmOC services among health facilities. The study found a relatively low average score of facilities to provide BEmONC. Furthermore, it found that type (level) of the facility, performing quality assurance, regular reviewing of maternal, newborn deaths or near-misses, reviewing clients' opinion, and more number of delivery beds per facility were significantly associated with higher readiness to provide BEmONC.

Availability of seven signal functions for BEmONC is crucial to reduce maternal and neonatal mortality.[19] The current study found variation in availability of these seven signal functions according to the type of facility and managing authority. Despite the fact that private facilities consistently reported the higher availability of the seven signal functions compared to public facilities, only three signal functions; parental administration of the antibiotic, parental administration of anticonvulsants**,** and neonatal resuscitation were signifintly more reported in privately owned than public owned facilities. Similarly, hospitals were found to report significantly more availability of the signal functions than lower-level facilities (health centers and dispensaries). These findings are in agreement with the findings of a study conducted in Haiti in 2014.[20] The similarity of the findings of these studies might be due to the similar methodology used; both studies used data from the national representative sample collected by DHS program. Therefore, the questionnaire used for the interviews were nearly similar.

Facility service readiness is an important aspect of facilities' commitment to ensuring cumulative availability of components required to provide a specific service [18]. The current study found the relatively low average score of readiness of facilities to provide BEmONC. A

similar finding has been observed in the study conducted in Nigeria.[21] The similarity of these studies might be due to similar socio-economic background between these two countries which are located in sub-Saharan Africa. Additionally, the current study found no difference in overall readiness of facility to provide BEmOC between public and private facilities. However, the study found the significant difference of BEmOC readiness according to the type of facility, in which higher-level facilities (hospitals) were found to have high readiness score compared to lower-level facilities (dispensaries/clinics). The suboptimal readiness observed in the lower-level facilities might due to inadequate availability of essential components for providing BEmOC i.e out of seven signal functions, only two functions were reported available in more than half of lower-level health facilities, while the remaining five were poorly reported in these facilities. The finding is in agreement with the previous study conducted in Kenya.[22]

Quality assurance is an essential process in healthcare, that ensures patient receive a safe and right care. This process involves the aspect of assessing the services that patients receive by either measuring or monitoring.[23] The current study found that facilities which reported to perform quality assurance were more likely to have high readiness for BEmOC than facilities reported not to perform quality assurance. This might be due to the fact that, quality assurance matched with continuous monitoring and persistent feedback for the purpose of improving services offered.[24] Therefore, based on recommendations from quality assurance teams these facilities are more likely to improve the availability of services which results in their high readiness score.

Maternal and newborn deaths review is a qualitative, in-depth investigation of the causes of, and circumstances surrounding these deaths which occur in the health care facilities. Since each maternal death has a story to tell,[25] maternal deaths review is recognized as a widely

recommended tool to improve obstetric and neonatal care.[26] In agreement with this previous sentence, the current study found that facilities which performed maternal and newborn death reviews were more likely to have higher readiness to provide BEmONC than facilities that did not perform these reviews. This might be due to the fact that the facilities used information obtained from the reviews as the prerequisite for improving BEmONC service availability and readiness.

Clients' opinions are most beneficial parameter for judging the availability and readiness of the facility to provide specific services. The current study indicated that the likelihood of facility readiness to provide BEmONC among facilities that reviewed clients' opinions was higher than those that did not. This might be explained by the fact that clients' opinions not only reflects the satisfaction with service received but also provide positive and negative feedback towards services provided by facility or providers.[27] This feedback may be used to correct the shortcomings highlighted by patients, hence improve the availability of services which are the important aspect to assess the readiness of the facility.

The availability of delivery bed is very important in the health facility as it supports physiologic birth by allowing women to use many positions, which can facilitate labor progress.[28,29] Therefore, facilities having this type of beds express their commitment towards the provision of BEmOC. The results from this current study found that facilities with the increased number of delivery beds were more likely to have the high readiness to provide BEmOC compared to those without or fewer number of the beds.

The strength of the current study is that it analyzed the data with a nationwide representative sample of health facilities in Tanzania as an example of low resource countries. The use of such dataset suggests that the findings from this study accurately reflect the current

situation regarding availability and readiness of facilities to provide BEmOC in the study setting. Since TSPA survey employed the complex sampling techniques, the findings were adjusted for clustering effect and weighted to correct for non- response and disproportionate sampling. However, the study has some limitations, being a cross-sectional in nature, the causal relationship could not be assessed, therefore, the results should be interpreted with caution.

In summary, the current study found the variation in availability of seven signal functions and readiness to provide BEmONC among health facilities in Tanzania. It also highlighted the gaps in the availability of important supportive items such as refresher training and guidelines for the provision of BEmONC. The study recommends that quality assurance measures and maternal mortality audits should be strengthened to improve BEmONC. The higher authorities government through ministry of health should create a conducive working environment by providing essential guidelines, an uninterrupted supply of medicines, essential equipment such as delivery beds and providing basic as well as frequent refresher training to health care providers.

Authors affiliations

[1]Department of Public Health, College of Health Sciences, The University of Dodoma

[2]Department of Obstetrics and Gynecology, College of Health Sciences, The University of Dodoma

[3]Department of Internal Medicine, College of Health Sciences, The University of Dodoma

Authors' contributions

DB originated the design of the study; DB&BCT performed statistical analysis and interpretation of data; DB, BCT, and AE drafted the manuscript and critically revised the drafted manuscript. All authors read and approved the final manuscript.

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Competing interest

None to declare.

Provenance and peer review

Not commissioned; externally peer reviewed.

A data sharing statement

The datasets generated during the current study are available from within the Demographic and Health Survey Program repository: http://dhsprogram.com/data/available-datasets.cfm

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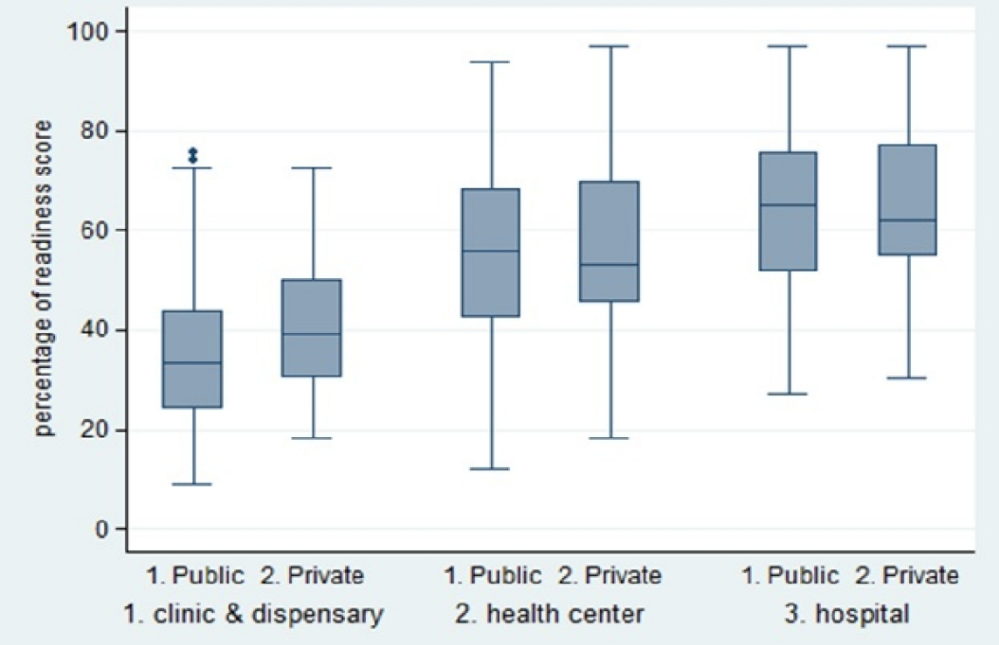
Figure titles/legend

Title; Figure 1 Average score of the three domains of readiness for delivery and newborn care services

Legend 1 Note: numbers in brackets "( )" are corresponding standard deviations of the mean values

Title; Figure 2 Overall readiness score for providing BEmOC according to type of facility and managing authority

Legend 2 Box shows the limits of 25 and 75% percentile. Horizontal line inside the box shows the median value. The bar shows the low and upper limits of 95% confidence interval. The dots show outliers



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Health facility service availability and readiness to provide basic emergency obstetric and newborn care in a low-resource setting: an evidence from Tanzania national survey

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Health facility service availability and readiness to provide basic emergency obstetric and newborn care in a low-resource setting: an evidence from Tanzania national survey

Deogratius Bintabara[1*], Alex Ernest[2], Bonaventura C. Mpondo[3]

[1]Department of Public Health, College of Health Sciences, The University of Dodoma, [2]Department of Obstetrics and Gynecology, College of Health Sciences, The University of Dodoma, [3]Department of Internal Medicine, College of Health Sciences, The University of Dodoma

Deogratius Bintabara , M.D. (Corresponding author)

Department of Public Health, College of Health Sciences,

The University of Dodoma, Dodoma, Tanzania

Phone: (255) 767 966 114, Email: bintabaradeo@gmail.com

Alex Ernest, M.D.

Department of Obstetrics and Gynecology, College of Health Sciences,

The University of Dodoma, Dodoma, Tanzania

Phone: (255) 767 625 828, Email: ibolinga@gmail.com

Bonaventura C. Mpondo, M.D.

Department of Internal Medicine, College of Health Sciences,

The University of Dodoma, Dodoma, Tanzania

Phone: (255) 688 530 690, Email: boniempondo@gmail.com

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ABSTRACT

Objective: This study used a nationally representative sample from Tanzania as an example of low-resource setting with a high burden of maternal and newborn deaths, to assess the availability and readiness of health facilities to provide Basic Emergency Obstetric and Newborn Care (BEmONC) and its associated factors.

Design: Health facility-based cross-sectional survey

Setting: We analyzed data for obstetric and newborn care services obtained from the 2014-2015 Tanzania Service Provision Assessment survey, using World Health Organization-Service Availability and Readiness Assessment tool.

Primary and secondary outcome measures: Availability of seven signal functions were measured based on the provision of "parental administration of antibiotic," "parental administration of oxytocic," "parental administration of anticonvulsants," "assisted vaginal delivery," "manual removal of placenta," "manual removal of retained products of conception," and 'neonatal resuscitation." Readiness was a composite variable measured based on the availability of supportive items categorized into three domains; staff training, diagnostic equipment, and basic medicines.

Results: Out of 1188 facilities, 905 (76.2%) reported to provide obstetric and newborn care services and therefore were included in the analysis of the current study. Overall availability of seven signal functions and average readiness score were consistently higher among hospitals than health centres and dispensaries (P<0.001). Furthermore, the type of facility, performing quality assurance, regular reviewing of maternal and newborn deaths, reviewing clients' opinion,

and number of delivery beds per facility were significantly associated with readiness to provide BEmONC.

Conclusion: The study found the disparities in the availability and readiness to provide BEmONC among health facilities in Tanzania. It recommends that, the high authorities through Ministry of Health to emphasize the health facilities about performing service quality assurance, maternal and newborns deaths audits on regular basis, also, to consider a fair distribution through 'push' system of clinical guidelines, essential medicines, equipment, and refresher training so that to improve BEmONC.

Strengths and limitations of this study

- This is the first study in this region to identify factors associated with readiness to provide Basic Emergency Obstetric and Newborn Care using the recommended World Health Organization service readiness indicators, and data obtained from a nationally representative sample.
- By using a nationally representative sample, this suggest that our findings accurately reflect the current situation regarding availability and readiness to provide Basic Emergency Obstetric and Newborn Care in low-resource setting such as Tanzania.
- The findings were adjusted for clustering effect and weighted to correct for complex sampling procedure and non- response and disproportionate sampling respectively.
- Being a cross-sectional in nature, the causal relationship could not be established, therefore, the results should be interpreted with caution.
- Misclassification bias, as a result of arbitrary cut-off point set at 50%, this might misclassify readiness of health facilities to provide BEmONC.

INTRODUCTION

Despite the evidence revealed a notable global reduction of maternal and neonatal mortality estimates over the past two decades,[1,2] approximately 800 women and 7700 newborns still die every day due to maternal complications.[3,4] It is estimated that about 99% of these deaths are occurring in low and middle-income countries (LMICs)[4], while 85% are contributed by low-income countries (LICs) alone.[5,6] Tanzania is amongst the LICs that despite reported increase coverage of antenatal care provided by skilled provider (96 to 98%), facility delivery (50 to 63%), and births assisted by skilled providers (51 to 64%) between 2010 to 2016 respectively, yet it experiencing high burden of maternal and newborn deaths.[7–10] The recent reports showed a remarkable increase of Maternal Mortality Ratio (MMR) [from 454 to 556 maternal deaths per 100,000 live births], while Neonatal Mortality Ratio (NMR) remained unchanged [26-25 deaths per 1,000 live births] between 2010 to 2016.[9,10] These estimates are still far from operational targets set by Ministry of Health throught the National Road Map Strategic Plan of 2008, aimed to accelerate reduction of maternal deaths to 193 per 100000 live-births and neonatal deaths to 19 per 1000 live births in Tanzania, that would have been achieved by the end of 2015.[11] Also, bring questions whether the country will be able to achieve the Sustainable Development Goal (SDG) number 3 at the end of 2030.[12]

This highlighted slow pace towards reduction of MMR and NMR observed in LIC such Tanzania, led World Health Organization (WHO) and other global initiative agencies to develop and recommend the availability of Basic Emergency Obstetric and Newborn care (BEmONC) services in each health facility as amongst strategies to narrow disparities in global maternal and newborn deaths.[4,13–15] The BEmONC is defined as an integrated strategy that aims at equipping health facilities to deal with major causes of direct obstetric emergencies which account for vast

majority of the maternal and newborn deaths, particularly in high mortality countries.[16,17] This strategy is the package of a set of seven key obstetric services or "signal functions" includes; the ability of the facility to administer parenteral antibiotics, administer uterotonic drugs (parenteral oxytocin), parenteral anticonvulsants (e.g magnesium sulphate), perform manual removal of placenta, perform removal of retained products, perform assisted vaginal delivery and perform basic neonatal resuscitation. Although the evidence revealed that provision of BEmONC under skilled personnel resulting to better maternal and newborn outcomes,[18] Tanzania and other LICs implemented this strategy, yet the majority of their health facilities lack some or all seven signal functions of BEmONC.[18–20] For example in Tanzania, the finding from national BEmONC assessment survey of 2015 revealed that 13% of dispensaries, 28% of all health centres and 62% of hospitals were capable of performing all seven signal functions.[21] These estimates are below the target that require all hospitals and at least 70% of health centres and dispensaries to provide BEmONC services.[22] Also, it is contrary to the effort made by Tanzanian government on improving maternal and newborn health such as developing number of policies and guidelines, as a response from international and regional policies and agreements (Delhi Declaration of 2005), that targets to reduce MMR and NMR.[11,22,23]

Based on previous reports it seems the countries with low availability of BEmONC services also have the higher burden of maternal and newborn deaths.[1,24] This observed correlation has been documented by the previous study and brought attention to many researchers to identify and address the critical gaps on BEmONC, that could reduce the burden of high MMR and NMR in those countries.[18,25] However, the majority of previous studies have concentrated on the assessment of the availability of services and few go-ahead to assess the readiness of the facilities to provide BEmONC services.[26–30] Despite these studies found

suboptimal availability and/or readiness of BEmONC, no one examined the factors associated with that observed suboptimal. To understand the factors associated with facility readiness to provide BEmONC is not only a step towards strengthening the maternal and newborn health but also a crucial area of study, as there is obviously limited empirical evidence regarding it. The present study is, therefore, using a nationally representative sample from Tanzania as an example of LICs to assess the current extent of availability and readiness of health facilities to provide BEmONC services and its associated factors according to the type of facility and managing authority by using WHO Service Availability and Readiness Assessment (SARA) manual.[31] The findings from this study will provide a road for policy-makers, administrators, and researchers not only in Tanzania but also to the other LICs on important factors that need to be addressed towards strengthening the BEmONC services.

