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BMJ Open

Emergency obstetric care provision in Southern Ethiopia: a facility-based survey

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2017-018459
Article Type:	Research
Date Submitted by the Author:	30-Jun-2017
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Primary Subject Heading:	Global health
Secondary Subject Heading:	Obstetrics and gynaecology
Keywords:	Emergency obstetric and neonatal care, quality of health care, maternal health services, health care facilities, manpower and services, maternal mortality

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Manuscripts

1 **Emergency obstetric care provision in Southern Ethiopia: a facility-based**

2 **survey**

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20

21 **Abstract**

22 **Objectives**: To assess the provision of basic emergency obstetric and newborn care, knowledge of

23 high-risk pregnancies and referral capacity at health centres in Southern Ethiopia.

24

25 **Design**: A facility-based survey, using an abbreviated version of the Averting Maternal Death and

26 Disability needs assessment tool for emergency obstetric and neonatal care. Modules included

27 infrastructure, staffing, number of deliveries, maternal and perinatal mortality, BEmONC signal

28 functions, referral capacity, and knowledge of risk factors in pregnancy.

29

30 **Setting**: Primary health care centres providing delivery services in the Eastern Gurage Zone, a

31 predominantly rural area in Southern Ethiopia.

32

33 **Participants**: All 20 health centres in the study area were selected for the assessment. One was

34 excluded, as no delivery services had been provided in the 12 months prior to the study.

35

36 **Results**: Thirteen out of 19 health centres met the recommended staffing norm. In the 12 months

37 prior to the survey, 10,004 ($\bar{X}$ = 527 ± 301) deliveries were attended to at the health centres, but

38 none had provided all seven BEmONC signal functions in the three months prior to the survey ($\bar{X}$ =

39 3.7 ± 1.2). Eight maternal and 32 perinatal deaths occurred. Most health centres had performed

40 administration of parenteral uterotonics (17/89.5%), manual removal of placenta (17/89.5%) and

41 neonatal resuscitation (17/89.5%), while few had performed assisted vaginal delivery (3/15.8%) or

42 administration of parenteral anticonvulsants (1/5.3%). Reasons mentioned for non-performance

43 were lack of patients with appropriate indications, lack of training, and supply problems. Health

44   workers mentioned on average 3.9 ± 1.4 of 13 risk factors for adverse pregnancy outcomes. Five

45   ambulances were available in the zone.

46

47   **Conclusion**: BEmONC provision is not guaranteed to women giving birth in health centres in Southern

48   Ethiopia. Since the government aims to increase facility deliveries, investments in capacity at health

49   centres are urgently needed.

50

51   **Keywords:** Emergency obstetric and neonatal care; quality of health care; maternal health services;

52   health care facilities; manpower and services; maternal mortality; neonatal mortality; Africa

53

54   **Strengths and limitations of this study**

55   ▪ **First BEmONC assessment in Ethiopia since 2008, using a validated Averting Maternal Death and**

56   **Disability tool**

57   ▪ **Wide range of modules assessed: infrastructure, staffing, number of deliveries, maternal and perinatal**

58   **mortality, BEmONC signal functions, referral capacity, and knowledge of risk factors in pregnancy**

59   ▪ **Survey including all of 20 health centres in Eastern Gurage Zone, Ethiopia**

60   **Background**

61   In 2015, 303,000 maternal deaths, 2.6 million stillbirths and 2.7 million early neonatal deaths were

62   estimated to have occurred worldwide, almost all in low-income countries (LICs) (1-3). Emergency

63   obstetric and newborn care (EmONC) is effective in treating obstetric complications and preventing

64   maternal and perinatal mortality and morbidity. However, availability and quality of EmONC was

65   found to be insufficient in most LICs (4).

66

67   Ethiopia's maternal mortality ratio (MMR) was 412 per 100,000 live births in 2016, a 39% reduction

68   compared to an MMR of 676 in 2011. Neonatal mortality rate showed a similar trend, with a

69   reduction of 22% from 37 to 29 per 1,000 live births (5,6). Although more women in Ethiopia gave

70   birth at a facility than ever before, its institutional birth rate of 26% in 2016 (versus 10% in 2011) still

71   ranked among the lowest in the world (5,7). Many interventions are aimed at further improving

72   women's access to maternity care, including expansion of the number of health facilities, distribution

73   of ambulances and introduction of Maternity Waiting Homes (MWHs) (8). Pregnant women at low

74   risk of complications are encouraged to stay at a MWH and deliver at a health centre, while those

75   with risk factors should be referred to hospital (9). Even if risk selection is successful, 20% of low-risk

76   pregnancies result in life-threatening complications requiring emergency treatment (10). Immediate

77   access to basic emergency obstetric care (BEmONC) should therefore be guaranteed at health

78   centres. In addition, a well-functioning referral system is essential to provide access to

79   comprehensive care.

80

81   Previous EmONC assessments in Ethiopia have shown that only 1 to 2% of health centres in 2008 and

82   2011 had provided all required life-saving services or "signal functions" (see Table 1) (11,12). This

83   study was undertaken at health centres in the Eastern Gurage Zone, Southern Ethiopia. In 2008,

84   there were three functioning health centres in this zone, where in total 369 births took place (13).

85

86   The objective of this study was to repeat a similar assessment of BEmONC signal functions, following

87   major public investments to upgrade service delivery. We also aimed to assess knowledge of health

88   workers regarding risk factors in pregnancy to assess feasibility of risk selection. Lastly, we aimed to

89   determine the zone's referral capacity to establish if women in need of comprehensive care have

90   appropriate access. Results from this study may help to further improve quality of BEmONC

91   throughout the region. If Ethiopia and other countries in sub-Saharan Africa are successful in

92   enhancing quality of BEmONC, women's utilization of these services may increase, and maternal and

93   neonatal mortality are likely to further decrease (14).

94

95   **Methods**

96   **Design and study area**

97   A cross-sectional survey was conducted at 20 health centres in the Eastern Gurage Zone, Ethiopia, in

98   March and April 2015.

99

100   **Setting**

101   The study took place in the Eastern Gurage Zone, a pre-dominantly rural and partly mountainous

102   area in the Southern Nations and Nationalities and Peoples Region in Ethiopia. In Ethiopia, a zone is a

103   mid-level administrative division of the country between region and district. The Eastern Gurage

104   Zone is made up of four districts. During the study period, the zone had an estimated population of

105   over 500,000 of whom nearly 119,000 were women in the reproductive age group (e-mail from Sahle

106   Kibru, Zonal Health Bureau Welkite (sahlekibru@yahoo.com) 2015 May 2 [cited 2017 June 29]. The

107   national Crude Birth Rate (CBR) was 31.8 births per 1,000 people; no regional data were available (5).

108   Ethiopia's health care system is three-tier, comprising of hospitals, health centres and health posts.

109   At the time of the study, there were two hospitals (one government and one faith-based), 20 health

110   centres and 119 health posts in the Eastern Gurage Zone. The hospitals had the option to refer to a

111   tertiary hospital located in the capital, Addis Ababa, a three-hour drive by ambulance.