METHODS

Data source

The analyzed data of the current study were drawn from 2014-2015 Tanzania Service Provision Assessment (TSPA) survey dataset. The 2014-2015 TSPA was undertaken by Tanzania's National Bureau of Statistics (NBS) in collaboration with the Office of the Chief Government Statistician (OCGS), Zanzibar, the Ministry of Health and Social Welfare (MoHSW), Tanzania Mainland, and the Ministry of Health (MOH), Zanzibar. Technical support for the survey was provided by ICF International under the Demographic and Health Survey (DHS) program. The survey assessed the facilities regarding availability and readiness of providing basic and essential health services, including the presence and function of components essential for the delivery of quality service for all aspects including maternal, newborn and child health care, family planning, and reproductive health services.

Sample and Sampling procedure

The sampling procedure used in TSPA survey is reported elsewhere,[32] but briefly a total of 1200 facilities out of sampling frame containing all health facilities (7102) in Tanzania were calculated and randomly sampled. This calculated sample size was designed to provide nationally representative results according to facility type, managing authority and regionally for both the Tanzania mainland and Zanzibar regions. The selection of desirable health facilities was achieved after excluding seven facilities that refused to participate, four had closed on the interview days, and one that could not be reached because of poor infrastructure. Then, a total of 1188 health facilities were assessed in TSPA survey. However, after excluding 283 facilities that did not meet inclusion criteria (not providing any services related to maternal and newborn health), a total of 905 health facilities were included in the current analysis.

Data collection methods

The 2014-2015 TSPA used four main types of questionnaires during data collection, however, the current analysis used data collected by Facility Inventory questionnaire and one variable regarding staff training from Health Provider questionnaire. After pre-testing of the questionnaires, the finalized and corrected versions were used in the main 2014-2015 TSPA survey data collection between October 20, 2014 – February 21, 2015, and revisit of some facilities that were not covered previous were conducted from March 2-13, 2015. The data collection were performed by 67 nurses who were trained for about four weeks and qualified the series of practical tests and examinations to be interviewers. Following the training, 20 teams were formed (2 for Zanzibar and 18 for Tanzania Mainland). Each team consisted of a team leader, 3 interviewers and a driver. On average, for each team data collection process took one day to a small facility (dispensary clinics and some health centres) and two or three days for large facilities (mostly hospitals). All collected data concern the health facility service availability and readiness were provided by the manager, the person-in-charge of the facility, or the most senior health worker responsible for the client services present at the facility, and finally, the interviewers observed and verified the presence of valid or functioning reported supplies.

Measurement of variables

Based on our research questions; the current study identified two outcome variables which were "BEmONC services availability" and "BEmONC services readiness". These variables were measured by using the WHO methods of assessing facility service availability and readiness. Hence, "BEmOC services availability" were measured based on whether the following seven signal functions have ever been carried out by providers as part of their work

within facility at least once during the past 3 months: "parental administration of antibiotic," "parental administration of oxytocic," "parental administration of anticonvulsants," "assisted vaginal delivery," "manual removal of placenta," "manual removal of retained products of conception," and 'neonatal resuscitation." "BEmONC services readiness" was measured based on the availability and functioning of supportive items categorized into three domains (groups) as follows; the first domain was staff training that had two indicators which were the presence of guidelines and at least one staff who had received any formal or structured in-service training (refresher training) related to the services offered in the 24 months preceding the assessment.

The second domain was diagnostic equipment which had eleven indicators i.e presence of "emergency transport," "sterilization equipment," "examination light," "delivery pack," "suction apparatus," "manual vacuum extractor," "vacuum aspirator or D&C kit," "neonatal bag and mask," "delivery bed," "Partograph," and "gloves." The third domain was basic medicine and commodities which had eleven indicators contains essential medicines for delivery and newborn i.e "injectable antibiotic," "injectable uterotonic," "injectable magnesium sulfate," "injectable diazepam," "intravenous fluids," "skin disinfectant," "antibiotic eye ointment," "4% chlorhexidine," "injectable gentamicin," "injectable ceftriaxone," and "amoxicillin suspension." The BEmOC service readiness was then created as a composite score by adding the presence of each indicator, with equal weight given to each of the domains and each of the indicators within the domains. As the expected target was 100%, each domain accounted for 33.3% (100%/3) of the total score. The percent for each indicator within the domain was equal to 33.3% divided by the number of indicators in that domain. The BEmONC service readiness score for each facility was then calculated by adding the percentages. Given that the readiness score is a relative measurement, then facilities that scored 50% or more were considered to be ready to provide

BEmONC services than those scored less than 50% in BEmONC readiness score. This cut-off point of 50% was also used in previous studies.[33,34]

Potential explanatory variables; the outcome variables were examined against the selected potential explanatory variables that we thought they are relevant in influencing the availability or readiness of the health facility to provide BEmONC services. These variables were: facility location (urbun or rural); facility type (hospital, health centre, clinic or dispensary); managing authority (public or private); duty schedule or call list for 24 hours, we included this variable because delays in receiving of healthcare during an emergency is associated with a long waiting to met with health providers, therefore, we wanted to assess whether having duty schedule is related to BEmONC readiness; quality assuarance, it is used to assess the quality of service provided by measuring or monitoring to ensure the patient receives a safe and right care,[35] therefore we included this variable to assess whether perfoming quality assurance is related with BEmONC readiness; regular reviews of maternal and newborn deaths or near-misses cases, since each maternal or newborn death has a story to tell, an in-depth investigation of their causes and circumstances surround might improve the maternal and newborn services,[36] also reviewing clients' opinions, helps to identify weakness and inefficiency in the provision of healthcare services, and eliminate them will make the facility to met the patients' demands at the highest levels of satisfaction, therefore, we wanted to assess whether these reviews have any influence on BEmONC readiness; number of staffs, scaling up number of health providers has been related to provision of quality health services,[37] hence facilities with many providers might have high BEmONC readiness than others, and finally, number of delivery beds per facility, we thought that shortage of medical supplies such as delivery beds can

compromise the capacity of facility to provide BEmONC,[38] hence we included this variable in our analysis.

Statistical analysis

Data were analyzed using Stata 14 (StataCorp, College Texas). For all the analyses, the "svy" set command in Stata was used to adjust for the complex sampling design employed by TSPA survey so that to obtain the accurate point estimates and their corresponding standard errors. All estimates were weighted to correct for non- response and disproportionate sampling. In the descriptive analysis, continuous variables were summarized using either mean (SD) for normally distributed variables or median (IQR) for non-normal distributed variables. All categorical variables were summarized using proportions and then presented in tables and graphs. Bivariate and multivariate regression models were fitted to assess the existence of the association between the outcome variable (BEmONC service readiness) and the explanatory variables. Before the models fitted the skewness/kurtosis tests for normality was performed by using "sktest" commands in Stata. The insignificant test statistic obtained indicated that the prior stated null hypothesis that outcome variable is normally distributed cannot be rejected, hence the normality assumption was met. Then, all variables that met the previous criteria were subjected to bivariate analysis and those with *a P*-value < 0.05 were included in the multivariate analysis to test for the association of each explanatory variable with the outcome variable. As the aim was to fit a final model that predicts well the association, the objective criterion-based method was used to include or exclude variable in the multiple regression models. A Pearson's chi-square (X^2) test was used to test for association and its corresponding *P*-value of less than 0.05 was considered statistically significant. A multicollinearity, the term refers the condition when the explanatory variables are correlated to each other in multiple regression models while in fact they are

supposed to be independent has been assessed. The generalized variance inflation factor (VIF) was performed to test for multicollinearity, which usually should not exceed 5. In this analysis each variable presented with VIF<2.0, suggesting the absence of multicollinearity in the final model.

Ethics statement

This study was based on an analysis of existing public domain survey data sets that are freely available online with all identifier information detached. The survey was approved by the Ethics Committee of the ICF Macro at Calverton in the USA and by the National Institute of Medical Research Ethics Committee in Tanzania. Informed consent was requested and obtained from participants before the interview.

Patient and Public Involvement Statement

Patient and public were not involved in the analysis of this study.

RESULTS

General characteristics of surveyed facilities

Table 1 presents a summary of the general characteristics of the included health facilities. Out of 1188 facilities involved in the TSPA survey, 905 (76.18%) reported to provide delivery and newborns care services and therefore were included in the analysis of the current study. More than 80% of the facilities were located in the rural area, and publicly owned, while less than 30% of the facilities regularly reviewed maternal and newborn deaths or "near-misses" cases occurred within the facility. Overall, the number of staffs per facility was low with a median (IQR) of 3 (2 - 6).

Table 1 Percent distribution of surveyed facilities according to background characteristics, TSPA 2014-2015 (N=905).

Variable	Frequency (n) weighted	Percentage [95% CI]
Facility location		
Rural	773	85.42 [82.32-88.05]
Urban	132	14.58 [11.95-17.68]
Facility type		
Clinic & dispensary	751	83.07 [82.50-83.62]
Health center	110	12.10 [11.95-12.26]
Hospital	44	4.83 [4.25-5.48]
Managing authority		
Public	756	83.58 [80.02-86.61]
Private	149	16.42 [13.39-19.68]
Duty schedule for 24 hours		
Yes	256	28.27 [25.01-31.77]
No	649	71.73 [68.23-74.99]
Quality assurance		
Performed	149	16.42 [13.60-19.69]
Not perfomed	756	83.58 [80.31-86.40]
Maternal/newborn deaths		
Reviewed	182	20.05 [17.13-23.33]
Not reviewed	723	79.95 [76.67-82.87]
Clients' opinions		
Reviewed	272	30.03 [26.39-33.94]
Not reviewed	633	69.97 [66.06-73.61]
Number of staffs per facility		
Median (IQR)	3 (2,6)	
Number of delivery beds per facility		
Mean (SD)	1.41 (1.02)	

IQR: Interquartile range; SD: Standard deviation

Seven signal functions for BEmONC by type of facility and managing authority

Table 2, shows the distribution of the availability of seven signal function for BEmONC by type of facility and managing authority. Overall availability of these seven signal functions (parental administration of the antibiotic, parental administration of oxytocic, parental administration of anticonvulsant, assisted vaginal delivery, manual removal of placenta, manual removal of retained products or conception, and neonatal resuscitation) were consistently higher among hospitals than health centers and dispensaries (P<0.001). Despite the fact that private facilities were consistently reported the higher availability of these seven signal functions compared to public facilities, only parental administration of the antibiotic, parental administration of anticonvulsants**,** and neonatal resuscitation were significantly higher in private facilities (P<0.001). Regardless of facility type and managing authority, majority of the facilities reported high availability of parental administration of oxytocic (83.61%), assisted vaginal delivery (69.60%), and neonatal resuscitations (52.14%) while less than half of all facilities reported availability of manual removal of retained products or conception (35.36%), parental administration of antibiotic (34.01%), manual removal of placenta (33.95%), and parental administration of anticonvulsants (13.35%).

Table 2 Percentage distribution of seven signal functions for Basic Emergency Obstetric and Newborn Care services by type of facility and managing authority, TSPA 2014-2015 (N=905).

Variable	Facility type			Managing authority		
	Dispensary/Clinic Percent [95% CI]	**Health centre** Percent [95% CI]	**Hospital** Percent [95% CI]	**Public Percent** [95% CI]	**Private** Percent [95% CI]	**Total percent** Percent [95% CI]
Parental administration of antibiotic	27.32 [22.76-32.40]	60.01 [54.49-65.29]	83.95* [69.70-92.24]	32.04 [27.75-36.65]	44.03* [33.88-54.7]	34.01 [30.05-38.20]
Parental administration of oxytocin	81.77 [77.30-85.52]	90.94 [86.81-93.87]	96.86* [93.83-98.42]	83.69 [79.43-87.22]	83.16 [73.18-89.93]	83.61 [79.87-86.76]
Parental administration of anticonvulsants	6.96 [4.61-10.37]	31.59 [26.67-36.96]	77.56* [65.35-86.34]	10.93 [8.64-13.74]	25.63* [18.48-34.39]	13.35 [11.09-15.99]
Assisted vaginal delivery	68.00 [62.94-72.67]	72.85 [67.72-77.44]	88.94* [84.21-92.39]	69.50 [64.70-73.91]	70.11 [59.07-79.22]	69.60 [65.35-73.54]
Manual removal of placenta	30.22 [25.45-35.46]	45.34 [40.00-50.79]	69.66* [58.79-78.70]	32.87 [28.43-37.64]	39.46 [29.99-49.80]	33.95 [29.86-38.31]
Manual removal of retained products of conception	31.10 [26.78-35.77]	51.35 [46.16-56.52]	68.56* [57.87-77.59]	34.88 [30.70-39.30]	37.79 [28.43-48.17]	35.36 [31.65-39.25]
Neonatal resuscitation	46.78 [41.67-51.95]	73.05 [68.12-77.47]	92.03* [87.78-94.88]	50.64 [45.87-55.41]	59.76* [48.35-70.20]	52.14 [47.8-56.45]
Number of facilities providing normal delivery services	751	110	44	756	169	905

*** = *P*-value <0.001**

Availability of important supportive items for delivery and newborns care services

Human resources (staff training): Only (206, 22.75%) facilities reported having at least one staff who had received refresher training in delivery and newborns care. Also about one-third (270, 29.80%) of facilities reported having recommended guidelines related to delivery and newborn care.

Essential equipment and supplies: Overall, the majority (890, 98.35%) of facilities reported dedicating at least one bed for delivery purposes, (780, 86.24%) having sterile gloves, (760, 84.05%) having delivery packs, and (692, 76.48%) having a neonatal bags and masks. However, less than a quarter of facilities reported having suction apparatus (23.14%), sterilization equipment (20.75%), examination light (14.37%), vacuum aspirator or Dilatation and Curettage D&C kit (7.51%), and manual vacuum extractor (5.31%).

Medicines and commodities: Regarding availability of essential medicines for delivery, injectable uterotonic (78.81%), skin disinfectant (61.10%), and injectable diazepam (55.23%) were highly reported. While intravenous fluids (48.15%), injectable magnesium sulfate (40.77%), injectable antibiotic (32.11%) were poorly reported. On the other hand, regarding essential medicines for newborn care, more than half of facilities reported availability of amoxicillin suspension (62.90%) and injectable ceftriaxone (56.69%) while less than one-third of facilities reported availability of injectable gentamicin (29.54%), antibiotic eye ointment (28.05%), and 4% chlorhexidine (11.95%) (Table 3).

Table 3 Percentage distribution of readiness indicators for providing Basic Emergency Obstetric and Newborn Care services, TSPA 2014-2015 (N=905).

Variable	Frequency (n) weighted	Percent [95% CI]
Staff and training		
Presence of guidelines	270	29.80 [26.16-33.70]
Availability of trained staff	206	22.75 [19.39-26.50]
Equipment and supplies		
Emergency transport	567	62.54 [58.05-66.82]
Sterilization equipment	188	20.75 [18.06-23.74]
Examination light	130	14.37 [11.80-17.39]
Delivery pack	760	84.05 [80.33-87.19]
Suction apparatus	209	23.14 [19.76-26.91]
Manual vacuum extractor	48	5.31 [4.04-6.95]
Vacuum aspirator or D&C kit	68	7.51 [6.07-9.27]
Neonatal bag and mask	692	76.48 [72.94-79.68]
Delivery bed	890	98.35 [96.53-99.23]
Partograph	520	57.51 [53.11-61.79]
Gloves	780	86.24 [82.89-89.01]
Medicines and commodities		
Essential medicines for delivery		
Injectable antibiotic	291	32.11 [28.04-36.47]
Injectable uterotonic	713	78.81 [74.66-82.44]
Injectable magnesium sulfate	368	40.77 [36.62-45.04]
Injectable diazepam	500	55.23 [50.81-59.57]
Intravenous fluids	436	48.15 [43.56-52.78]
Skin disinfectant	553	61.10 [56.50-65.51]
Essential medicines for newborns		
Antibiotic eye ointment	254	28.05 [24.32-32.11]
4% chlorhexidine	108	11.95 [9.43-15.04]
Injectable gentamicin	267	29.54 [25.69-33.71]
Injectable ceftriaxone	513	56.69 [52.08-61.19]
Amoxicillin suspension	569	62.90 [58.29-67.28

Facility readiness to provide BEmONC services

Figure 1 shows the mean percentage score corresponding to the three domains and the overall index of facility readiness to provide BEmONC. Each of the three domains had a mean percentage score of less than 50% based on the indicators suggested by WHO-SARA tool, that yield overall mean percentage score (SD) of 40.3 (17.6)%. However, 267 (29.50%) of all health facilities had overall percentage readiness score of 50% or more, therefore, were considered ready to provide BEmONC services.

Overall BEmONC readiness score according to the type of facility and managing authority

The overall readiness score was found to differ significantly according to the type of facility, with a higher score at hospitals level than at dispensaries ($P<0.001$). However, there was no difference in the overall readiness score according to the managing authority at each level of facility type ($P>0.05$) (Figure 2).

Factors associated with facility readiness to provide BEmONC services

Table 4 presents the results of the bivariate and multivariate analysis. In bivariate analysis, all explanatory variables showed association with outcome variable "BEmONC service readiness" at $P<0.05$, therefore, were selected and included in multiple regression models by using objective criterion-based methods to predict their association with readiness to provide BEmONC services. The results of multiple regression analysis showed that the readiness of facility to provide BEmONC services was higher at health centres (11.54 percentage points better than dispensary and clinics), at facilities which performed quality assurance (5.45 percentage points better than those not performed), at facilities reported regular reviewing maternal, newborn deaths or "near-misses" (6.49 percentage points better than those not reviewed), at facilities that reviewed clients opinion about heath facility or its services (4.29 percentage points better than those not reviewed

clients opinions), and facility with more delivery beds (2.44 percentage points for each doubling of bed per facility).

Table 4 Results of unadjusted and udjusted multiple regression models of factors associated with readiness to provide Basic Emergency Obstetric and Newborn Care services, TSPA 2014-2015 (N=905).

Variable	Unadjusted		Adjusted	
	Coef	Std error	Coef[@]	Std error
Facility location (ref: Rural)				
Urban	8.64**	2.29	0.20	2.08
Facility type (ref: clinic/dispensary)				
Health center	18.15**	1.24	**11.54****	2.02
Hospital	26.09**	2.54	8.06	4.15
Managing authority (ref: Public)				
Private	8.46**	1.90	3.56	1.87
Duty schedule for 24 hours (ref: No)				
Yes	12.28**	1.62	0.52	2.13
Quality assurance (ref: Not performed)				
Performed	14.24**	2.36	**5.45***	2.44
Maternal/newborn deaths (ref: Not reviewed)				
Reviewed	14.76**	1.76	**6.49****	1.89
Clients' opinions reviewed (ref: No)				
Yes	9.90**	1.74	**4.29***	1.68
Number of staffs per facility (as continous variable)	0.09**	0.04	-0.001	0.013
Number of delivery beds per facility (as continous variable)	6.28**	0.58	**2.44***	0.83

*** *P*<0.05; ** *P*<0.001.**

Coef: Coefficient; Std: Standard error.

[@]Adjusted coefficient; it has been adjusted by all variables in the table.

DISCUSSION

This study used a nationally representative data from Tanzania as an example of low-resource country to assess the availability and readiness of health facilities to provide BEmONC services among health facilities. The study found a relatively low average score of facilities to provide BEmONC services. Furthermore, it found that type of the facility, performing quality assurance, regular reviewing of maternal, newborn deaths or near-miss cases, reviewing clients' opinion, and the number of delivery beds per facility were significantly associated with higher readiness to provide BEmONC services.

Availability of seven signal functions for BEmONC is crucial to reduce maternal and neonatal mortality.[39] The current study found disparities in the availability of these seven signal functions according to the type of facility and managing authority. Despite the fact that private facilities consistently reported the higher availability of the seven signal functions compared to public facilities, only three signal functions; parental administration of the antibiotic, parental administration of anticonvulsants**,** and neonatal resuscitation were significantly more reported in privately owned than publicly owned facilities. Similarly, hospitals were found to report significantly more availability of the signal functions than lower-level facilities (health centres and dispensaries). These findings are in agreement with the findings of a study conducted in Haiti in 2014.[40] The similarity of the findings of these studies might be due to the similar methodology used; both studies used data from the national representative sample collected by DHS program. Therefore, the questionnaire used for the interviews were nearly similar. Also, similar in socio-economic determinants as all these two countries are under the group of LMICs. Furthermore, the current study found that availability of parental administration of anticonvulsants is still a challenge and as a result it compromises the provision of BEmONC in

Tanzania particularly in public and lower-level health facilities. The similar finding has been reported in another region with a low-resource setting.[41] Lack of this important component of BEmONC, might led to unnecessary delays to prevent or intervene pre-eclampsia/eclampsia that is one of the three leading causes of maternal morbidity and mortality.[42] Together with other suboptimal availability of parental administration of antibiotic, manual removal of placenta and retained products of conception suggesting that, despite the increased coverage of antenatal care, facility deliveries, births assisted by skilled provider and postnatal care, these efforts alone can not reduce MMR and NMR without improving the availability of BEmONC services.[38,43] The explanation of the low availability of seven signal functions in the public and lower-level facilities in Tanzania might be due to the current long process of ordering and delivering of drugs and medical supplies that use a new system called Integrated Logistic System (ILS). With this system, facility places its order through District Medical Officer's (DMO) office to the Medical Department Store (MSD), a body that operates under Ministry of Health responsible for managing all the procurement and supply of medical items concerning public facilities.[44] Hence, any faults or delays in one of this channel of the ordering system, may result into the low availability of items or services in the facilities. This may compromise the efforts towards achieving the target set by Tanzanian government that requires, all hospitals and at least 70% of health centres and dispensaries to provide BEmONC services at the end of 2020.[22]

Facility service readiness is an important aspect of facilities' commitment to ensuring cumulative availability of components required to provide a specific service [31]. The current study found a relatively low average score of readiness of facilities to provide BEmONC services. A similar finding has been observed in the study conducted in Nigeria.[45] The similarity of the finding between these studies might be due to similar socio-economic background between these

two countries which are located in sub-Saharan Africa. Additionally, the current study found no difference in overall readiness of facility to provide BEmONC services between public and private facilities. However, the study found the significant difference of BEmONC readiness according to the type of facility, in which higher-level facilities (hospitals) were found to have high readiness score compared to lower-level facilities (dispensaries/clinics). The suboptimal readiness observed in the lower-level facilities might be due to inadequate availability of essential components for providing BEmONC i.e out of seven signal functions, only two functions were reported available in more than half within lower-level health facilities, while the remaining five were poorly reported in these facilities. The finding is in agreement with the previous study conducted in Kenya.[30]

In agreement with the fact that quality assurance guaranteeing and maintaining a high standard of the service provided within the healthcare systems.[46] The current study found that facilities that reported performing quality assurance were more likely to be ready to provide BEmONC services than facilities reported not performing quality assurance. This might be due to the fact that, quality assurance matched with continuous monitoring and persistent feedback for the purpose of improving services offered.[47] Therefore, based on recommendations from quality assurance teams, these facilities are more likely to improve the availability of services that may result in their high readiness score. However, the performance of quality assurance is still a problem in Tanzanian health system in which minority of health facilities regularly performing it.[48]

Each maternal or newborn death has a story to tell,[36] therefore, reviewing of these deaths is recognized as a widely recommended tool to improve obstetric and neonatal care.[49] In agreement with this previous fact, the current study found that facilities which performed

maternal and newborn deaths reviews were more likely to be ready to provide BEmONC services than facilities that reported not performing these reviews. This might be due to the fact that the facilities that performing deaths reviews, used information obtained from the reviews as the prerequisite for improving BEmONC service availability and readiness. Also, clients' opinions are the most beneficial parameter for judging the availability and readiness of the facility to provide specific services. The current study indicated that the likelihood of facility readiness to provide BEmONC were higher among facilities that reviewed clients' opinions than those that did not. This might be explained by the fact that clients' opinions not only reflects the satisfaction with service received but also provide positive and negative feedback towards services provided by facility or health providers.[50] This feedback may be used to correct the shortcomings highlighted by patients, hence improve the availability of services that are important aspect to assess the readiness of the facility to provide services.

The availability of delivery bed is very important in the health facility as it creates a better birth environment for both mother and health provider to support the childbirth process and labor progress.[51,52] Therefore, facilities having delivery beds express their commitment towards the provision of BEmONC. The current study provides evidence that facilities with many numbers of delivery beds were more likely to be ready to provide BEmONC than those without or with the fewer number of delivery beds. However, the unreliability of delivery beds and other medical supplies within health facilities in Tanzania have been highlighted as among the barriers of timely provision of BEmONC. This might be contributed by inadequate allocated budget from central government, insufficient ordering of BEmONC supplies, out of stock at MSD, and lack of accountability within the supply system.[38]

The strength of the current study is that it analyzed the data with a nationwide representative sample of health facilities in Tanzania as an example of the low-resource country. The use of such dataset suggests that the findings from this study accurately reflect the current situation regarding availability and readiness of facilities to provide BEmONC in the study setting. Since TSPA survey employed the complex sampling procedures, the estimates were adjusted for clustering effect and weighted to correct for non- response and disproportionate sampling. However, the study has some limitations, being a cross-sectional in nature, the causal relationship could not be assessed, therefore, the results should be interpreted with caution. Also, the study is subjected to misclassification bias as a result of arbitrary cut-off point set at 50%, this might misclassified readiness of health facilities to provide BEmONC services. Though, the effect of this bias has been minimized by include many indicators as suggested by WHO to assess the level of facility readiness.

In summary, the current study found the disparities in the availability of seven signal functions and readiness to provide BEmONC services among health facilities in Tanzania. It also highlighted the gaps in the availability of important supportive items such as refresher training and guidelines for the provision of BEmONC. The study recommends that the higher authorities (government) through ministry of health to emphasizes the health facilities to perform service quality assurance and maternal and newborns deaths audits on regular basis, also, to consider a fair distribution through 'push' system of clinical guidelines, essential medicines, equipment refresher training so that to improve BEmONC services. Furthermore, it suggests other studies to be conducted to identify what hinders the effective implementation of government policies regarding the readiness of health facilities to provide BEmONC services.

Authors' contributions

DB conceptualized and designed the study, performed statistical analysis and wrote the first and revised draft of the manuscript. AE involved in the interpretation of data, revised and edited the manuscript. BCM provided advice on statistical analysis, interpretation of data, and edited the manuscript; All authors read and approved the final manuscript.

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Competing interest

None to declare.

Provenance and peer review

Not commissioned; externally peer reviewed.

A data sharing statement

The datasets generated during the current study are available from within the Demographic and Health Survey Program repository: http://dhsprogram.com/data/available-datasets.cfm

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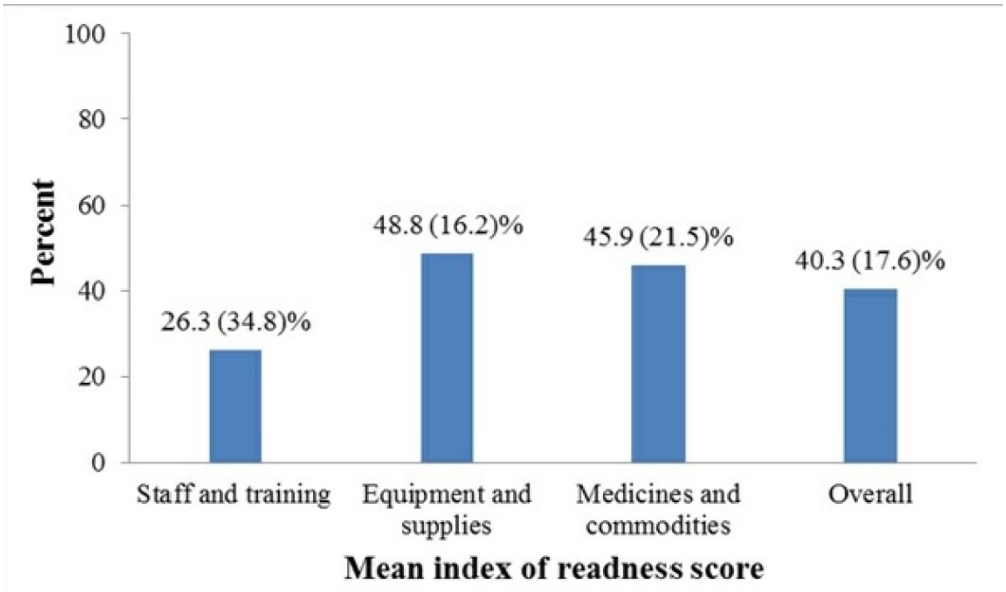
Figure titles/legend

Title; Figure 1 Percentage mean score of the three domains of readiness to provide Basic Emergency Obstetric and Newborn Care services

Legend 1 Note: numbers in brackets "( )" are corresponding standard deviations of the mean values

Title; Figure 2 Overall readiness score for providing Basic Emergency Obstetric and Newborn Care according to type of facility and managing authority

Legend 2 Box shows the limits of 25 and 75% percentile. Horizontal line inside the box shows the median value. The bar shows the low and upper limits of 95% confidence interval. The dots show outliers



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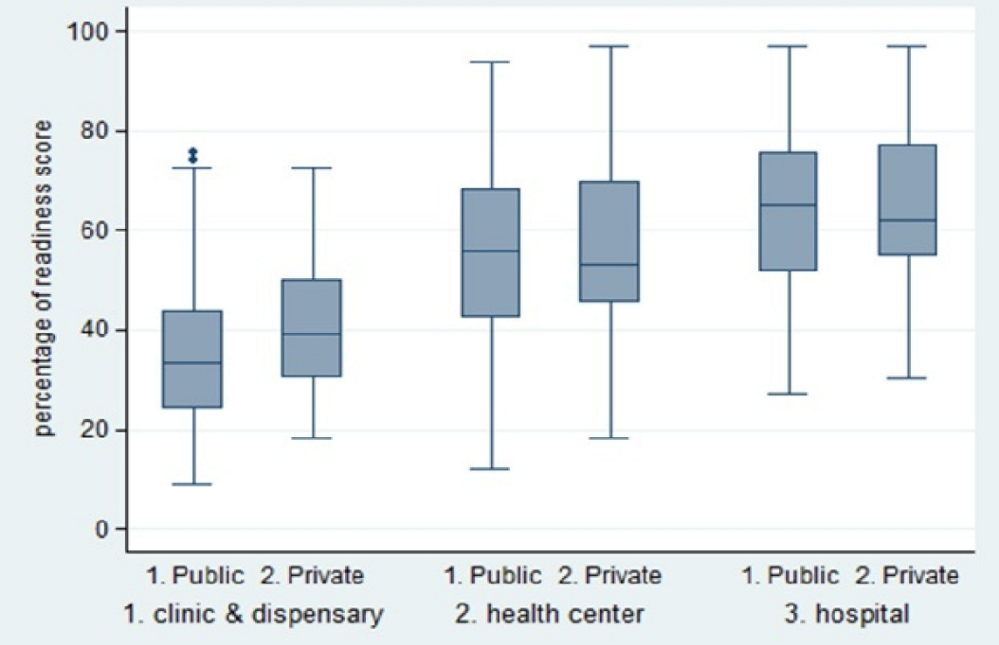

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

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	Page 1, and 2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Page 2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Page 5-6
Objectives	3	State specific objectives, including any prespecified hypotheses	Page 6
Methods			
Study design	4	Present key elements of study design early in the paper	Page 7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 7-8
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	Page 7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Page 8-10
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	Page 8-10
Bias	9	Describe any efforts to address potential sources of bias	Page 11-2
Study size	10	Explain how the study size was arrived at	Page 7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Page 11
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Page 11-2
		(*b*) Describe any methods used to examine subgroups and interactions	Page 11-2
		(*c*) Explain how missing data were addressed	N/A
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	Page 11
		(*e*) Describe any sensitivity analyses	N/A
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Page 12 and Table 1
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Page 12 and Table 1
		(b) Indicate number of participants with missing data for each variable of interest	N/A
Outcome data	15*	Report numbers of outcome events or summary measures	Page 14-8
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	Page 18 and Table 4
		(*b*) Report category boundaries when continuous variables were categorized	Table 1
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A
Discussion			
Key results	18	Summarise key results with reference to study objectives	Page 20-3
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	Page 24
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Page 24
Generalisability	21	Discuss the generalisability (external validity) of the study results	Page 24
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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Health facility service availability and readiness to provide basic emergency obstetric and newborn care in a low-resource setting: evidence from a Tanzania national survey

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Secondary Subject Heading:	Health services research
Keywords:	Availability and readiness, Obstetric and newborn care, Low-income countries

Health facility service availability and readiness to provide basic emergency obstetric and newborn care in a low-resource setting: evidence from a Tanzania national survey

Deogratius Bintabara[1*], Alex Ernest[2], Bonaventura C. Mpondo[3]

[1]Department of Public Health, College of Health Sciences, The University of Dodoma, [2]Department of Obstetrics and Gynecology, College of Health Sciences, The University of Dodoma, [3]Department of Internal Medicine, College of Health Sciences, The University of Dodoma

Deogratius Bintabara, M.D. (Corresponding author)

Department of Public Health, College of Health Sciences,

The University of Dodoma, Dodoma, Tanzania

Phone: (255) 767 966 114, Email: bintabaradeo@gmail.com

Alex Ernest, M.D.