112

113   The study took place in health centres. A health centre is a primary health care facility that serves a

114   population of up to 25,000 people. Staff working at a health centre include mid-level health-care

115   providers: health officers, midwives and nurses. The minimum recommended number of health

116   centres is 5 per 500,000 population; minimum staffing level at a health centre is one health officer

117   and two midwives. In addition to routine preventive and curative maternal and neonatal health

118   services, health centres are responsible for the provision of full BEmONC services (11).

119

120   **Study sites**

121   A total of 20 health centres were found in the Eastern Gurage Zone (an increase from three centres

122   just seven years earlier), which were all selected for the study. Health centres were included in the

123   survey if they had provided delivery services in the 12 months prior to our study. One health centre

124   was excluded as it had opened only one month prior to the site visit.

125

126   **Procedure**

127   A structured questionnaire was drafted using questions from the Averting Maternal Death and

128   Disability (AMDD) EmONC needs assessment tool, developed by Columbia University, New York, and

129   various partners of the United Nations (15). This extensively tested tool has proven successful in both

130   country-wide and regional assessments (16-18). The purpose of the tool is to determine the existing

131   capacity of health facilities to provide necessary life-saving care to pregnant women and neonates

132   when complications occur. Based on their performance in the three months prior to the survey,

133   facilities were either classified as non-EmONC facility (no signal functions performed), BEmONC

134   facility (first seven signal functions performed), or CEmONC facility (nine signal functions performed)

135   (Table 1). Facilities that performed between one and six signal functions were classified as 'partial-

136   BEmONC' facilities. In addition, modules were included on facility infrastructure and staffing. The

137 availability of a labour ward, number of beds for obstetric patients, number of delivery beds, and

138 availability of a Maternity Waiting Room or Home were checked through observation. Data on the

139 number of attended deliveries, maternal deaths, intra-uterine foetal deaths and early neonatal

140 deaths in the 12 months prior to the survey were obtained using the health centres' monthly reports

141 to the District Health Bureau, which are based on the health centres' labour ward registers.

142 Furthermore, specific questions were formulated with regard to knowledge of pregnancy-related risk

143 factors. Respondents were asked to spontaneously mention which women they would describe as

144 being at risk of complications. In addition, they were asked which pregnant women they would admit

145 to a MWH and which types of high-risk pregnancies they encounter most frequently. Respondents'

146 answers were recorded and coded using a multiple-response set of 14 options (antepartum

147 haemorrhage, hypertensive disorders, malpresentation, previous caesarean section, non-obstetric

148 medical problems, breech presentation, distance from the facility, grand multiparity, anaemia,

149 previous stillbirth, multiple pregnancy, polyhydramnios, previous obstetric fistula repair, and "other,

150 namely"). Multiple choice questions were avoided since these may be vulnerable to guessing and do

151 not test explicit knowledge. Lastly, a module was included on the facility's referral capacity. The

152 questionnaire was originally drafted in English and then translated in Amharic, the national language

153 of Ethiopia. It was then translated back into English to check for consistency. The questionnaire was

154 pilot-tested on three employees of Butajira General Hospital.

155

156 The data collection team consisted of the first author and an experienced data collector from Butajira

157 town. The data collector received additional training comprising the study objectives and methods,

158 maternal health related topics, interviewing skills and ethical aspects of the study.

159

160 **Data analysis**

161 Completed questionnaires were checked for completeness and consistency on site. Data were

162 entered into SPSS version 22 by the first author. Means and standard deviations were calculated for

163   continuous variables; frequencies and percentages for categorical variables. Simple linear regression

164   was calculated to determine the relationship between the number of performed signal functions

165   (dependent variable) and the number of attended deliveries (independent variable), using a 95%

166   confidence interval.

167

168   **Ethical approval and consent to participate**

169   Ethical approval was obtained from the Southern Nations Nationalities and People Regional State

170   Health Bureau in Hawassa, Ethiopia on February 4, 2014, with reference number 1-1/9466.

171   Additional written permission to conduct a health centre assessment in the Eastern Gurage Zone was

172   given by the Zonal Health Bureau in Welkite, Ethiopia. Written informed consent was obtained from

173   all respondents after explaining the purpose of the study, the importance of their contribution and

174   the right to refuse participation. Questionnaires were stored anonymously to ensure respondents'

175   confidentiality.

176

177   **Results**

178   Table 2 summarizes health centres' infrastructure and staffing. A total of 36 health officers, 41

179   midwives and 155 nurses were employed at the 19 health centres. Thirteen (68.4%) health centres

180   met the recommended staffing norm of one health officer and two midwives. In addition, at least

181   two nurses were working at each facility. 10,004 deliveries were attended to ($\bar{X}$ = 527 ± 301

182   deliveries), one to two deliveries per day per health centre on average. Nineteen intra-uterine fetal

183   deaths and 13 early neonatal deaths were registered, corresponding with a perinatal mortality rate

184   of 3.2 per 1,000 live births, as well as eight maternal deaths, corresponding with an MMR of 80 per

185   100,000 live births.

186

187   **Performance of BEmONC signal functions**

188 No health centre had performed all seven basic signal functions in the three months prior to the

189 survey, with a mean performance of 3.7 ± 1.2 signal functions. Results regarding provision of

190 BEmONC signal functions are found in Table 3 and Figure 1. In general, the most commonly cited

191 reason for not performing a signal function was 'lack of a patient with an appropriate indication'.

192 Health workers mentioned lack of training and supplies for not performing administration of

193 parenteral anticonvulsants (3/15.8% and 5/26.3% respectively) and for not performing assisted

194 vaginal delivery (6/31.6% and 8/41.1% respectively). The number of performed signal functions did

195 not correlate significantly with the number of attended deliveries (F (1, 17) = 2.297, p < 0.148, with

196 an R^2 of 0.119).

197

198 **Knowledge of risk factors for complications**

199 On average, 3.9 ± 1.4 risk factors for complications during labour or delivery were mentioned by

200 respondents (Figure 2). Two of the three risk factors mentioned most frequently were also said to be

201 the most commonly encountered: hypertensive disorders (8/42.1%) and antepartum haemorrhage

202 (6/31.6%). Distance from health facility (16/84.2%) and hypertensive disorders (13/68.4%) were

203 stated most often as indications for MWH admission. At eight health centres (42.1%), at least one

204 health worker ($\bar{X}$ = 2.0 ± 1.1) had received training on how to diagnose high-risk pregnancies. Of the

205 41 midwives, 11 (26.8%) had received training for this purpose.

206

207 **Referral capacity**

208 Eighteen (94.7%) health centres had referred high-risk pregnant and labouring women to a higher-

209 level facility. For referral purposes, staff used their own mobile phones, as only five (26.3%) had a

210 working land-line telephone and one (5.3%) facility owned a mobile phone. In total, five ambulances

211 were available for the Eastern Gurage Zone population. Two ambulances were stationed at health

212 centres, three were stationed at District Health Offices and shared between the other 17 health

213 centres. When ambulances were not available, nine (47.4%) health centres indicated using public

214   transport to transfer labouring women. The majority of health centres (10/52.6%) were difficult to

215   access as these were located in mountains or arid lowlands, accessible by unpaved roads only. The

216   mean distance to Butajira General Hospital, the referral hospital used by all health centres, was 18.1

217   ± 11.1 kilometres.