Department of Obstetrics and Gynecology, College of Health Sciences,

The University of Dodoma, Dodoma, Tanzania

Phone: (255) 767 625 828, Email: ibolinga@gmail.com

Bonaventura C. Mpondo, M.D.

Department of Internal Medicine, College of Health Sciences,

The University of Dodoma, Dodoma, Tanzania

Phone: (255) 688 530 690, Email: boniempondo@gmail.com

Keywords: Availability and readiness, Obstetric and newborn care, Low-income countries

Word count: 4798; Abstract 287

ABSTRACT

Objective: This study used a nationally-representative sample from Tanzania as an example of low-resource setting with a high burden of maternal and newborn deaths, to assess the availability and readiness of health facilities to provide Basic Emergency Obstetric and Newborn Care (BEmONC) and its associated factors.

Design: Health facility-based cross-sectional survey

Setting: We analyzed data for obstetric and newborn care services obtained from the 2014-2015 Tanzania Service Provision Assessment survey, using World Health Organization-Service Availability and Readiness Assessment tool.

Primary and secondary outcome measures: Availability of seven signal functions were measured based on the provision of "parental administration of antibiotic," "parental administration of oxytocic," "parental administration of anticonvulsants," "assisted vaginal delivery," "manual removal of placenta," "manual removal of retained products of conception," and 'neonatal resuscitation." Readiness was a composite variable measured based on the availability of supportive items categorized into three domains; staff training, diagnostic equipment, and basic medicines.

Results: Out of 1188 facilities, 905 (76.2%) reported to provide obstetric and newborn care services and therefore were included in the analysis of the current study. Overall availability of seven signal functions and average readiness score were consistently higher among hospitals than health centres and dispensaries (P<0.001). Furthermore, the type of facility, performing quality assurance, regular reviewing of maternal and newborn deaths, reviewing clients' opinion,

and number of delivery beds per facility were significantly associated with readiness to provide BEmONC.

Conclusion: The study findings show disparities in the availability and readiness to provide BEmONC among health facilities in Tanzania. The Tanzanian Ministry of Health should emphasize quality assurance efforts and systematic maternal and newborn death audits. Health leadership should fairly distribute clinical guidelines, essential medicines, equipment, and refresher trainings to improve availability and quality BEmONC.

Strengths and limitations of this study

- This is the first study in this region to identify factors associated with readiness to provide Basic Emergency Obstetric and Newborn Care using the recommended World Health Organization service readiness indicators, and data obtained from a nationally-representative sample.
- By using a nationally-representative sample, this suggests that our findings accurately reflect the current situation regarding availability and readiness to provide Basic Emergency Obstetric and Newborn Care in low-resource setting such as Tanzania.
- The findings were adjusted for clustering effect and weighted to correct for complex sampling procedure and non- response and disproportionate sampling respectively.
- Being a cross-sectional in nature, the causal relationship could not be established. Therefore, the results should be interpreted with caution.
- Misclassification bias, as a result of arbitrary cut-off point set at 50%, this might misclassify readiness of health facilities to provide BEmONC.

INTRODUCTION

Despite a global reduction of maternal and neonatal mortality over the past two decades,[1,2] approximately 800 women and 7700 newborns still die every day due to complications related to pregnancy, childbirth and postpartum.[3,4] It is estimated that 99% of these deaths occur in low and middle-income countries (LMICs),[4] while 85% are contributed by low-income countries (LICs) alone.[5,6] Tanzania is among the LICs that continuous to experience a high burden of maternal and newborn deaths. This is despite increased coverage of antenatal care provided by skilled providers (96 to 98%), facility delivery (50 to 63%), and births assisted by skilled providers (51 to 64%) between 2010 to 2016.[7–10] Recent reports showed a remarkable increase of Maternal Mortality Ratio (MMR) [from 454 to 556 maternal deaths per 100,000 live births], while Neonatal Mortality Ratio (NMR) remained unchanged [26-25 deaths per 1,000 live births] between 2010 to 2016.[9,10] These estimates remain far from operational targets set by the Tanzanian Ministry of Health throught the National Road Map Strategic Plan of 2008. This plan aimed to accelerate the reduction in maternal deaths to 193 per 100000 live-births and neonatal deaths to 19 per 1000 live births in Tanzania by the end of 2015.[11] Given recent MMR estimates, one wonders whether Tanzania will be able to achieve targets for Sustainable Development Goal (SDG-3) to reduce maternal deaths to less than 70 in 100,000 live births and neonatal deaths to less than 12 per 1,000 live births at the end of 2030.[12]

This slow pace of MMR and NMR reduction observed in LIC including Tanzania, led the World Health Organization (WHO) to develop and recommend the availability of Basic Emergency Obstetric and Newborn Care (BEmONC) services in each health facility as key strategy to narrow disparities in global maternal and newborn deaths.[4,13–15] BEmONC is an integrated strategy that aims to equip health facilities to deal with major causes of direct obstetric

emergencies which account for the vast majority of maternal and newborn deaths, particularly in high mortality countries.[16,17] This strategy comprises a package of seven key obstetric services or "signal functions" including: 1) the ability of the facility to administer parenteral antibiotics, 2) administer uterotonic drugs (parenteral oxytocin), 3) administer parenteral anticonvulsants (e.g magnesium sulphate), 4) perform manual removal of placenta, 5) perform removal of retained products of conception, 6) perform assisted vaginal delivery and 7) perform basic neonatal resuscitation. Evidence has demonstrated that provision of BEmONC by skilled personnel results in better maternal and newborn outcomes[18] and Tanzania and other LICs have partially implemented this strategy. However, the majority of health facilities lack some or all seven signal functions of BEmONC.[18–20] For example in Tanzania, national BEmONC assessment survey of 2015 revealed that 13% of dispensaries, 28% of all health centres and 62% of hospitals were capable of performing all seven signal functions.[21] These estimates are below the target that require all hospitals and at least 70% of health centres and dispensaries to provide BEmONC services.[22] Furthermore, it is contrary to the effort made by Tanzanian government on improving maternal and newborn health such as developing number of policies and guidelines, as a response from international and regional policies and agreements (Delhi Declaration of 2005), that targets to reduce MMR and NMR.[11,22,23]

Countries with low availability of BEmONC services also experienced a higher burden of maternal and newborn deaths.[1,24] This correlation has been documented by previous studies and many researchers have identified critical gaps on BEmONC that if addressed could reduce the burden of high MMR and NMR in those countries.[18,25] However, the majority of previous studies have concentrated on the assessment of services availability and few have assessed the readiness of the facilities to provide BEmONC services.[26–30] In addition, these studies found low readiness

of the facilities to provide BEmONC. Hence, there is little information regarding factors associated with low readiness of facilities to provide BEmONC in Tanzania. Better understanding of the factors associated with facility readiness to provide BEmONC is crucial area of study to support maternal and newborn health system improvements.

To that end, this study used a nationally-representative sample from Tanzania to assess the current extent of availability and readiness of health facilities to provide BEmONC services. Associated factors were also examined according to the type of facility and managing authority by using WHO Service Availability and Readiness Assessment (SARA) manual [31] with modification to some questions to fit the study setting.[31] The findings from this study will provide a crucial guidance on important factors that need to be addressed to strengthen the BEmONC services for policy-makers, administrators, and researchers in Tanzania and other LICs.

METHODS

Data source

The analyzed data of the current study was drawn from 2014-2015 Tanzania Service Provision Assessment (TSPA) survey dataset. The 2014-2015 TSPA was undertaken by Tanzania's National Bureau of Statistics (NBS) in collaboration with the Office of the Chief Government Statistician (OCGS), Zanzibar, the Ministry of Health and Social Welfare (MoHSW), Tanzania Mainland, and the Ministry of Health (MOH), Zanzibar. Technical support for the survey was provided by ICF International under the Demographic and Health Survey (DHS) program. The survey assessed the facilities regarding availability and readiness of providing basic and essential health services, including the presence and function of components essential for the delivery of quality service for all aspects including maternal, newborn and child health care, family planning, and reproductive health services.

Sample and Sampling procedure

The sampling procedure used in TSPA survey is reported elsewhere.[32] A random stratified sampling of health facilities according to facility type, managing authority, and regions was used to select a nationally-representative sample of 1200 facilities from the national master facility list contains 7102 health facilities. The selection of desirable health facilities was achieved after excluding seven facilities that refused to participate, four had closed on the interview days, and one that could not be reached because of poor infrastructure. Then, a total of 1188 health facilities were assessed in 2014-2015 TSPA survey. However, after excluding 283 facilities that did not meet inclusion criteria (not providing any services related to maternal and newborn health), a total of 905 health facilities were included in the current analysis.

Data collection methods

The 2014-2015 TSPA used four main types of questionnaires during data collection. The current analysis used data collected by the *Facility Inventory Questionnaire* and one variable regarding staff training from *Health Provider Questionnaire*. After pre-testing of the questionnaires, the finalized and corrected versions were used in the main 2014-2015 TSPA survey data collection between October 20, 2014 – February 21, 2015. Additional, visits of some facilities that were not covered previously were conducted from March 2-13, 2015. The data collection was performed by 67 nurses who were trained for four weeks and were qualified by a series of practical tests and examinations to be interviewers. Following the training, 20 teams were formed (2 for Zanzibar and 18 for Tanzania Mainland). Each team consisted of a team leader, 3 interviewers and a driver. On average, the data collection process lasted one day at a small facility (dispensary clinics and some health centres) and two or three days for large facilities (mostly hospitals). All collected data regarding the health facility service availability and readiness were provided by the manager, the person-in-charge of the facility, or the most senior health worker responsible for the client services present at the facility. The interviewers observed and verified the presence of valid or functioning reported services or supplies.

Measurement of variables

Based on our research questions; the current study identified two outcome variables which were "BEmONC services availability" and "BEmONC services readiness". These variables were measured by using the WHO methods of assessing facility service availability and readiness. Hence, "BEmONC services availability" in this study is defined as "physical presence of the services related with provision of BEmONC. This was measured based on whether the following seven signal functions have ever been carried out by providers as part of their work

within facility at least once during the past 3 months: "parental administration of antibiotic," "parental administration of oxytocic," "parental administration of anticonvulsants," "assisted vaginal delivery," "manual removal of placenta," "manual removal of retained products of conception," and 'neonatal resuscitation."

"BEmONC services readiness" in this study is defined as the willingness or preparedness of the facility to provided BEmONC. This was measured based on the availability and functioning of supportive items categorized into three domains (groups) as follows; the first domain was staff training that had two indicators which were the presence of guidelines and at least one staff who had received any formal or structured in-service training (refresher training) related to the services offered in the 24 months preceding the assessment. The second domain was diagnostic equipment which had eleven indicators i.e presence of "emergency transport," "sterilization equipment," "examination light," "delivery pack," "suction apparatus," "manual vacuum extractor," "vacuum aspirator or D&C kit," "neonatal bag and mask," "delivery bed," "Partograph," and "gloves." The third domain was basic medicine and commodities which had eleven indicators contains essential medicines for delivery and newborn i.e "injectable antibiotic," "injectable uterotonic," "injectable magnesium sulfate," "injectable diazepam," "intravenous fluids," "skin disinfectant," "antibiotic eye ointment," "4% chlorhexidine," "injectable gentamicin," "injectable ceftriaxone," and "amoxicillin suspension." The BEmOC service readiness was then created as a composite score by adding the presence of each indicator, with equal weight given to each of the domains and each of the indicators within the domains. As the expected target was 100%, each domain accounted for 33.3% (100%/3) of the total score. The percent for each indicator within the domain was equal to 33.3% divided by the number of indicators in that domain. The BEmONC service readiness score for each facility was then

calculated by adding the percentages. Given that the readiness score is a relative measurement, then facilities that scored 50% or more were considered to be ready to provide BEmONC services than those scored less than 50% in BEmONC readiness score. This cut-off point of 50% was also used in previous studies.[33,34]

The outcome variables were examined against selected potential explanatory variables that we proposed as key variables that influence the availability or readiness of the health facility to provide BEmONC services. These variables were: facility location was coded as "0" for urban and "1" for Rural. The facility type was coded as "0" for clinic or dispensary, "1" for a health centre, and "2" for a Hospital. Managing authority was coded as "0" for a public facility and "1" for the private facility. Duty schedule for 24 hours was coded as "Yes" for the facility that had a duty schedule or call list for 24 hours staff assignment, otherwise, the facility was coded as "No." Quality assurance was coded as "performed" for facility reported to perform quality assurance at least once per year, otherwise the facility was coded as "not performed." Maternal or newborn deaths were coded as "reviewed" for the facility that conducted regular reviews of maternal or newborn deaths or near-misses, otherwise, the facility was coded as "not reviewed." Clients' opinions was coded as "reviewed" for facility reported having a system of determining and reviewing clients' opinion, otherwise, the facility was coded as "not reviewed." A number of staffs and number of beds per facility remained as discrete quantitative variables.

Statistical analysis

Data were analyzed using Stata 14 (StataCorp, College Texas). For all the analyses, the "svy" set command in Stata was used to adjust for the complex sampling design employed by TSPA survey. Moreover, as the facilities sampled were not evenly distributed and the response rate might be very different by regions or facility type, then over and under-sampled in the

regions with fewer and more facilities respectively were performed before data collection. Therefore, before analysis, facility weight was used to restore the actual representativeness of the facilities sampled.

In the descriptive analysis, continuous variables were summarized using either mean (SD) for normally distributed variables or median (IQR) for non-normal distributed variables. All categorical variables were summarized using proportions and then presented in tables and graphs. Bivariate and multivariate regression models were fitted to assess the existence of the association between the outcome variable (BEmONC service readiness) and the explanatory variables. As the aim was to fit a final model that predicts well the association, the objective criterion-based method was used to include or exclude variable in the multiple regression models. A *t*-test for each of the coefficient in multiple regression model was calculated and used to test for the association. A *P*-value of less than 0.05 was considered indicative of statistically significant difference.