218

219   **Discussion**

220   In response to a very low proportion of facility births, the main strategy of the Ethiopian Ministry of

221   Health has been to scale up the number of health centres, as illustrated by a more than six-fold

222   increase in the number of such facilities in just seven years in this specific zone. Our study provides

223   insight into whether these facilities (are able to) provide life-saving BEmONC services. Moreover, our

224   study is the first facility-based BEmONC assessment in rural Ethiopia since the introduction of MWHs

225   aimed at enhancing uptake of facility-based birth care. Our results indicate that, although most

226   health centres provide such care on a daily basis, none could be classified as fully functional BEmONC

227   facilities. In addition, lack of knowledge about pregnancy-related risk factors among health workers

228   and a resource-constrained referral system prevent women from arriving at the appropriate level of

229   care in case they require CEmONC.

230

231   Compared to the 2008 national EmONC assessment, the number of health centers in the Eastern

232   Gurage Zone increased from three to twenty and the number of ambulances from one per eight

233   health centres to one per four (19). The number of professional health staff increased from 31 to

234   234, although the average staffing level per health centre remained the same. Women are

235   increasingly seeking facility-based birth care, since the average annual number of attended births per

236   health centre has increased by five times. The three health centres that were functional in 2008 did

237   not improve with regard to the number of performed signal functions (four to five). Overall

238   performance in the zone was low, with an average of 3.7 signal functions performed. Poorest

239   performance was found on administration of parenteral anticonvulsants and assisted vaginal

240 delivery. These findings are largely in line with earlier EmONC assessments in Ethiopia, the main

241 difference being that our surveyed health centres performed better on neonatal resuscitation

242 (11,12,20). The most frequently mentioned reason for non-performance was lack of patients with the

243 appropriate indication. However, no relationship was found between the number of attended

244 deliveries and the number of signal functions performed. Underperformance therefore likely also

245 reflects lack of knowledge and competence (or confidence) to recognize and treat complications.

246 Given the recent expansion of health facilities and health workers in Ethiopia, focus on quality of care

247 should now be urgently intensified. This is especially important since women are encouraged to stay

248 at MWHs at health centre level. If women are given the option stay at a MWH, immediate access to

249 emergency care must be guaranteed (10), both from a medical and an ethical perspective.

250

251 Health centre staff play a crucial role in risk selection, to ensure that women give birth at the right

252 level of care. Health workers are expected to select low-risk pregnant women for a two-week stay at

253 their MWH to await birth in close proximity to skilled care, and refer high-risk pregnant women to

254 stay at a MWH adjacent to hospital. Although respondents scored slightly higher than those in the

255 2008 assessment (3.9 risk factors mentioned compared to 3.4 in 2008), improving knowledge among

256 staff of risk during pregnancy and labour remains a key priority (13). Even if risk selection is

257 successful and full BEmONC services are provided, referral options are needed when women need

258 comprehensive care. Since 2012, the Ethiopian government has distributed one ambulance per

259 district, and two for larger districts. Utilization of these ambulances has reduced pregnancy-related

260 deaths (21,22). Our study area met the target number of one ambulance per district. We recommend

261 further expanding the number of ambulances in areas that are difficult to access, such as the Eastern

262 Gurage Zone.

263

264 Based on the national CBR of 31.8 per 1,000 people and an estimated population of 500,000, an

265 expected 15,900 deliveries occurred in one year in the Eastern Gurage Zone. This study reported

266 10,004 health centre births. Between 2011 and 2014, the average number of deliveries at Butajira

267 Hospital was 2,368 [Braat 2017, unpublished data]. This would correspond to an institutional delivery

268 rate in the zone of at least 78%, which is substantially higher than the reported 28% in the EDHS for

269 2016. Further research into this discrepancy is needed.

270

271 The WHO has indicated that one of the greatest challenges LICs face are implementation challenges

272 (23). We evaluated BEmONC provision, knowledge of high-risk pregnancies and referral options at all

273 health centres in one area in Ethiopia. By including multiple aspects of delivery care services,

274 stakeholders can take targeted action to improve quality of care on different levels within the

275 Eastern Gurage Zone.

276

277 A small-scale assessment such as this study is a time- and resource-efficient means to monitoring

278 progress throughout the wider region. It is unlikely that in similar facilities in other areas results

279 would be much different. However, our findings should be interpreted with caution because

280 interviews with health centre staff are vulnerable to recall bias, and the assessed health centres are

281 limited in number and to one zone only. Re-assessments should capture performance on the newly

282 proposed signal functions by Gabrysch et al, which were introduced following the growing consensus

283 that more focus is needed on routine care to prevent complications. These include the use of the

284 partograph, active management of third stage of labour, and infection prevention measures (24,25).

285 Checking (non-) availability of supplies, drugs and equipment would also provide a more

286 comprehensive understanding of EmONC performance and the challenges involved in providing

287 quality care.

288

289 **Conclusion**

290 It is important to hold regular systematic assessments of EmONC at health facilities to assess

291 availability of these essential lifesaving services to mothers and newborns. While most health centres

292   in our study area provided delivery services on a daily basis, none provided all BEmONC services. This

293   study shows that there is an urgent need to train health centre staff in the identification of high-risk

294   pregnancies and BEmONC, specifically on diagnosing and treating (pre-)eclampsia and performance

295   of assisted vaginal delivery. Women who are encouraged to give birth in a facility should be able to

296   give birth safely, attended by health centre staff knowledgeable and skilled to recognise high-risk

297   pregnancies and to provide BEmONC.

298

299   **Data sharing**

300   The data in support of the conclusions of this paper are included in the paper. Further information on

301   the survey and dataset can be requested from the authors.

302

303   **Competing interests**

304   The authors declare that no competing interests exist.

305

306   **Funding**

307   Laerdal Foundation (grant number 40171) supported this study as part of a PhD project of

308   investigator TV. Investigator FB received funding from VSO Ethiopia and Otto Kranendonck

309   Foundation for data collection.

310

311   **Authors' contributions**

312   MW, TV, FB, AM, AG and JS conceived and designed the study. MW led data collection. Data analysis

313   was done by MW and TV. FB, TvdA and JS helped interpret the data. MW and TV drafted a first

314   manuscript, which was then edited by all other authors. All authors read and approved the final

315   manuscript.

316

Acknowledgments

318   We wish to thank employees of the health centres and Butajira hospital for their cooperation in this

319   study.

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378 ability of health facilities to provide routine and emergency newborn care. PLoS Med 2012;9(11):e1001340.

379

380 **Table 1. Signal functions of basic and comprehensive emergency obstetric care services**

EmONC[a] signal functions	Health centres (BEmONC[b])	Hospitals (CEmONC[c])
Administration of parenteral antibiotics	✓	✓
Administration of parenteral uterotonics	✓	✓
Administration of parenteral anticonvulsants	✓	✓
Manual removal of placenta	✓	✓
Removal of retained products	✓	✓
Assisted vaginal delivery	✓	✓
Neonatal resuscitation with bag and mask	✓	✓
Blood transfusion		✓
Obstetric surgery		✓

381 [a] EmONC = emergency obstetric and neonatal care

382 [b] BEmONC = basic emergency obstetric and neonatal care

383 [c] CEmONC = comprehensive emergency obstetric and neonatal care

384

385 **Table 2. Infrastructure & staffing at health centres (N = 19)**

Available resources [a]	Health centres
Infrastructure	
Electricity	13 (68.4)
Running water	12 (63.2)
Labour ward	19 (100.0)
Postpartum room	19 (100.0)
Beds for obstetric patients	2.3 ± 2.1
Delivery coaches	2.7 ± 1.1
MWH [b] – available	9 (47.4)
MWH [b] – under construction	10 (52.6)

Available skilled providers	
Health officers	1.9 ± 2.0
Midwives	2.2 ± 1.3
Nurses	8.2 ± 3.9

386   [a] Values are given as number (percentage) or mean ± standard deviation

387   [b] MWH – maternity waiting home
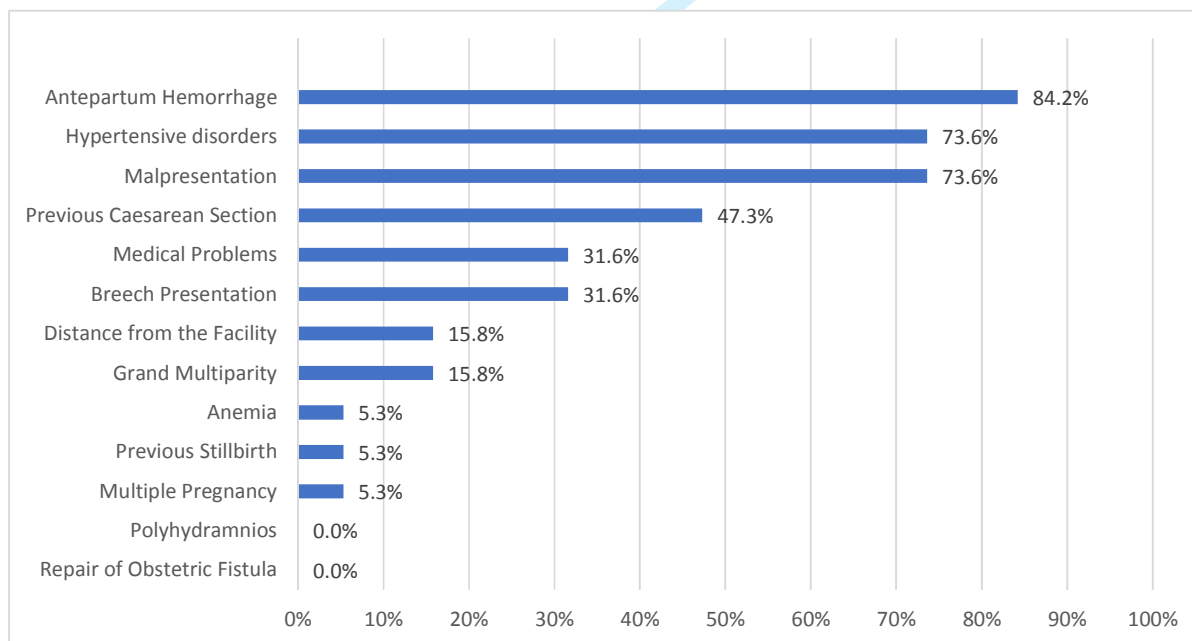
388

389   **Figure 1. Number of BEmONC[a] signal functions performed at health centres (N = 19)**
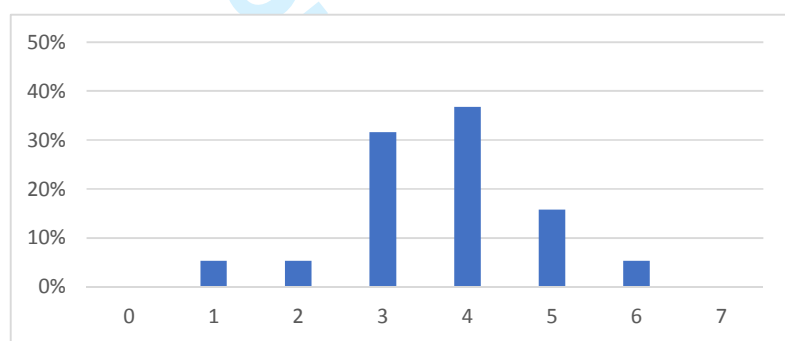
390   [a] BEmONC – basic emergency obstetric and neonatal care

391   **Figure 2. Knowledge at health centres regarding risk factors for high-risk pregnancies (N = 19)**

392

393

394

395 **Table 3. Performance of basic signal functions at health centres (N = 19)**

Performed signal functions in the last three months[a]	Health centres
Parenteral administration of antibiotics	8 (42.1)
Parenteral administration of uterotonics	17 (89.5)
Parenteral administration of anticonvulsants	1 (5.3)
Manual removal of placenta	17 (89.5)
Removal of retained products	7 (36.8)
Assisted vaginal delivery	3 (15.8)
Neonatal resuscitation with bag and mask	17 (89.5)

396 [a] Values are given as number (percentage)

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

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	n/a
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	8
		(*c*) Explain how missing data were addressed	n/a
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	n/a
		(*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	6
		(b) Give reasons for non-participation at each stage	6
		(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	6
		(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	5
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	8-10
		(*b*) Report category boundaries when continuous variables were categorized	n/a
		(*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	9
Discussion			
Key results	18	Summarise key results with reference to study objectives	10
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	12
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10-11
Generalisability	21	Discuss the generalisability (external validity) of the study results	12
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	13

*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.

Emergency obstetric care provision in Southern Ethiopia: a facility-based survey

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Manuscripts

1   **Emergency obstetric care provision in Southern Ethiopia: a facility-based**

2   **survey**

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20

21 **Abstract**

22 **Objectives**: To assess the provision of basic emergency obstetric and newborn care, knowledge of

23 high-risk pregnancies and referral capacity at health centres in Southern Ethiopia.

24

25 **Design**: A facility-based survey, using an abbreviated version of the Averting Maternal Death and

26 Disability needs assessment tool for emergency obstetric and neonatal care. Modules included

27 infrastructure, staffing, number of deliveries, maternal and perinatal mortality, BEmONC signal

28 functions, referral capacity, and knowledge of risk factors in pregnancy.

29

30 **Setting**: Primary health care centres providing delivery services in the Eastern Gurage Zone, a

31 predominantly rural area in Southern Ethiopia.

32

33 **Participants**: All 20 health centres in the study area were selected for the assessment. One was

34 excluded, as no delivery services had been provided in the 12 months prior to the study.

35

36 **Results**: Thirteen out of 19 health centres met the government's staffing norm. In the 12 months

37 prior to the survey, 10,004 ($\bar{X}$ = 527 ± 301) deliveries were attended to at the health centres, but

38 none had provided all seven BEmONC signal functions in the three months prior to the survey ($\bar{X}$ =

39 3.7 ± 1.2). Eight maternal and 32 perinatal deaths occurred. Most health centres had performed

40 administration of parenteral uterotonics (17/89.5%), manual removal of placenta (17/89.5%) and

41 neonatal resuscitation (17/89.5%), while few had performed assisted vaginal delivery (3/15.8%) or

42 administration of parenteral anticonvulsants (1/5.3%). Reasons mentioned for non-performance

43 were lack of patients with appropriate indications, lack of training, and supply problems. Health

44   workers mentioned on average 3.9 ± 1.4 of 13 risk factors for adverse pregnancy outcomes. Five

45   ambulances were available in the zone.