Normality of the residuals, this was assessed by using "swilk test," which based on the assumption that the distribution of the residuals is normal. Although it gave a *P*-value < 0.05, the violation of this assumption in a large sample size (e.g., where the number of observations per variable is > 10) like the one used in this analysis often do not noticeably impact results.[35] A multicollinearity, the term refers to the condition when the explanatory variables are correlated to each other in multiple regression models while in fact they are supposed to be independent has been assessed. The generalized variance inflation factor (VIF) was performed to test for multicollinearity, which usually should not exceed 5.[36] In this analysis each variable presented with VIF<2.0, suggesting the absence of multicollinearity in the final model. The homogeneity of variance of the residuals (homoscedasticity) was checked by using "Breusch-Pagan test"

which test that the null hypothesis of the variance of the residuals is homogenous. As the test gave a *P*-value of 0.31, we accepted the null hypothesis that the variance was homogenous.

Ethics statement

This study was based on an analysis of existing public domain survey data sets that are freely available online with all identifier information detached. The survey was approved by the Ethics Committee of the ICF Macro at Calverton in the USA and by the National Institute of Medical Research Ethics Committee in Tanzania. Informed consent was requested and obtained from participants before the interview.

Patient and Public Involvement Statement

Patient and public were not involved in the analysis of this study.

RESULTS

General characteristics of surveyed facilities

Table 1 presents a summary of the general characteristics of the included health facilities. Out of 1188 facilities involved in the TSPA survey, 905 (76.18%) reported to provide delivery and newborns care services and therefore were included in the analysis of the current study. More than 80% of the facilities were located in rural area and publicly owned. Less than 30% of the facilities regularly reviewed maternal and newborn deaths or "near-misses" cases that occurred within the facility. Overall, the number of staffs per facility was low with a median (IQR) of 3 (2 - 6).

Table 1 Percent distribution of surveyed facilities according to background characteristics, TSPA 2014-2015 (N=905).

Variable	n (%)
Facility location	
Rural	773 (85.41)
Urban	132 (14.59)
Facility type	
Clinic & dispensary	751 (82.98)
Health center	110 (12.16)
Hospital	44 (4.86)
Managing authority	
Public	756 (83.54)
Private	149 (16.46)
Duty schedule for 24 hours	
Yes	256 (28.29)
No	649 (71.71)
Quality assurance	
Performed	149 (16.46)
Not performed	756 (83.54)
Maternal/newborn deaths	
Reviewed	182 (20.11)
Not reviewed	723 (79.89)
Clients' opinions	
Reviewed	272 (30.06)
Not reviewed	633 (69.94)
Number of staffs per facility	
Median (IQR)	3 (2,6)
Number of delivery beds per facility	
Mean (SD)	1.41 (1.02)

IQR: Interquartile range; SD: Standard deviation

Seven signal functions for BEmONC by type of facility and managing authority

Table 2, shows the distribution of the availability of seven signal function for BEmONC by type of facility and managing authority. Overall availability of these seven signal functions (parental administration of the antibiotic, parental administration of oxytocic, parental administration of anticonvulsant, assisted vaginal delivery, manual removal of placenta, manual removal of retained products of conception, and neonatal resuscitation) were consistently higher among hospitals than health centers and dispensaries ($P<0.001$). Despite the fact that private facilities consistently reported the higher availability of these seven signal functions compared to public facilities, only parental administration of the antibiotic, parental administration of anticonvulsants**,** and neonatal resuscitation were significantly higher in private facilities ($P<0.001$). Regardless of facility type and managing authority, majority of the facilities reported high availability of parental administration of oxytocic (83.61%), assisted vaginal delivery (69.60%), and neonatal resuscitations (52.14%) while less than half of all facilities reported availability of manual removal of retained products of conception (35.36%), parental administration of antibiotic (34.01%), manual removal of placenta (33.95%), and parental administration of anticonvulsants (13.35%).

Table 2 Percentage distribution of seven signal functions for Basic Emergency Obstetric and Newborn Care services by type of facility and managing authority, TSPA 2014-2015 (N=905).

Variable	Facility type			Managing authority		
	Dispensary/ Clinic n (%)	Health centre n (%)	Hospital n (%)	Public n (%)	Private n (%)	Total n (%)
Parental administration of antibiotic	205 (27.32)	66 (60.01)	37 (83.95)*	242 (32.04)	66 (44.03)*	308 (34.01)
Parental administration of oxytocin	614 (81.77)	100 (90.94)	42 (96.86)*	633 (83.69)	123 (83.16)	756 (83.61)
Parental administration of anticonvulsants	52 (6.96)	35 (31.59)	34 (77.56)*	83 (10.93)	38 (25.63)*	121 (13.35)
Assisted vaginal delivery	511 (68.00)	80 (72.85)	39 (88.94)*	525 (69.50)	104 (70.11)	629 (69.60)
Manual removal of placenta	227 (30.22)	50 (45.34)	30 (69.66)*	248 (32.87)	59 (39.46)	307 (33.95)
Manual removal of retained products of conception	234 (31.10)	56 (51.35)	30 (68.56)*	264 (34.88)	56 (37.79)	320 (35.36)
Neonatal resuscitation	352 (46.78)	80 (73.05)	40 (92.03)*	383 (50.64)	89 (59.76)*	472 (52.14)
Number of facilities providing normal delivery services	751	110	44	756	149	905

*** = *P*-value <0.001**

Availability of important supportive items for delivery and newborns care services

Human resources (staff training): Only (206, 22.75%) facilities reported having at least one staff who had received refresher training in delivery and newborn care. Also about one-third (270, 29.80%) of facilities reported having recommended guidelines related to delivery and newborn care.

Essential equipment and supplies: Overall, the majority (890, 98.35%) of facilities reported dedicating at least one bed for delivery purposes, (780, 86.24%) had sterile gloves, (760, 84.05%) had delivery packs, and (692, 76.48%) had a neonatal bags and masks for resuscitation. However, less than a quarter of facilities reported having suction apparatus (23.14%), sterilization equipment (20.75%), examination light (14.37%), vacuum aspirator or dilatation and curettage D&C kit (7.51%), or manual vacuum extractor (5.31%).

Medicines and commodities: Regarding availability of essential medicines for delivery, injectable uterotonic (78.81%), skin disinfectant (61.10%), and injectable diazepam (55.23%) were highly reported. While intravenous fluids (48.15%), injectable magnesium sulfate (40.77%), injectable antibiotic (32.11%) were not widely available. On the other hand, regarding essential medicines for newborn care, more than half of facilities reported availability of amoxicillin suspension (62.90%) and injectable ceftriaxone (56.69%) while less than one-third of facilities reported availability of injectable gentamicin (29.54%), antibiotic eye ointment (28.05%), and 4% chlorhexidine (11.95%) (Table 3).

Table 3 Percentage distribution of readiness indicators for providing Basic Emergency Obstetric and Newborn Care services, TSPA 2014-2015 (N=905).

Variable	n (%)
Staff and training	
Presence of guidelines	270 (29.80)
Availability of trained staff	206 (22.75)
Equipment and supplies	
Emergency transport	567 (62.54)
Sterilization equipment	188 (20.75)
Examination light	130 (14.37)
Delivery pack	760 (84.05)
Suction apparatus	209 (23.14)
Manual vacuum extractor	48 (5.31)
Vacuum aspirator or D&C kit	68 (7.51)
Neonatal bag and mask	692 (76.48)
Delivery bed	890 (98.35)
Partograph	520 (57.51)
Gloves	780 (86.24)
Medicines and commodities	
Essential medicines for delivery	
Injectable antibiotic	291 (32.11)
Injectable uterotonic	713 (78.81)
Injectable magnesium sulfate	368 (40.77)
Injectable diazepam	500 (55.23)
Intravenous fluids	436 (48.15)
Skin disinfectant	553 (61.10)
Essential medicines for newborns	
Antibiotic eye ointment	254 (28.05)
4% chlorhexidine	108 (11.95)
Injectable gentamicin	267 (29.54)
Injectable ceftriaxone	513 (56.69)
Amoxicillin suspension	569 (62.90)

Facility readiness to provide BEmONC services

Figure 1 shows the readiness score corresponding to the three domains and the overall index of facility readiness to provide BEmONC. Each of the three domains had an average readiness score of less than 50% based on the indicators suggested by WHO-SARA manual, that yield overall mean readiness score (SD) of 40.3 (17.6)%. However, 267 (29.50%) of all health facilities had overall percentage readiness score of 50% or more, therefore, were considered ready to provide BEmONC services.

Overall BEmONC readiness score according to the type of facility and managing authority

The overall readiness score was found to differ significantly according to the type of facility, with a higher score among hospitals compared to dispensaries ($P<0.001$). However, there was no difference in the overall readiness score according to the managing authority at each level of facility type ($P>0.05$) (Figure 2).

Factors associated with facility readiness to provide BEmONC services

Table 4 presents the results of the bivariate and multivariate analysis. In bivariate analysis, all explanatory variables showed association with outcome variable "BEmONC service readiness" at $P<0.05$, therefore, were selected and included in multiple regression models by using objective criterion-based methods to predict their association with readiness to provide BEmONC services. The results of multiple regression analysis showed that the readiness of facility to provide BEmONC services was higher at health centres (11.54 percentage points better than dispensary and clinics), at facilities which performed quality assurance (5.45 percentage points better than those not performed), at facilities reported regular reviewing maternal, newborn deaths or "near-misses" (6.49 percentage points better than those not reviewed), at facilities that reviewed clients opinion about heath facility or its services (4.29 percentage points better than those not reviewed

clients opinions), and facility with more delivery beds (2.44 percentage points for each doubling of bed per facility).

Table 4 Results of unadjusted and adjusted multiple regression models of factors associated with readiness to provide Basic Emergency Obstetric and Newborn Care services, TSPA 2014-2015 (N=905).

Variable	Unadjusted		Adjusted	
	Coef	Std error	Coef[A]	Std error
Facility location (ref: Rural)				
Urban	8.64**	2.29	0.20	2.08
Facility type (ref: clinic/dispensary)				
Health center	18.15**	1.24	**11.54****	2.02
Hospital	26.09**	2.54	8.06	4.15
Managing authority (ref: Public)				
Private	8.46**	1.90	3.56	1.87
Duty schedule for 24 hours (ref: No)				
Yes	12.28**	1.62	0.52	2.13
Quality assurance (ref: Not performed)				
Performed	14.24**	2.36	**5.45***	2.44
Maternal/newborn deaths (ref: Not reviewed)				
Reviewed	14.76**	1.76	**6.49****	1.89
Clients' opinions reviewed (ref: No)				
Yes	9.90**	1.74	**4.29***	1.68
Number of staffs per facility (as continuous variable)	0.09**	0.04	-0.001	0.013
Number of delivery beds per facility (as continous variable)	6.28**	0.58	**2.44***	0.83

*** *P*<0.05; ** *P*<0.001.**

Coef: Coefficient; Std: Standard error.

[A]Adjusted coefficient: Each variable in the model has been adjusted by all variables.

DISCUSSION

This study used a nationally-representative data from Tanzania as an example of low-resource country to assess the availability and readiness of health facilities to provide BEmONC services among health facilities. The study findings indicate a relatively poor readiness of Tanzanian health facilities to provide BEmONC services. The observed scarcity of human resource (trained providers), essential diagnostic equipment, and basic medicine resulted into poor readiness of the facilities to provide BEmONC. The observed poor facility readiness to provide BEmONC in this study, extend the findings from other studies across different regions of LICs.[37,38] These findings continuous to highlight essential gaps in delivery maternal and newborn services that are obstacles to universal access to health services.[39] Therefore, the findings have greater implications for the improvement of emergency obstetric care in Tanzania and other LICs.

Availability of seven signal functions for BEmONC is crucial to reduce maternal and neonatal mortality.[40] The current study found disparities in the availability of these seven signal functions according to the type of facility and managing authority. Despite the fact that private facilities consistently reported the higher availability of the seven signal functions compared to public facilities, only three signal functions; parental administration of the antibiotic, parental administration of anticonvulsants**,** and neonatal resuscitation were significantly more reported in privately owned than publicly owned facilities. Similarly, hospitals were found to report significantly more availability of the signal functions than lower-level facilities (health centres and dispensaries). These findings are in agreement with the findings of a study conducted in Haiti in 2014.[41] The similarity of the findings of these studies might be due to the similar methodology used; both studies used data from the national representative sample collected by

DHS program. Therefore, the questionnaire used for the interviews were nearly similar. Also, Tanzania and Haiti share socio-economic determinants as these two countries are both LICs.

Furthermore, our results indicate that availability of parental administration of anticonvulsants (magnesium sulfate) is still a challenge and as a result, it compromises the provision of BEmONC in Tanzania particularly in public and lower-level health facilities. The similar finding has been reported in another low-resource setting.[42] Inadequate availability of this important component of BEmONC, might led to unnecessary delays to prevent or intervene pre-eclampsia/eclampsia that is one of the three leading causes of maternal morbidity and mortality.[43] Together with other suboptimal availability of parental administration of antibiotic, manual removal of placenta and retained products of conception suggesting that, despite the increased coverage of antenatal care, facility deliveries, and postnatal care, these efforts alone can not reduce MMR and NMR without improving the availability of BEmONC services.[44,45] The low availability of seven signal functions in the public and lower-level facilities in Tanzania is further impacted by the current long process of ordering and delivering of drugs and medical supplies through a system called Integrated Logistic System (ILS). With this system, facility places its order through District Medical Officer's (DMO) office to the Medical Department Store (MSD), a body that operates under Ministry of Health responsible for managing all the procurement and supply of medical items concerning public facilities.[46] Hence, any faults or delays in the ordering system may result in the low availability of items or services in the facilities. These delays will compromise efforts towards achieving targets set by the Tanzanian government that all hospitals and at least 70% of health centres and dispensaries be able to provide BEmONC services at the end of 2020.[22]

Facility readiness is an important aspect that demonstrate facility's commitment to ensuring cumulative availability of components required to provide a specific service.[31] Our analysis identified the significant difference of BEmONC readiness according to the type of facility, in which higher-level facilities (hospitals) were found to have high readiness score compared to lower-level facilities (dispensaries/clinics). The suboptimal readiness observed in the lower-level facilities might be due to unclear formula on how to allocate funds in these facilities that may contribute to insufficiencies and inequities in the distribution of medical supplies.[46] The strengthening of the lower-level facilities which are usually located in the rural areas and serve about 75% of Tanzanian population is highly needed to address the increasing burden of maternal and neonatal deaths. The finding is in agreement with the previous study conducted in Kenya.[30]

Quality assurance is a process that aims to promote a high standard of the service provision within healthcare systems.[47] The results of this study show that facilities that performed quality assurance were more likely to be ready to provide BEmONC services compared to facilities not engaged in quality assurance activities. This might be due to the fact that, quality assurance involves continuous monitoring and persistent feedback to improve services offered.[48] Therefore, based on recommendations from quality assurance teams, these facilities are more likely to improve the availability of services that may result in their high readiness score. However, the uptake of quality improvement and quality assurance activities remains low within the Tanzanian health system as a small number of health facilities regular perform such activities.[49]

Each maternal or newborn death has a story to tell,[50] therefore, review of these deaths is widely recognized as a recommended tool to improve obstetric and neonatal care.[51] Our results

show that facilities which perform maternal and newborn death reviews were more likely to be ready to provide BEmONC services compared to facilities that did not perform these reviews. It may be that facilities that perform death reviews use that information to improve BEmONC service availability and readiness. Despite the maternal death reviews have been imposed over the past two decades as the national policy to improve the quality of BEmONC services the results show that majority of Tanzania health facilities do not regularly perform such kind of reviews.[52] Therefore, the number of facilities miss the opportunity of reflection and direct feedback to improve the BEmONC services.[53,54]

Also, clients' opinions are beneficial parameter for judging the availability and readiness of the facility to provide specific services. The results of this study indicate that facilities which review clients' opinion were more likely to be ready to provide BEmONC services. This might be explained by the fact that clients' opinions not only reflects the satisfaction with service received but also provide positive and negative feedback towards services provided by facility or health providers.[55] This feedback may be used to correct the shortcomings highlighted by patients, hence improve the availability of services that are important aspect to assess the readiness of the facility to provide services. However, we also found low number of health facilities that regularly collect and review clients' opinion regarding the provision of maternal and newborn services.