46

47   **Conclusion**: BEmONC provision is not guaranteed to women giving birth in health centres in Southern

48   Ethiopia. Since the government aims to increase facility deliveries, investments in capacity at health

49   centres are urgently needed.

50

51   **Keywords:** Emergency obstetric and neonatal care; quality of health care; maternal health services;

52   health care facilities; manpower and services; maternal mortality; neonatal mortality; Africa

53

54   **Strengths and limitations of this study**

55   ▪ **First BEmONC assessment in Ethiopia since 2008, using a validated Averting Maternal Death and**

56   **Disability tool**

57   ▪ **Wide range of modules assessed: infrastructure, staffing, number of deliveries, maternal and perinatal**

58   **mortality, BEmONC signal functions, referral capacity, and knowledge of risk factors in pregnancy**

59   ▪ **Survey including all of 20 health centres in Eastern Gurage Zone, Ethiopia**

60   ▪ **The number of health centres and area of study were relatively small**

61   ▪ **Methods include interviews with health centre staff, which is vulnerable to recall bias**

62 **Background**

63 In 2015, 303,000 maternal deaths, 2.6 million stillbirths and 2.7 million early neonatal deaths were

64 estimated to have occurred worldwide, almost all in low-income countries (LICs) (1-3). Emergency

65 obstetric and newborn care (EmONC) is effective in treating obstetric complications and preventing

66 maternal and perinatal mortality and morbidity. However, availability and quality of EmONC was

67 found to be insufficient in most LICs (4).

68

69 Ethiopia's maternal mortality ratio (MMR) was 412 per 100,000 live births in 2016, a 39% reduction

70 compared to an MMR of 676 in 2011. Neonatal mortality rate showed a similar trend, with a

71 reduction of 22% from 37 to 29 per 1,000 live births (5,6). Although more women in Ethiopia gave

72 birth at a facility than ever before, its institutional birth rate of 26% in 2016 (versus 10% in 2011) still

73 ranked among the lowest in the world (5,7). Many interventions are aimed at further improving

74 women's access to maternity care, including expansion of the number of health facilities, distribution

75 of ambulances and introduction of Maternity Waiting Homes (MWHs) (8). Pregnant women at low

76 risk of complications are encouraged to stay at a MWH and deliver at a health centre, while those

77 with risk factors should be referred to hospital (9). Even if risk selection is successful, 20% of low-risk

78 pregnancies result in life-threatening complications requiring emergency treatment (10). Immediate

79 access to basic emergency obstetric care (BEmONC) should therefore be guaranteed at health

80 centres. In addition, a well-functioning referral system is essential to provide access to

81 comprehensive care.

82

83 Previous EmONC assessments in Ethiopia have shown that only 1 to 2% of health centres in 2008 and

84 2011 had provided all required life-saving services or "signal functions" (see Table 1) (11,12). This

85 study was undertaken at health centres in the Eastern Gurage Zone, Southern Ethiopia. In 2008,

86 there were three functioning health centres in this zone, where in total 369 births took place (13).

87

88 The objective of this study was to assess progress of BEmONC signal function provision, following

89 major public investments to upgrade service delivery. We also aimed to assess knowledge of health

90 workers regarding risk factors in pregnancy to assess feasibility of risk selection. Lastly, we aimed to

91 determine the zone's referral capacity to establish if women in need of comprehensive care have

92 appropriate access. Results from this study may help to further improve quality of BEmONC

93 throughout the region. If Ethiopia and other countries in sub-Saharan Africa are successful in

94 enhancing quality of BEmONC, women's utilization of these services may increase, and maternal and

95 neonatal mortality are likely to further decrease (14).

96

97 **Methods**

98 **Design and study area**

99 A cross-sectional survey was conducted at 20 health centres in the Eastern Gurage Zone, Ethiopia, in

100 March and April 2015.

101

102 **Setting**

103 The study took place in the Eastern Gurage Zone, a pre-dominantly rural and partly mountainous

104 area in the Southern Nations and Nationalities and Peoples Region in Ethiopia. In Ethiopia, a zone is a

105 mid-level administrative division of the country between region and district. The Eastern Gurage

106 Zone is made up of four districts. During the study period, the zone had an estimated population of

107 over 500,000 of whom nearly 119,000 were women in the reproductive age group (e-mail from Sahle

108 Kibru, Zonal Health Bureau Welkite (sahlekibru@yahoo.com) 2015 May 2 [cited 2017 June 29]). The

109 national Crude Birth Rate was 31.8 births per 1,000 people; no regional data were available (5).

110 Ethiopia's health care system is three-tier, comprising tertiary level (specialized hospitals), secondary

111 level (general hospitals) and primary level (primary hospitals, health centres and health posts). At the

112 time of the study, there were two hospitals (one government and one faith-based), 20 health centres

113 and 119 health posts in the Eastern Gurage Zone. The hospitals had the option to refer to a tertiary

114 hospital located in the capital, Addis Ababa, a three-hour drive by ambulance.

115

116 The study took place in health centres. A health centre is a primary health care facility that serves a

117 population of up to 25,000 people. Staff working at a health centre include mid-level health-care

118 providers: health officers, midwives and nurses. The minimum staffing level at a health centre, set by

119 the government, is one health officer and two midwives. In addition to routine preventive and

120 curative maternal and neonatal health services, health centres are responsible for the provision of

121 full BEmONC services (11). Additionally, the WHO has set a minimum standard of five EmONC

122 facilities for a population of 500,000, including one that provides full comprehensive emergency

123 obstetric and newborn care (CEmONC) services (15)**.**

124

125 **Study sites**

126 A total of 20 health centres were found in the Eastern Gurage Zone (an increase from only three

127 centres just seven years earlier), which were all selected for the study. Health centres were included

128 in the survey if they had provided delivery services in the 12 months prior to our study. One health

129 centre was excluded as it had opened only one month prior to the site visit.

130

131 **Procedure**

132 A structured questionnaire was adapted from the Averting Maternal Death and Disability (AMDD)

133 EmONC needs assessment tool, developed by Columbia University, New York, and various partners of

134 the United Nations (16). This extensively tested tool has proven successful in both country-wide and

135 regional assessments (17-19). The purpose of the tool is to determine the existing capacity of health

136 facilities to provide necessary life-saving care to pregnant women and neonates when complications

137 occur. Our aim was to interview both the head of the health centre and the head of the maternity

138 ward. In all but one health centre both were present during the interview; at one health centre we

139 only interviewed the head of the maternity ward. Consequently, staff in all 19 health centres

140 responded to our survey. Based on their performance in the three months prior to the survey,

141 facilities were either classified as non-EmONC facility (no signal functions performed), BEmONC

142 facility (first seven signal functions performed), or CEmONC facility (nine signal functions performed)

143 (Table 1). Facilities that performed between one and six signal functions were classified as 'partial-

144 BEmONC' facilities. In addition, modules were included on facility infrastructure and staffing. The

145 availability of a labour ward, number of beds for obstetric patients, number of delivery beds, and

146 availability of a Maternity Waiting Room or Home were checked through observation. Data on the

147 number of attended deliveries, maternal deaths, intra-uterine foetal deaths and early neonatal

148 deaths in the 12 months prior to the survey were obtained using the health centres' monthly reports

149 to the District Health Bureau, which are based on the health centres' labour ward registers.

150 Furthermore, specific questions were formulated with regard to knowledge of pregnancy-related risk

151 factors. Respondents were asked to spontaneously mention which women they would describe as

152 being at risk of complications. In addition, they were asked which pregnant women they would admit

153 to a MWH and which types of high-risk pregnancies they encounter most frequently. Respondents'

154 answers were recorded and coded using a multiple-response set of 14 options (antepartum

155 haemorrhage, hypertensive disorders, malpresentation, previous caesarean section, non-obstetric

156 medical problems, breech presentation, distance from the facility, grand multiparity, anaemia,

157 previous stillbirth, multiple pregnancy, polyhydramnios, previous obstetric fistula repair, and "other,

158 namely"). Multiple choice questions were avoided since these may be vulnerable to guessing and do

159 not test explicit knowledge. Lastly, a module was included on the facility's referral capacity. The

160 questionnaire was originally drafted in English and then translated in Amharic, the national language

161 of Ethiopia. It was then translated back into English to check for consistency. The questionnaire was

162 pilot-tested on three employees of Butajira General Hospital.

163

164 The data collection team consisted of the first author and an experienced data collector from Butajira

165 town. The data collector received additional training comprising the study objectives and methods,

166 maternal health related topics, interviewing skills and ethical aspects of the study.

167

168 **Data analysis**

169 Completed questionnaires were checked for completeness and consistency on site. Data were

170 entered into SPSS version 22 by the first author. Means and standard deviations were calculated for

171 continuous variables; frequencies and percentages for categorical variables. Simple linear regression

172 was calculated to determine the relationship between the number of performed signal functions

173 (dependent variable) and the number of attended deliveries (independent variable), using a 95%

174 confidence interval.

175

176 **Ethical approval and consent to participate**

177 Ethical approval was obtained from the Southern Nations Nationalities and People Regional State

178 Health Bureau in Hawassa, Ethiopia on February 4, 2014, with reference number 1-1/9466.

179 Additional written permission to conduct a health centre assessment in the Eastern Gurage Zone was

180 given by the Zonal Health Bureau in Welkite, Ethiopia. Written informed consent was obtained from

181 all respondents after explaining the purpose of the study, the importance of their contribution and

182 the right to refuse participation. Questionnaires were stored anonymously to ensure respondents'

183 confidentiality.

184

185 **Results**

186 In total, 37 persons were interviewed. Eighteen were head of the health centre, of whom 17 were

187 male. Out of the other 19 respondents, 14 were midwives, three were nurses, one was a health

188 officer and one was designated as 'other'. Of these 19 respondents, 14 were female. The median age

189 of the heads of the health centre was 27.5 years and they had a median 45 months of professional

190 experience as a health worker. The other respondents had a median age of 24 years, while their

191 median professional experience was 24 months.

192

193 **Infrastructure and staffing**

194 Table 2 summarizes health centres' infrastructure and staffing. A total of 36 health officers, 41

195 midwives and 155 nurses were employed at the 19 health centres. Thirteen (68.4%) health centres

196 met the recommended staffing norm of one health officer and two midwives. In addition, at least

197 two nurses were working at each facility. 10,004 deliveries were attended to ($\bar{X}$ = 527 ± 301

198 deliveries), one to two deliveries per day per health centre on average. The number of deliveries

199 attended ranged between 88 and 1,086. Nineteen intra-uterine fetal deaths and 13 early neonatal

200 deaths were registered, corresponding with a perinatal mortality rate of 3.2 per 1,000 births, as well

201 as eight maternal deaths, corresponding with an MMR of 80 per 100,000 live births.

202

203 **Performance of BEmONC signal functions**

204 No health centre had performed all seven basic signal functions in the three months prior to the

205 survey, with a mean performance of 3.7 ± 1.2 signal functions. Results regarding provision of

206 BEmONC signal functions are found in Table 3 and Figure 1. In general, the most commonly cited

207 reason for not performing a signal function was 'lack of a patient with an appropriate indication'.

208 Health workers mentioned lack of training and supplies for not performing administration of

209 parenteral anticonvulsants (3/15.8% and 5/26.3% respectively) and for not performing assisted

210 vaginal delivery (6/31.6% and 8/41.1% respectively). The commonest reasons for not administering

211 antibiotics were 'lack of a patient with an appropriate indication' (10/90%) and lack of supplies

212 (3/27%). The number of performed signal functions did not correlate significantly with the number of

213 attended deliveries ($F_{(1, 17)}$ = 2.297, $p < 0.148$, with an R^2 of 0.119).

214

215   **Knowledge of risk factors for complications**

216   On average, 3.9 ± 1.4 risk factors for complications during labour or delivery were mentioned by

217   respondents (Figure 2). Two of the three risk factors mentioned most frequently were also said to be

218   the most commonly encountered: hypertensive disorders (8/42.1%) and antepartum haemorrhage

219   (6/31.6%). Distance from health facility (16/84.2%) and hypertensive disorders (13/68.4%) were

220   stated most often as indications for MWH admission. At eight health centres (42.1%), at least one

221   health worker ($\bar{X}$ = 2.0 ± 1.1) had received training on how to diagnose high-risk pregnancies. Of the

222   41 midwives, 11 (26.8%) had received training for this purpose.

223

224   **Referral capacity**

225   Eighteen (94.7%) health centres had referred high-risk pregnant and labouring women to a higher-

226   level facility. For referral purposes, staff used their own mobile phones, as only five (26.3%) had a

227   working land-line telephone and one (5.3%) facility owned a mobile phone. In total, five ambulances

228   were available for the Eastern Gurage Zone population. Two ambulances were stationed at health

229   centres, three were stationed at District Health Offices and shared among the other 17 health

230   centres. When ambulances were not available, nine (47.4%) health centres indicated using public

231   transport to transfer labouring women. The majority of health centres (10/52.6%) were difficult to

232   access as these were located in mountains or arid lowlands, accessible by unpaved roads only. The

233   median distance to Butajira General Hospital, the referral hospital used by all health centres, was

234   16.5 kilometres.

235

236   **Discussion**

237   In response to a very low proportion of facility births, the main strategy of the Ethiopian Ministry of

238   Health has been to scale up the number of health centres, as illustrated by a more than six-fold

239   increase in the number of such facilities in just seven years in this specific zone. Our study provides

240   insight into whether these facilities (are able to) provide life-saving BEmONC services. Moreover, our

241 study is the first facility-based BEmONC assessment in rural Ethiopia since the introduction of MWHs

242 aimed at enhancing uptake of facility-based birth care. Our results indicate that, although most

243 health centres provide delivery care on a daily basis, none could be classified as fully functional

244 BEmONC facilities. In addition, lack of knowledge about pregnancy-related risk factors among health

245 workers and a resource-constrained referral system prevent women from arriving at the appropriate

246 level of care in case they require CEmONC.