The availability of delivery beds is very important in the health facility for both mother and health provider to support the childbirth.[56,57] Therefore, facilities having delivery beds express their commitment towards the provision of BEmONC. The current study provides evidence that facilities with many numbers of delivery beds were more likely to be ready to provide BEmONC than those without or with the fewer number of delivery beds. However, the

unreliability of delivery beds and other medical supplies within health facilities in Tanzania have been highlighted as among the barriers of timely provision of BEmONC. This might be related to inadequate budgeting from central government, insufficient ordering of BEmONC supplies, stock outages at MSD, and lack of accountability within the supply system.[45]

The strength of the current study is that it analyzed a nationally-representative sample of health facilities in Tanzania, providing key insight into the BEmONC availability and readiness in the LICs with higher MMR and NMR. It provides important information about the current situation regarding availability and readiness of facilities to provide BEmONC in a resource-constrained environment. Since TSPA survey employed complex sampling procedures, the estimates were adjusted for clustering effect and weighted to correct for non-response and disproportionate sampling. However, the study has some limitations. As it was a cross-sectional survey, the causal relationship could not be assessed. Therefore, the results should be interpreted with caution. Also, the study is subjected to misclassification bias as a result of arbitrary cut-off point set at 50%; this might be misclassified readiness of health facilities to provide BEmONC services. Though, the effect of this bias has been minimized by inclusion of many indicators as suggested by WHO to assess the level of facility readiness.

In summary, the results of this study indicate disparities in the availability of seven signal functions and readiness to provide BEmONC services among health facilities in Tanzania. It also highlighted the gaps in the availability of important supportive items such as refresher training and clinical guidelines for the provision of BEmONC. To improve the quality of BEmONC services, there are key steps that government authorities might consider. These includes:- the emphasis on quality assurance and quality improvement activities and implementation of regular maternal and newborn death audits. In order to improve BEmONC services, the health system

leaders should implement strategies to better ensure fair distribution of clinical guidelines, essential medicines, equipment, and refresher training. Additional studies may be useful to ensure effective implementation of government policies to support the readiness of health facilities to provide BEmONC services.

Authors' contributions

DB conceptualized and designed the study, performed statistical analysis and wrote the first and revised draft of the manuscript. AE involved in the interpretation of data revised and edited the manuscript. BCM provided advice on statistical analysis, interpretation of data, and edited the manuscript; All authors read and approved the final manuscript.

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Competing interest

None to declare.

Provenance and peer review

Not commissioned; externally peer reviewed.

A data sharing statement

The datasets generated during the current study are available from within the Demographic and Health Survey Program repository: http://dhsprogram.com/data/available-datasets.cfm

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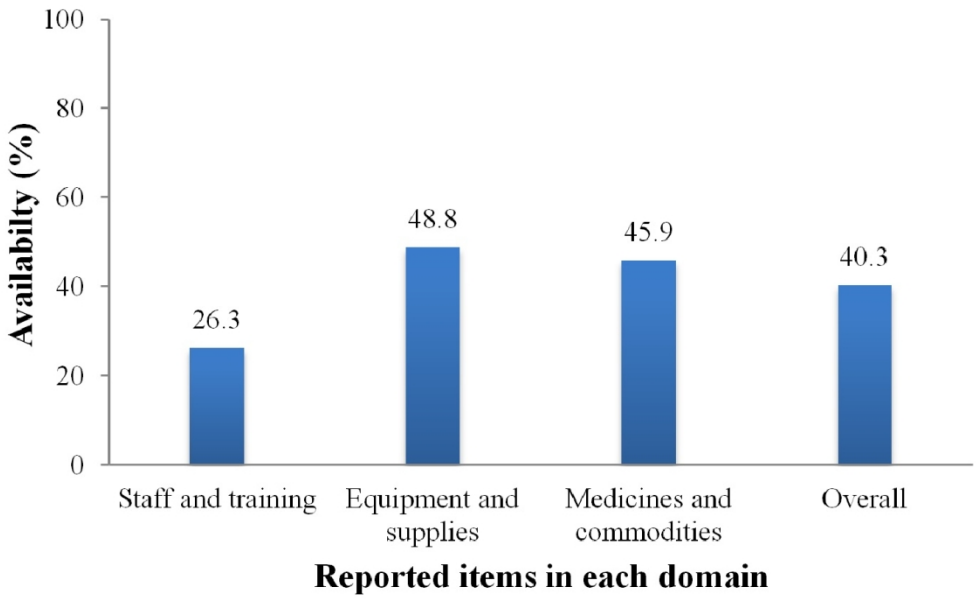
Figure titles/legend

Title; Figure 1 Percentage score of the three domains of readiness to provide Basic Emergency Obstetric and Newborn Care services

Title; Figure 2 Overall readiness score for providing Basic Emergency Obstetric and Newborn Care according to the type of facility and managing authority

Legend 2 Box shows the limits of 25 and 75% percentile. Horizontal line inside the box shows the median value. The bar shows the low and upper limits of 95% confidence interval. The dots show outliers



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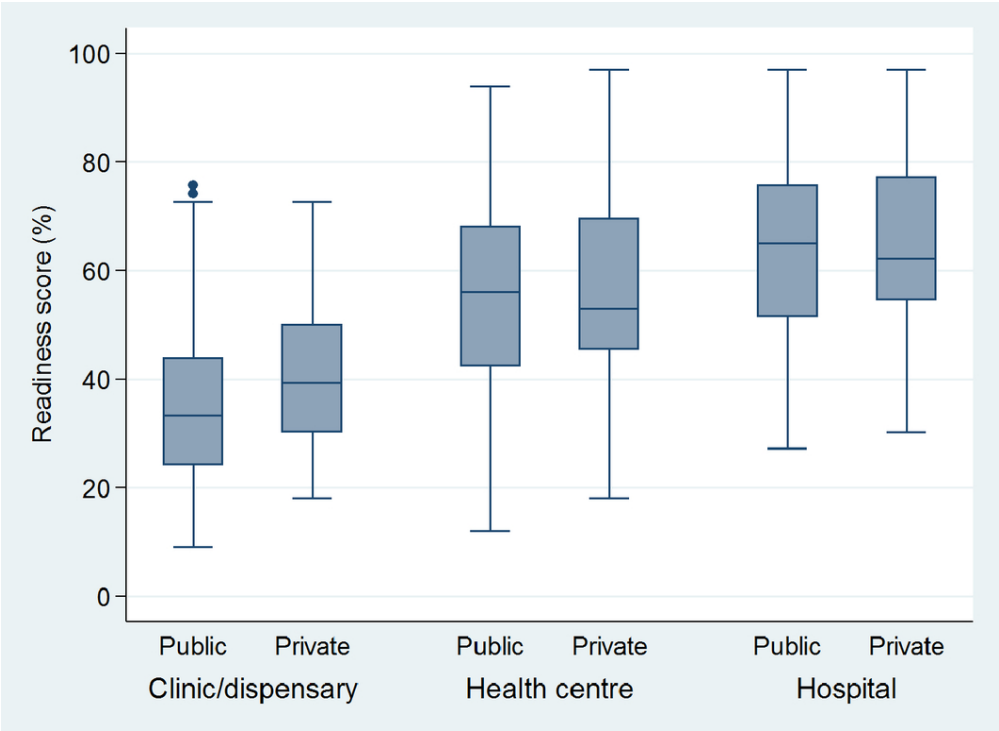

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

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	Page 1, and 2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Page 2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Page 5-6
Objectives	3	State specific objectives, including any prespecified hypotheses	Page 6
Methods			
Study design	4	Present key elements of study design early in the paper	Page 7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 7-8
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	Page 7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Page 8-10
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	Page 8-10
Bias	9	Describe any efforts to address potential sources of bias	Page 11-2
Study size	10	Explain how the study size was arrived at	Page 7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Page 11
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Page 11-2
		(*b*) Describe any methods used to examine subgroups and interactions	Page 11-2
		(*c*) Explain how missing data were addressed	N/A
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	Page 11
		(*e*) Describe any sensitivity analyses	N/A
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Page 12 and Table 1
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Page 12 and Table 1
		(b) Indicate number of participants with missing data for each variable of interest	N/A
Outcome data	15*	Report numbers of outcome events or summary measures	Page 14-8
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	Page 18 and Table 4
		(*b*) Report category boundaries when continuous variables were categorized	Table 1
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A
Discussion			
Key results	18	Summarise key results with reference to study objectives	Page 20-3
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	Page 24
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Page 24
Generalisability	21	Discuss the generalisability (external validity) of the study results	Page 24
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

Health facility service availability and readiness to provide basic emergency obstetric and newborn care in a low-resource setting: evidence from a Tanzania national survey

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Secondary Subject Heading:	Health services research
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Health facility service availability and readiness to provide basic emergency obstetric and newborn care in a low-resource setting: evidence from a Tanzania national survey

Deogratius Bintabara[1*], Alex Ernest[2], Bonaventura C. Mpondo[3]

[1]Department of Public Health, College of Health Sciences, The University of Dodoma, [2]Department of Obstetrics and Gynecology, College of Health Sciences, The University of Dodoma, [3]Department of Internal Medicine, College of Health Sciences, The University of Dodoma

Deogratius Bintabara, M.D. (Corresponding author)

Department of Public Health, College of Health Sciences,

The University of Dodoma, Dodoma, Tanzania

Phone: (255) 767 966 114, Email: bintabaradeo@gmail.com

Alex Ernest, M.D.

Department of Obstetrics and Gynecology, College of Health Sciences,

The University of Dodoma, Dodoma, Tanzania

Phone: (255) 767 625 828, Email: ibolinga@gmail.com

Bonaventura C. Mpondo, M.D.

Department of Internal Medicine, College of Health Sciences,

The University of Dodoma, Dodoma, Tanzania

Phone: (255) 688 530 690, Email: boniempondo@gmail.com

Keywords: Availability and readiness, Obstetric and newborn care, Low-income countries

Word count: 4500; Abstract 285

ABSTRACT

Objective: This study used a nationally-representative sample from Tanzania as an example of low-resource setting with a high burden of maternal and newborn deaths, to assess the availability and readiness of health facilities to provide Basic Emergency Obstetric and Newborn Care (BEmONC) and its associated factors.

Design: Health facility-based cross-sectional survey

Setting: We analyzed data for obstetric and newborn care services obtained from the 2014-2015 Tanzania Service Provision Assessment survey, using World Health Organization-Service Availability and Readiness Assessment tool.

Primary and secondary outcome measures: Availability of seven signal functions was measured based on the provision of "parental administration of antibiotic," "parental administration of oxytocic," "parental administration of anticonvulsants," "assisted vaginal delivery," "manual removal of placenta," "manual removal of retained products of conception," and "neonatal resuscitation." Readiness was a composite variable measured based on the availability of supportive items categorized into three domains; staff training, diagnostic equipment, and basic medicines.

Results: Out of 1188 facilities, 905 (76.2%) were reported to provide obstetric and newborn care services and therefore were included in the analysis of the current study. Overall availability of seven signal functions and average readiness score were consistently higher among hospitals than health centres and dispensaries (P<0.001). Furthermore, the type of facility, performing quality assurance, regular reviewing of maternal and newborn deaths, reviewing clients' opinion,

and number of delivery beds per facility were significantly associated with readiness to provide BEmONC.

Conclusion: The study findings show disparities in the availability and readiness to provide BEmONC among health facilities in Tanzania. The Tanzanian Ministry of Health should emphasize quality assurance efforts and systematic maternal and newborn death audits. Health leadership should fairly distribute clinical guidelines, essential medicines, equipment, and refresher trainings to improve availability and quality BEmONC.

Strengths and limitations of this study

- This is the first study in this region to identify factors associated with readiness to provide Basic Emergency Obstetric and Newborn Care using the recommended World Health Organization service readiness indicators, and data obtained from a nationally-representative sample.
- By using a nationally-representative sample, this suggests that our findings accurately reflect the current situation regarding availability and readiness to provide Basic Emergency Obstetric and Newborn Care in low-resource setting such as Tanzania.
- The findings were adjusted for clustering effect and weighted to correct for complex sampling procedure and non- response and disproportionate sampling respectively.
- Being a cross-sectional study, causal relationship could not be established. Therefore, the results should be interpreted with caution.
- Misclassification bias, as a result of arbitrary cut-off point set at 50%, this might misclassify readiness of health facilities to provide BEmONC.

INTRODUCTION

Despite a global reduction of maternal and neonatal mortality over the past two decades,[1,2] approximately 800 women and 7700 newborns still die every day due to complications related to pregnancy, childbirth and postpartum.[3,4] It is estimated that 99% of these deaths occur in low and middle-income countries (LMICs),[4] while 85% are contributed by low-income countries (LICs) alone.[5,6] Tanzania is among the LICs that continuous to experience a high burden of maternal and newborn deaths. This is despite increased coverage of antenatal care provided by skilled providers (96 to 98%), facility delivery (50 to 63%), and births assisted by skilled providers (51 to 64%) between 2010 to 2016.[7–10] Recent reports showed a remarkable increase of Maternal Mortality Ratio (MMR) [from 454 to 556 maternal deaths per 100,000 live births], while Neonatal Mortality Ratio (NMR) remained unchanged [26-25 deaths per 1,000 live births] between 2010 to 2016.[9,10] These estimates remain far from operational targets set by the Tanzanian Ministry of Health throught the National Road Map Strategic Plan of 2008. This plan aimed to accelerate the reduction in maternal deaths to 193 per 100000 live-births and neonatal deaths to 19 per 1000 live births in Tanzania by the end of 2015.[11] Given recent MMR estimates, one wonders whether Tanzania will be able to achieve targets for Sustainable Development Goal (SDG-3) to reduce maternal deaths to less than 70 in 100,000 live births and neonatal deaths to less than 12 per 1,000 live births at the end of 2030.[12]

This slow pace of MMR and NMR reduction observed in LIC including Tanzania, led the World Health Organization (WHO) to develop and recommend the availability of Basic Emergency Obstetric and Newborn Care (BEmONC) services in each health facility as a key strategy to narrow disparities in global maternal and newborn deaths.[4,13–15] BEmONC is an integrated strategy that aims to equip health facilities to deal with major causes of direct obstetric

emergencies which account for the vast majority of maternal and newborn deaths, particularly in high mortality countries.[16,17] This strategy comprises a package of seven key obstetric services or "signal functions" including: 1) the ability of the facility to administer parenteral antibiotics, 2) administer uterotonic drugs (parenteral oxytocin), 3) administer parenteral anticonvulsants (e.g magnesium sulphate), 4) perform manual removal of placenta, 5) perform removal of retained products of conception, 6) perform assisted vaginal delivery and 7) perform basic neonatal resuscitation. Evidence has demonstrated that provision of BEmONC by skilled personnel results in better maternal and newborn outcomes[18] and Tanzania and other LICs have partially implemented this strategy. However, the majority of health facilities lack some or all seven signal functions of BEmONC.[18–20] For example in Tanzania, national BEmONC assessment survey of 2015 revealed that 13% of dispensaries, 28% of all health centres and 62% of hospitals were capable of performing all seven signal functions.[21] These estimates are below the target that require all hospitals and at least 70% of health centres and dispensaries to provide BEmONC services.[22] Furthermore, it is contrary to the effort made by Tanzanian government on improving maternal and newborn health such as developing number of policies and guidelines, as a response from international and regional policies and agreements (Delhi Declaration of 2005), that targets to reduce MMR and NMR.[11,22,23]

Countries with low availability of BEmONC services also experienced a high burden of maternal and newborn deaths.[1,24] This correlation has been documented by previous studies and many researchers have identified critical gaps on BEmONC that if addressed could reduce the burden of high MMR and NMR in those countries.[18,25] However, the majority of previous studies have concentrated on the assessment of services availability and few have assessed the readiness of the facilities to provide BEmONC services.[26–30] In addition, these studies found low readiness

of the facilities to provide BEmONC. Hence, there is little information regarding factors associated with low readiness of facilities to provide BEmONC in Tanzania. Better understanding of the factors associated with facility readiness to provide BEmONC is crucial to support maternal and newborn health system improvements.