247

248 Compared to the 2008 national EmONC assessment, the number of health centers in the Eastern

249 Gurage Zone increased from three to twenty and the number of ambulances from one per eight

250 health centres to one per four (20). The number of professional health staff increased from 31 to

251 234, although the average staffing level per health centre remained the same. Women are

252 increasingly seeking facility-based birth care, since the average annual number of attended births per

253 health centre has increased by five times. The three health centres that were functional in 2008 did

254 not improve with regard to the number of performed signal functions (four to five). Overall

255 performance in the zone was low, with an average of 3.7 signal functions performed. Poorest

256 performance was found on administration of parenteral anticonvulsants and assisted vaginal

257 delivery. These findings are largely in line with earlier EmONC assessments in Ethiopia, the main

258 difference being that our surveyed health centres performed better on neonatal resuscitation

259 (11,12,21). Our findings also correlate with EmONC assessments in other countries. Between 2009

260 and 2011, 218 health facilities that were expected to provide BEmONC services were surveyed in six

261 countries with medium to high maternal mortality. Only five (2.3%) of the health facilities provided

262 all BEmONC services. In three countries, none of the surveyed health facilities provided full BEmONC

263 (22). The most frequently mentioned reason for non-performance was lack of patients with the

264 appropriate indication. However, no relationship was found between the number of attended

265 deliveries and the number of signal functions performed. Underperformance therefore likely also

266 reflects lack of knowledge and competence (or confidence) to recognize and treat complications.

267 Given the recent expansion of health facilities and health workers in Ethiopia, focus on quality of care

268 should now be urgently intensified. This is especially important since women are encouraged to stay

269 at MWHs at health centre level. If women are given the option stay at a MWH, immediate access to

270 emergency care must be guaranteed, both from a medical and an ethical perspective (10).

271

272 Health centre staff play a crucial role in risk selection, to ensure that women give birth at the right

273 level of care. Health workers are expected to select low-risk pregnant women for a two-week stay at

274 their MWH to await birth in close proximity to skilled care, and refer high-risk pregnant women to

275 stay at a MWH adjacent to hospital. Respondents in our survey scored worse on knowledge of high-

276 risk pregnancies than those in the 2008 assessment (3.9 risk factors out of 14 options compared to

277 3.4 risk factors out of 8 options). While the two surveys used different options and only three options

278 were exactly the same, our results show that improving knowledge among staff of risk during

279 pregnancy and labour is a key priority (13). Even if risk selection is successful and full BEmONC

280 services are provided, referral options are needed when women need comprehensive care. Since

281 2012, the Ethiopian government has distributed one ambulance per district, and two for larger

282 districts. Utilization of these ambulances has reduced pregnancy-related deaths (22,23). Our study

283 area met the target number of one ambulance per district. We recommend further expanding the

284 number of ambulances in areas that are difficult to access, such as the Eastern Gurage Zone.

285

286 Based on the national Crude Birth Ratio of 31.8 per 1,000 people and an estimated population of

287 500,000, an expected 15,900 deliveries occurred in one year in the Eastern Gurage Zone. This study

288 reported 10,004 health centre births. Between 2011 and 2014, the average number of deliveries at

289 Butajira Hospital was 2,368 [Braat 2017, unpublished data]. This would correspond to an institutional

290 delivery rate in the zone of at least 78%, which is substantially higher than the reported 26% in the

291 EDHS for 2016. Further research into this discrepancy is needed.

292

293   The WHO has indicated that one of the greatest challenges LICs face are implementation challenges

294   (24). We evaluated BEmONC provision, knowledge of high-risk pregnancies and referral options at all

295   health centres in one area in Ethiopia. By including multiple aspects of delivery care services,

296   stakeholders can take targeted action to improve quality of care on different levels within the

297   Eastern Gurage Zone.

298

299   A small-scale assessment such as this study is a time- and resource-efficient means to monitoring

300   progress throughout the wider region. It is unlikely that in similar facilities in other areas results

301   would be much different. However, our findings should be interpreted with caution because

302   interviews with health centre staff are vulnerable to recall bias, and the assessed health centres are

303   limited in number and to one zone only. It should also be noted that while we make comparisons

304   between our study and the 2008 EmONC assessment, the region we studied had only three

305   functioning health centres in 2008 compared to twenty health centres in 2015. The comparisons are

306   made between the twenty health centres we surveyed and a total of 650 health centers surveyed in

307   2008. This should be considered a limitation. However, the findings in our study are consistent with

308   other assessments done in Ethiopia and other low-income countries. We therefore think that our

309   findings can be extrapolated to other low-income countries with high maternal mortality rates. Re-

310   assessments should capture performance on the newly proposed signal functions by Gabrysch et al,

311   which were introduced following the growing consensus that more focus is needed on routine care

312   to prevent complications. These include the use of the partograph, active management of third stage

313   of labour, and infection prevention measures (25,26). Checking (non-) availability of supplies, drugs

314   and equipment would also provide a more comprehensive understanding of EmONC performance

315   and the challenges involved in providing quality care. Re-assessments should also include a more

316   thorough examination of the referral system. This study did not capture information about the

317   efficient use of ambulances and other resources, pre-referral treatment or timeliness of referrals.

318

Conclusion

319

320 It is important to hold regular systematic assessments of EmONC at health facilities to assess

321 availability of these essential lifesaving services to mothers and newborns. While most health centres

322 in our study area provided delivery services on a daily basis, none provided all BEmONC services. This

323 study shows that there is an urgent need to train health centre staff in the identification of high-risk

324 pregnancies and BEmONC, specifically on diagnosing and treating (pre-)eclampsia and performance

325 of assisted vaginal delivery. Women who are encouraged to give birth in a facility should be able to

326 give birth safely, attended by health centre staff knowledgeable and skilled to recognise high-risk

327 pregnancies and to provide BEmONC, and have access to emergency transport if more

328 comprehensive care is needed.

329

Data sharing

330

331 The data in support of the conclusions of this paper are included in the paper. Further information on

332 the survey and dataset can be requested from the authors.

333

Competing interests

334

335 The authors declare that no competing interests exist.

336

Funding

337

341

Authors' contributions

342

343 MW, TV, FB, AM, AG and JS conceived and designed the study. MW led data collection. Data analysis

344 was done by MW and TV. FB, TvdA and JS helped interpret the data. MW and TV drafted a first

345 manuscript, which was then edited by all other authors. All authors read and approved the final

346 manuscript.