To that end, this study used a nationally-representative sample from Tanzania to assess the current extent of availability and readiness of health facilities to provide BEmONC services. Associated factors were also examined according to the type of facility and managing authority by using WHO Service Availability and Readiness Assessment (SARA) manual [31] with modification to some questions to fit the study setting.[31] The findings from this study will provide a crucial guidance on important factors that need to be addressed to strengthen the BEmONC services for policy-makers, administrators, and researchers in Tanzania and other LICs.

METHODS

Data source

The analyzed data of the current study was drawn from 2014-2015 Tanzania Service Provision Assessment (TSPA) survey dataset. The 2014-2015 TSPA was undertaken by Tanzania's National Bureau of Statistics (NBS) in collaboration with the Office of the Chief Government Statistician (OCGS), Zanzibar, the Ministry of Health and Social Welfare (MoHSW), Tanzania Mainland, and the Ministry of Health (MOH), Zanzibar. Technical support for the survey was provided by ICF International under the Demographic and Health Survey (DHS) program. The survey assessed the facilities regarding availability and readiness of providing basic and essential health services, including the presence and function of components essential for the delivery of quality service for all aspects including maternal, newborn and child health care, family planning, and reproductive health services.

Sample and Sampling procedure

The sampling procedure used in TSPA survey is reported elsewhere.[32] A random stratified sampling of health facilities according to facility type, managing authority, and regions was used to select a nationally-representative sample of 1200 facilities from the national master facility list contains 7102 health facilities. The selection of desirable health facilities was achieved after excluding seven facilities that refused to participate, four had closed on the interview days, and one that could not be reached because of poor infrastructure. Then, a total of 1188 health facilities were assessed in 2014-2015 TSPA survey. However, after excluding 283 facilities that did not meet inclusion criteria (not providing any services related to maternal and newborn health), a total of 905 health facilities were included in the current analysis.

Data collection methods

The 2014-2015 TSPA used four main types of questionnaires during data collection. The current analysis used data collected by the *Facility Inventory Questionnaire* and one variable regarding staff training from *Health Provider Questionnaire*. After pre-testing of the questionnaires, the finalized and corrected versions were used in the main 2014-2015 TSPA survey data collection between October 20, 2014 – February 21, 2015. Additionaly, visits of some facilities that were not covered previously were conducted from March 2-13, 2015. The data collection was performed by 67 nurses who were trained for four weeks and were qualified by a series of practical tests and examinations to be interviewers. Following the training, 20 teams were formed (2 for Zanzibar and 18 for Tanzania Mainland). Each team consisted of a team leader, 3 interviewers and a driver. On average, the data collection process lasted one day at a small facility (dispensary clinics and some health centres) and two or three days for large facilities (mostly hospitals). All collected data regarding the health facility service availability and readiness were provided by the manager, the person-in-charge of the facility, or the most senior health worker responsible for the client services present at the facility. The interviewers observed and verified the presence of valid or functioning reported services or supplies.

Measurement of variables

Based on our research questions; the current study identified two outcome variables which were "BEmONC services availability" and "BEmONC services readiness". These variables were measured by using the WHO methods of assessing facility service availability and readiness. Hence, "BEmONC services availability" in this study is defined as "physical presence of the services related with provision of BEmONC". This was measured based on whether the following seven signal functions have ever been carried out by providers as part of their work

within facility at least once during the past 3 months: “parental administration of antibiotic,” “parental administration of oxytocic,” “parental administration of anticonvulsants,” “assisted vaginal delivery,” “manual removal of placenta,” “manual removal of retained products of conception,” and ‘neonatal resuscitation.”

“BEmONC services readiness” in this study is defined as the willingness or preparedness of the facility to provided BEmONC. This was measured based on the availability and functioning of supportive items categorized into three domains (groups) as follows; the first domain was staff training which had two indicators - the presence of guidelines and at least one staff who has received any formal or structured in-service training (refresher training) related to the services offered in the last 24 months preceding the assessment. The second domain was diagnostic equipment which had eleven indicators i.e presence of “emergency transport,” “sterilization equipment,” “examination light,” “delivery pack,” “suction apparatus,” “manual vacuum extractor,” “vacuum aspirator or D&C kit,” “neonatal bag and mask,” “delivery bed,” “Partograph,” and “gloves.” The third domain was basic medicine and commodities which had eleven indicators contains essential medicines for delivery and newborn i.e “injectable antibiotic,” “injectable uterotonic,” “injectable magnesium sulfate,” “injectable diazepam,” “intravenous fluids,” “skin disinfectant,” “antibiotic eye ointment,” “4% chlorhexidine,” “injectable gentamicin,” “injectable ceftriaxone,” and “amoxicillin suspension.” The BEmOC service readiness was then created as a composite score by adding the presence of each indicator, with equal weight given to each of the domains and each of the indicators within the domains. As the expected target was 100%, each domain accounted for 33.3% (100%/3) of the total score. The proportion of each indicator within the domain was equal to 33.3% divided by the number of indicators in that domain. The BEmONC service readiness score for each facility was then

calculated by adding the proportions. Given that the readiness score is a relative measurement, then facilities that scored 50% or more were considered to be ready to provide BEmONC services than those scored less than 50% in BEmONC readiness score. This cut-off point of 50% was also used in previous studies.[33,34]

The outcome variables were examined against selected potential explanatory variables that we proposed as key variables that may potentially influence the availability or readiness of the health facility to provide BEmONC services. These variables were: facility location was coded as "0" for urban and "1" for Rural. The facility type was coded as "0" for clinic or dispensary, "1" for a health centre, and "2" for a Hospital. Managing authority was coded as "0" for a public facility and "1" for the private facility. Duty schedule for 24 hours was coded as "Yes" for the facility that had a duty schedule or call list for 24 hours staff assignment, otherwise, the facility was coded as "No." Quality assurance was coded as "performed" for facility reported to perform quality assurance at least once per year, otherwise the facility was coded as "not performed." Maternal or newborn deaths were coded as "reviewed" for the facility that conducted regular reviews of maternal or newborn deaths or near-misses, otherwise, the facility was coded as "not reviewed." Clients' opinions was coded as "reviewed" for facility reported having a system of determining and reviewing clients' opinion, otherwise, the facility was coded as "not reviewed." A number of staff and number of beds per facility remained as discrete quantitative variables.

Statistical analysis

Data were analyzed using Stata 14 (StataCorp, College Texas). For all the analyses, the "svy" set command in Stata was used to adjust for the complex sampling design employed by TSPA survey. Moreover, as the facilities sampled were not evenly distributed and the response

rate might be very different by regions or facility type, then over and under-sampled in the regions with fewer and more facilities respectively were performed before data collection. Therefore, before analysis, facility weight was used to restore the actual representativeness of the facilities sampled.

In the descriptive analysis, continuous variables were summarized using either mean (SD) for normally distributed variables or median (IQR) for non-normal distributed variables. All categorical variables were summarized using proportions and then presented in tables and graphs. Bivariate and multivariable regression models were fitted to assess the existence of the association between the outcome variable (BEmONC service readiness) and the explanatory variables. As the aim was to fit a final model that predicts the association, the objective criterion-based method was used to include or exclude variable in the multiple regression models. A *t*-test for each of the coefficient in multiple regression model was calculated and used to test for the association. A *P*-value of less than 0.05 was considered indicative of statistically significant association.

Ethics statement

This study was based on an analysis of existing public domain survey data sets that are freely available online with all identifier information detached. The survey was approved by the Ethics Committee of the ICF Macro at Calverton in the USA and by the National Institute of Medical Research Ethics Committee in Tanzania. Informed consent was requested and obtained from participants before the interview.

Patient and Public Involvement Statement

Patient and public were not involved in the analysis of this study.

RESULTS

General characteristics of surveyed facilities

Table 1 presents a summary of the general characteristics of the included health facilities. Out of 1188 facilities involved in the TSPA survey, 905 (76.18%) reported to provide delivery and newborns care services and therefore were included in the analysis of the current study. More than 80% of the facilities were located in rural area and publicly owned. Less than 30% of the facilities regularly reviewed maternal and newborn deaths or "near-misses" cases that occurred within the facility. Overall, the number of staff per facility was low with a median (IQR) of 3 (2 - 6).

Table 1 Percent distribution of surveyed facilities according to background characteristics, TSPA 2014-2015 (N=905).

Variable	n (%)
Facility location	
Rural	773 (85.41)
Urban	132 (14.59)
Facility type	
Clinic & dispensary	751 (82.98)
Health center	110 (12.16)
Hospital	44 (4.86)
Managing authority	
Public	756 (83.54)
Private	149 (16.46)
Duty schedule for 24 hours	
Yes	256 (28.29)
No	649 (71.71)
Quality assurance	
Performed	149 (16.46)
Not performed	756 (83.54)
Maternal/newborn deaths	
Reviewed	182 (20.11)
Not reviewed	723 (79.89)
Clients' opinions	
Reviewed	272 (30.06)
Not reviewed	633 (69.94)
Number of staffs per facility	
Median (IQR)	3 (2,6)
Number of delivery beds per facility	
Mean (SD)	1.41 (1.02)

IQR: Interquartile range; SD: Standard deviation

Seven signal functions for BEmONC by type of facility and managing authority

Table 2, shows the distribution of the availability of seven signal function for BEmONC by type of facility and managing authority. Overall availability of these seven signal functions (parental administration of the antibiotic, parental administration of oxytocic, parental administration of anticonvulsant, assisted vaginal delivery, manual removal of placenta, manual removal of retained products of conception, and neonatal resuscitation) were consistently higher among hospitals than health centers and dispensaries (P<0.001). Despite the fact that private facilities consistently reported the higher availability of these seven signal functions compared to public facilities, only parental administration of the antibiotic, parental administration of anticonvulsants**,** and neonatal resuscitation were significantly higher in private facilities (P<0.001). Regardless of facility type and managing authority, majority of the facilities reported high availability of parental administration of oxytocic (83.61%), assisted vaginal delivery (69.60%), and neonatal resuscitations (52.14%) while less than half of all facilities reported availability of manual removal of retained products of conception (35.36%), parental administration of antibiotic (34.01%), manual removal of placenta (33.95%), and parental administration of anticonvulsants (13.35%).

Table 2 Percentage distribution of seven signal functions for Basic Emergency Obstetric and Newborn Care services by type of facility and managing authority, TSPA 2014-2015 (N=905).

Variable	Facility type			Managing authority		
	Dispensary/ Clinic n (%)	Health centre n (%)	Hospital n (%)	Public n (%)	Private n (%)	Total n (%)
Parental administration of antibiotic	205 (27.32)	66 (60.01)	37 (83.95)*	242 (32.04)	66 (44.03)*	308 (34.01)
Parental administration of oxytocin	614 (81.77)	100 (90.94)	42 (96.86)*	633 (83.69)	123 (83.16)	756 (83.61)
Parental administration of anticonvulsants	52 (6.96)	35 (31.59)	34 (77.56)*	83 (10.93)	38 (25.63)*	121 (13.35)
Assisted vaginal delivery	511 (68.00)	80 (72.85)	39 (88.94)*	525 (69.50)	104 (70.11)	629 (69.60)
Manual removal of placenta	227 (30.22)	50 (45.34)	30 (69.66)*	248 (32.87)	59 (39.46)	307 (33.95)
Manual removal of retained products of conception	234 (31.10)	56 (51.35)	30 (68.56)*	264 (34.88)	56 (37.79)	320 (35.36)
Neonatal resuscitation	352 (46.78)	80 (73.05)	40 (92.03)*	383 (50.64)	89 (59.76)*	472 (52.14)
Number of facilities providing normal delivery services	751	110	44	756	149	905

Note : The availability of seven functions were based on whether the intervention has been carried out at least once during the past 3 months.

: * = $P < 0.05$ according to type of facility.

Availability of important supportive items for delivery and newborns care services

Human resources (staff training): Only (206, 22.75%) facilities reported having at least one staff who had received refresher training in delivery and newborn care. Also about one-third (270, 29.80%) of facilities reported having recommended guidelines related to delivery and newborn care.

Essential equipment and supplies: Overall, the majority (890, 98.35%) of facilities reported dedicating at least one bed for delivery purposes, (780, 86.24%) had sterile gloves, (760, 84.05%) had delivery packs, and (692, 76.48%) had a neonatal bags and masks for resuscitation. However, less than a quarter of facilities reported having suction apparatus (23.14%), sterilization equipment (20.75%), examination light (14.37%), vacuum aspirator or dilatation and curettage D&C kit (7.51%), or manual vacuum extractor (5.31%).

Medicines and commodities: Regarding availability of essential medicines for delivery, injectable uterotonic (78.81%), skin disinfectant (61.10%), and injectable diazepam (55.23%) were often available, while intravenous fluids (48.15%), injectable magnesium sulfate (40.77%), injectable antibiotic (32.11%) were not widely available. On the other hand, regarding essential medicines for newborn care, more than half of facilities reported availability of amoxicillin suspension (62.90%) and injectable ceftriaxone (56.69%) while less than one-third of facilities reported availability of injectable gentamicin (29.54%), antibiotic eye ointment (28.05%), and 4% chlorhexidine (11.95%) (Table 3).

Table 3 Indicators of readiness to providing Basic Emergency Obstetric and Newborn Care services, TSPA 2014-2015 (N=905).

Indicators	n (%) of facilities in which indicator is available
Staff and training	
Presence of guidelines	270 (29.80)
Availability of trained staff	206 (22.75)
Equipment and supplies	
Emergency transport	567 (62.54)
Sterilization equipment	188 (20.75)
Examination light	130 (14.37)
Delivery pack	760 (84.05)
Suction apparatus	209 (23.14)
Manual vacuum extractor	48 (5.31)
Vacuum aspirator or D&C kit	68 (7.51)
Neonatal bag and mask	692 (76.48)
Delivery bed	890 (98.35)
Partograph	520 (57.51)
Gloves	780 (86.24)
Medicines and commodities	
Essential medicines for delivery	
Injectable antibiotic	291 (32.11)
Injectable uterotonic	713 (78.81)
Injectable magnesium sulfate	368 (40.77)
Injectable diazepam	500 (55.23)
Intravenous fluids	436 (48.15)
Skin disinfectant	553 (61.10)
Essential medicines for newborns	
Antibiotic eye ointment	254 (28.05)
4% chlorhexidine	108 (11.95)
Injectable gentamicin	267 (29.54)
Injectable ceftriaxone	513 (56.69)
Amoxicillin suspension	569 (62.90)

Facility readiness to provide BEmONC services

Figure 1 shows the readiness score corresponding to the three domains and the overall index of facility readiness to provide BEmONC. Each of the three domains had an average readiness score of less than 50% based on the indicators suggested by WHO-SARA manual, that yield overall mean readiness score (SD) of 40.3 (17.6)%. However, 267 (29.50%) of all health facilities had overall percentage readiness score of 50% or more, therefore, were considered ready to provide BEmONC services.

Overall BEmONC readiness score according to the type of facility and managing authority

The overall readiness score was found to differ significantly according to the type of facility, with a higher score among hospitals compared to dispensaries ($P<0.001$). However, there was no difference in the overall readiness score according to the managing authority at each level of facility type ($P>0.05$) (Figure 2).

Factors associated with facility readiness to provide BEmONC services

Table 4 presents the results of the bivariate and multivariate analysis. In bivariate analysis, all explanatory variables showed association with outcome variable "BEmONC service readiness" at $P<0.05$, therefore, were selected and included in multiple regression models by using objective criterion-based methods to predict their association with readiness to provide BEmONC services. The results of multiple regression analysis showed that the readiness of facility to provide BEmONC services was higher at health centres (11.54 percentage points better than dispensary and clinics), at facilities which performed quality assurance (5.45 percentage points better than those not performed), at facilities reported regular reviewing maternal, newborn deaths or "near-misses" (6.49 percentage points better than those not reviewed), at facilities that reviewed clients opinion about heath facility or its services (4.29 percentage points better than those not reviewed

clients opinions), and facility with more delivery beds (2.44 percentage points for each doubling of beds per facility).

Table 4 Results of unadjusted and adjusted multiple regression models of factors associated with readiness to provide Basic Emergency Obstetric and Newborn Care services, TSPA 2014-2015 (N=905).

Variable	Unadjusted		Adjusted	
	Coef	Std error	Coef[A]	Std error
Facility location (ref: Rural)				
Urban	8.64**	2.29	0.20	2.08
Facility type (ref: clinic/dispensary)				
Health center	18.15**	1.24	**11.54****	2.02
Hospital	26.09**	2.54	8.06	4.15
Managing authority (ref: Public)				
Private	8.46**	1.90	3.56	1.87
Duty schedule for 24 hours (ref: No)				
Yes	12.28**	1.62	0.52	2.13
Quality assurance (ref: Not performed)				
Performed	14.24**	2.36	**5.45***	2.44
Maternal/newborn deaths (ref: Not reviewed)				
Reviewed	14.76**	1.76	**6.49****	1.89
Clients' opinions reviewed (ref: No)				
Yes	9.90**	1.74	**4.29***	1.68
Number of staffs per facility (as continuous variable)	0.09**	0.04	-0.001	0.013
Number of delivery beds per facility (as continous variable)	6.28**	0.58	**2.44***	0.83

*** *P*<0.05; ** *P*<0.001.**

Coef: Coefficient; Std: Standard error.

[A]Adjusted coefficient: Each variable in the model has been adjusted by all variables.

DISCUSSION

This study used a nationally-representative data from Tanzania as an example of low-resource country to assess the availability and readiness of health facilities to provide BEmONC services among health facilities. The study findings indicate a relatively poor readiness of Tanzanian health facilities to provide BEmONC services. The observed scarcity of human resource (trained providers), essential diagnostic equipment, and basic medicine resulted into poor readiness of the facilities to provide BEmONC. The observed poor facility readiness to provide BEmONC in this study, extend the findings from other studies across different regions of LICs.[35,36] These findings continue to highlight essential gaps in delivery maternal and newborn services that are obstacles to universal access to health services.[37] Therefore, the findings have greater implications for the improvement of emergency obstetric care in Tanzania and other LICs.

Availability of seven signal functions for BEmONC is crucial to reduce maternal and neonatal mortality.[38] The current study found disparities in the availability of these seven signal functions according to the type of facility and managing authority. Despite the fact that private facilities consistently reported higher availability of the seven signal functions compared to public facilities, only three signal functions; parental administration of the antibiotic, parental administration of anticonvulsants**,** and neonatal resuscitation were significantly more reported in privately owned than publicly owned facilities. Similarly, hospitals were found to report significantly greater availability of the signal functions than lower-level facilities (health centres and dispensaries). These findings are in agreement with a study conducted in Haiti in 2014.[39] The similarity of the findings of these studies might be due to the similar methodology used; both studies used data from the national representative sample collected by DHS program.

Therefore, the questionnaire used for the interviews were nearly similar. Also, Tanzania and Haiti share socio-economic determinants as these two countries are both LICs.

Furthermore, our results indicate that availability of parental administration of anticonvulsants (magnesium sulfate) is still a challenge and as a result, it compromises the provision of BEmONC in Tanzania particularly in public and lower-level health facilities. A similar finding has been reported in another low-resource setting.[40] Inadequate availability of this important component of BEmONC, might led to unnecessary delays to prevent or intervene pre-eclampsia/eclampsia that is one of the three leading causes of maternal morbidity and mortality.[41] Together with other suboptimal availability of parental administration of antibiotic, manual removal of placenta and retained products of conception suggesting that, despite the increased coverage of antenatal care, facility deliveries, and postnatal care, these efforts alone can not reduce MMR and NMR without improving the availability of BEmONC services.[42,43] The low availability of seven signal functions in the public and lower-level facilities in Tanzania is further impacted by the current long process of ordering and delivering of drugs and medical supplies through a system called Integrated Logistic System (ILS). With this system, facility places its order through District Medical Officer's (DMO) office to the Medical Department Store (MSD), a body that operates under Ministry of Health responsible for managing all the procurement and supply of medical items concerning public facilities.[44] Hence, any faults or delays in the ordering system may result in the low availability of items or services in the facilities. These delays will compromise efforts towards achieving targets set by the Tanzanian government that all hospitals and at least 70% of health centres and dispensaries be able to provide BEmONC services at the end of 2020.[22]

Facility readiness is an important aspect that demonstrates a facility's commitment to ensuring cumulative availability of components required to provide a specific service.[31] Our analysis identified the significant difference of BEmONC readiness according to the type of facility, in which higher-level facilities (hospitals) were found to have high readiness score compared to lower-level facilities (dispensaries/clinics). The suboptimal readiness observed in the lower-level facilities might be due to unclear formula on how to allocate funds in these facilities that may contribute to insufficiencies and inequities in the distribution of medical supplies.[44] The strengthening of the lower-level facilities which are usually located in the rural areas and serve about 75% of Tanzanian population is highly needed to address the increasing burden of maternal and neonatal deaths. The finding is in agreement with the previous study conducted in Kenya.[30]

Quality assurance is a process that aims to promote a high standard of the service provision within healthcare systems.[45] The results of this study show that facilities that performed quality assurance were more likely to be ready to provide BEmONC services compared to facilities not engaged in quality assurance activities. This might be due to the fact that, quality assurance involves continuous monitoring and persistent feedback to improve services offered.[46] Therefore, based on recommendations from quality assurance teams, these facilities are more likely to improve the availability of services that may result in their high readiness score. However, the uptake of quality improvement and quality assurance activities remains low within the Tanzanian health system as a small number of health facilities regular perform such activities.[47]

Each maternal or newborn death has a story to tell,[48] therefore, review of these deaths is widely recognized as a recommended tool to improve obstetric and neonatal care.[49] Our results

show that facilities which perform maternal and newborn death reviews were more likely to be ready to provide BEmONC services compared to facilities that did not perform these reviews. It may be that facilities that perform death reviews use that information to improve BEmONC service availability and readiness. Despite the maternal death reviews have been imposed over the past two decades as the national policy to improve the quality of BEmONC services the results show that majority of Tanzania health facilities do not regularly perform such kind of reviews.[50] Therefore, the number of facilities miss the opportunity of reflection and direct feedback to improve the BEmONC services.[51,52]

Also, clients' opinions are beneficial parameter for judging the availability and readiness of the facility to provide specific services. The results of this study indicate that facilities which review clients' opinion were more likely to be ready to provide BEmONC services. This might be explained by the fact that clients' opinions not only reflects the satisfaction with service received but also provide positive and negative feedback towards services provided by facility or health providers.[53] This feedback may be used to correct the shortcomings highlighted by patients, hence improve the availability of services that are important aspect to assess the readiness of the facility to provide services. However, we also found low number of health facilities that regularly collect and review clients' opinion regarding the provision of maternal and newborn services.

Despite on-the-job training creates an opportunity of healthcare providers to receive the up-to-date information and skills required to provide better healthcare.[33] The results of this study indicated a low proportion of health facilities with at least one staff member trained in providing delivery and newborn care services. This severe lack of trained staff together with shortage of health workers in health facilities reported in previous studies, may compromise the readiness of

the facilities to provide BEmONC in Tanzania.[54,55] Although, the Tanzanian government made several efforts to deal with shortage of human resources and othe challeges in the health system, yet its heath budgets over decades remained consistently below Abuja target of 15%.[55,56] This might explain the observed low readiness of the facilities to provide BEmONC and that the MMR remains high if inadequate budgets are allocated to improve maternal and child health services.

The strength of the current study is that it analyzed a nationally-representative sample of health facilities in Tanzania, providing key insight into the BEmONC availability and readiness in the LICs with higher MMR and NMR. It provides important information about the current situation regarding availability and readiness of facilities to provide BEmONC in a resource-constrained environment. Since TSPA survey employed complex sampling procedures, the estimates were adjusted for clustering effect and weighted to correct for non-response and disproportionate sampling. However, this study had some limitations, being a cross-sectional study, causal relationship could not be established. Therefore, the results should be interpreted with caution. Also, the study is subjected to misclassification bias due to the use of arbitrary cut-off point set at 50%; this might be misclassified readiness of health facilities to provide BEmONC services. Though, the effect of this bias has been minimized by inclusion of many indicators as suggested by WHO to assess the level of facility readiness.

In summary, the results of this study indicate disparities in the availability of seven signal functions and readiness to provide BEmONC services among health facilities in Tanzania. It also highlighted the gaps in the availability of important supportive items such as refresher training and clinical guidelines for the provision of BEmONC. To improve the quality of BEmONC services, there are key steps that government authorities might consider. These includes:- the

emphasis on quality assurance and quality improvement activities and implementation of regular maternal and newborn death audits. In order to improve BEmONC services, the health system leaders should implement strategies to better ensure fair distribution of clinical guidelines, essential medicines, equipment, and refresher training. Additional studies may be useful to ensure effective implementation of government policies to support the readiness of health facilities to provide BEmONC services.

Authors' contributions

DB conceptualized and designed the study, performed statistical analysis and wrote the first and revised draft of the manuscript. AE involved in the interpretation of data, revised and edited the manuscript. BCM provided advice on statistical analysis, interpretation of data, and edited the manuscript; All authors read and approved the final manuscript.

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Competing interest

None to declare.

Provenance and peer review

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A data sharing statement

The datasets generated during the current study are available from within the Demographic and Health Survey Program repository: http://dhsprogram.com/data/available-datasets.cfm

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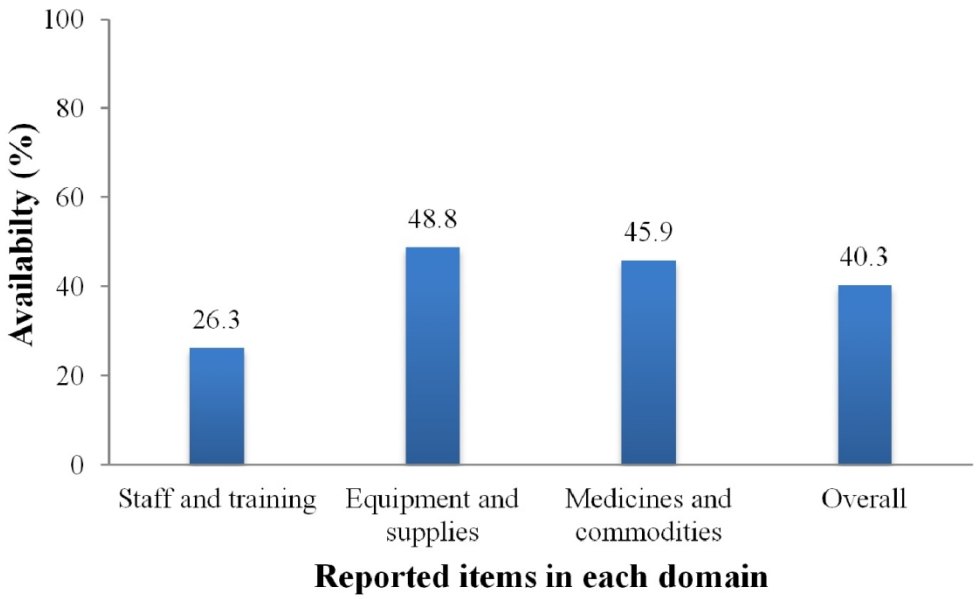
Figure titles/legend

Title; Figure 1 Percentage score of the three domains of readiness to provide Basic Emergency Obstetric and Newborn Care services

Title; Figure 2 Overall readiness score for providing Basic Emergency Obstetric and Newborn Care according to the type of facility and managing authority

Legend 2 Box shows the limits of 25 and 75% percentile. Horizontal line inside the box shows the median value. The bar shows the low and upper limits of 95% confidence interval. The dots show outliers



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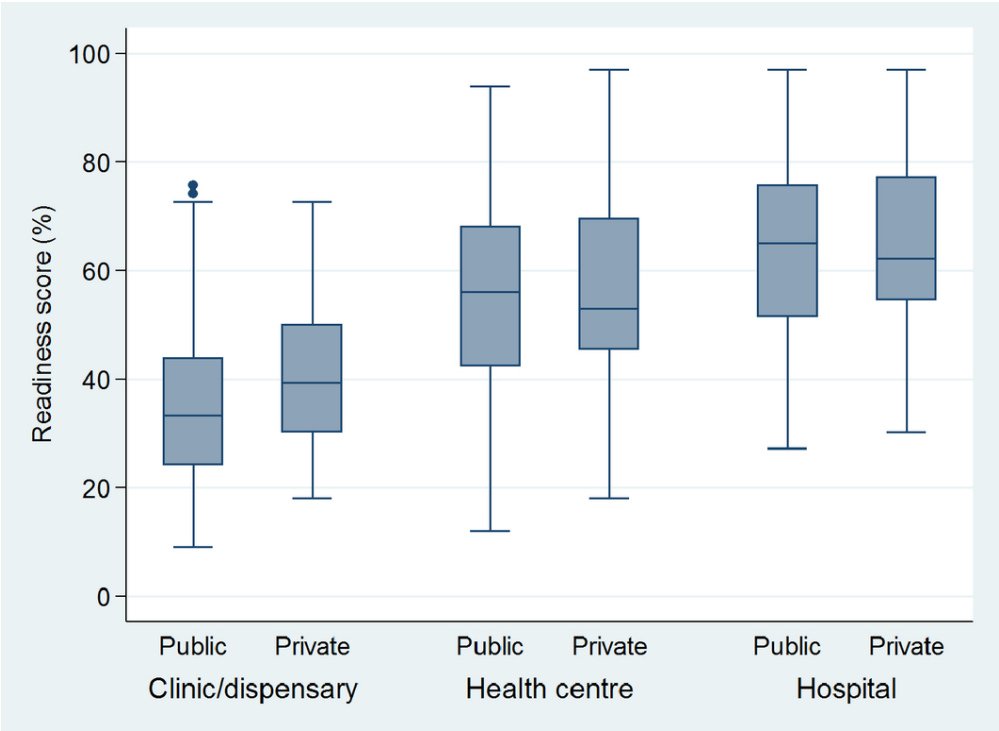

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

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	Page 1, and 2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Page 2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Page 5-6
Objectives	3	State specific objectives, including any prespecified hypotheses	Page 6
Methods			
Study design	4	Present key elements of study design early in the paper	Page 7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 7-8
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	Page 7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Page 8-10
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	Page 8-10
Bias	9	Describe any efforts to address potential sources of bias	Page 11-2
Study size	10	Explain how the study size was arrived at	Page 7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Page 11
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Page 11-2
		(*b*) Describe any methods used to examine subgroups and interactions	Page 11-2
		(*c*) Explain how missing data were addressed	N/A
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	Page 11
		(*e*) Describe any sensitivity analyses	N/A
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Page 12 and Table 1
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Page 12 and Table 1
		(b) Indicate number of participants with missing data for each variable of interest	N/A
Outcome data	15*	Report numbers of outcome events or summary measures	Page 14-8
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	Page 18 and Table 4
		(*b*) Report category boundaries when continuous variables were categorized	Table 1
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A
Discussion			
Key results	18	Summarise key results with reference to study objectives	Page 20-3
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	Page 24
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Page 24
Generalisability	21	Discuss the generalisability (external validity) of the study results	Page 24
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.