347

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410

411 **Table 1. Signal functions of basic and comprehensive emergency obstetric care services**

EmONC[a] signal functions	Health centres (BEmONC[b])	Hospitals (CEmONC[c])
Administration of parenteral antibiotics	✓	✓
Administration of parenteral uterotonics	✓	✓
Administration of parenteral anticonvulsants	✓	✓
Manual removal of placenta	✓	✓
Removal of retained products	✓	✓
Assisted vaginal delivery	✓	✓
Neonatal resuscitation with bag and mask	✓	✓
Blood transfusion		✓
Obstetric surgery		✓

412 [a] EmONC = emergency obstetric and neonatal care

413 [b] BEmONC = basic emergency obstetric and neonatal care

414 [c] CEmONC = comprehensive emergency obstetric and neonatal care

415

416 **Table 2. Infrastructure & staffing at health centres (N = 19)**

Available resources [a]	Health centres
Infrastructure	
Electricity	13 (68.4)
Running water	12 (63.2)
Labour ward	19 (100.0)
Postpartum room	19 (100.0)
Beds for obstetric patients	2.3 ± 2.1
Delivery coaches	2.7 ± 1.1
MWH [b] – available	9 (47.4)
MWH [b] – under construction	10 (52.6)

Available skilled providers	
Health officers	1.9 ± 2.0
Midwives	2.2 ± 1.3
Nurses	8.2 ± 3.9

417   [a] Values are given as number (percentage) or mean ± standard deviation

418   [b] MWH – maternity waiting home

419

420   **Table 3. Performance of basic signal functions at health centres (N = 19)**

Performed signal functions in the last three months[a]	Health centres
Parenteral administration of antibiotics	8 (42.1)
Parenteral administration of uterotonics	17 (89.5)
Parenteral administration of anticonvulsants	1 (5.3)
Manual removal of placenta	17 (89.5)
Removal of retained products	7 (36.8)
Assisted vaginal delivery	3 (15.8)
Neonatal resuscitation with bag and mask	17 (89.5)

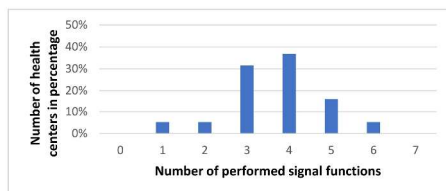421   [a] Values are given as number (percentage)

Figure 1. Number of BEmONCª signal functions performed at health centres (N = 19)

ª BEmONC – basic emergency obstetric and neonatal care

Figure 1. Number of BEmONCa signal functions performed at health centres (N = 19)
a BEmONC – basic emergency obstetric and neonatal care
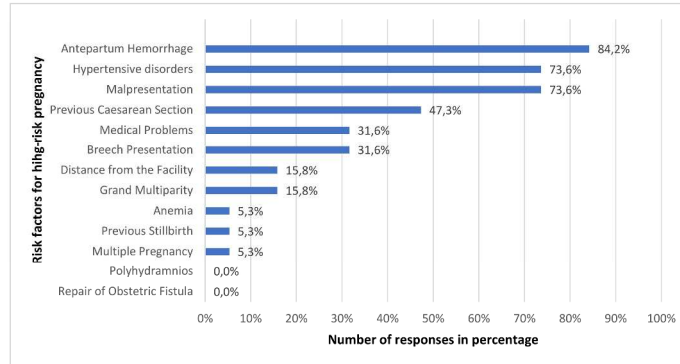
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Figure 2. Knowledge at health centres regarding risk factors for high-risk pregnancies (N = 19)

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

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	n/a
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	6-7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	8
		(*c*) Explain how missing data were addressed	n/a
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	n/a
		(*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	6
		(b) Give reasons for non-participation at each stage	6
		(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	6
		(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	5-6
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	8-10
		(*b*) Report category boundaries when continuous variables were categorized	n/a
		(*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	9
Discussion			
Key results	18	Summarise key results with reference to study objectives	10-12
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	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11, 13-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	13
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	14

*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

Emergency obstetric care provision in Southern Ethiopia: a facility-based survey

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Manuscripts

1 **Emergency obstetric care provision in Southern Ethiopia: a facility-based**

2 **survey**

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20

21 **Abstract**

22 **Objectives**: To assess the provision of basic emergency obstetric and newborn care, knowledge of

23 high-risk pregnancies and referral capacity at health centres in Southern Ethiopia.

24

25 **Design**: A facility-based survey, using an abbreviated version of the Averting Maternal Death and

26 Disability needs assessment tool for emergency obstetric and neonatal care. Modules included

27 infrastructure, staffing, number of deliveries, maternal and perinatal mortality, BEmONC signal

28 functions, referral capacity, and knowledge of risk factors in pregnancy.

29

30 **Setting**: Primary health care centres providing delivery services in the Eastern Gurage Zone, a

31 predominantly rural area in Southern Ethiopia.

32

33 **Participants**: All 20 health centres in the study area were selected for the assessment. One was

34 excluded, as no delivery services had been provided in the 12 months prior to the study.

35

36 **Results**: Three out of 19 health centres met the government's staffing norm. In the 12 months prior

37 to the survey, 10,004 ($\bar{X}$ = 527 ± 301) deliveries were attended to at the health centres, but none had

38 provided all seven BEmONC signal functions in the three months prior to the survey ($\bar{X}$ = 3.7 ± 1.2).

39 Eight maternal and 32 perinatal deaths occurred. Most health centres had performed administration

40 of parenteral uterotonics (17/89.5%), manual removal of placenta (17/89.5%) and neonatal

41 resuscitation (17/89.5%), while few had performed assisted vaginal delivery (3/15.8%) or

42 administration of parenteral anticonvulsants (1/5.3%). Reasons mentioned for non-performance

43 were lack of patients with appropriate indications, lack of training, and supply problems. Health

44   workers mentioned on average 3.9 ± 1.4 of 13 risk factors for adverse pregnancy outcomes. Five

45   ambulances were available in the zone.

46

47   **Conclusion**: BEmONC provision is not guaranteed to women giving birth in health centres in Southern

48   Ethiopia. Since the government aims to increase facility deliveries, investments in capacity at health

49   centres are urgently needed.

50

51   **Keywords:** Emergency obstetric and neonatal care; quality of health care; maternal health services;

52   health care facilities; manpower and services; maternal mortality; neonatal mortality; Africa

53

54   **Strengths and limitations of this study**

55   ▪   **First BEmONC assessment in Ethiopia since 2008, using a validated Averting Maternal Death and**

56   **Disability tool**

57   ▪   **Wide range of modules assessed: infrastructure, staffing, number of deliveries, maternal and perinatal**

58   **mortality, BEmONC signal functions, referral capacity, and knowledge of risk factors in pregnancy**

59   ▪   **Survey included all of 20 health centres in Eastern Gurage Zone, Ethiopia**

60   ▪   **The number of health centres and area of study were relatively small**

61   ▪   **Methods included interviews with health centre staff, which are vulnerable to recall bias**

62 **Background**

63 In 2015, 303,000 maternal deaths, 2.6 million stillbirths and 2.7 million early neonatal deaths were

64 estimated to have occurred worldwide, almost all in low-income countries (LICs) (1-3). Emergency

65 obstetric and newborn care (EmONC) is effective in treating obstetric complications and preventing

66 maternal and perinatal mortality and morbidity. However, availability and quality of EmONC was

67 found to be insufficient in most LICs (4).

68

69 Ethiopia's maternal mortality ratio (MMR) was 412 per 100,000 live births in 2016, a 39% reduction

70 compared to an MMR of 676 in 2011. Neonatal mortality rate showed a similar trend, with a

71 reduction of 22% from 37 to 29 per 1,000 live births (5,6). Although more women in Ethiopia gave

72 birth at a facility than ever before, its institutional birth rate of 26% in 2016 (versus 10% in 2011) still

73 ranked among the lowest in the world (5,7). Many interventions are aimed at further improving

74 women's access to maternity care, including expansion of the number of health facilities, distribution

75 of ambulances and introduction of Maternity Waiting Homes (MWHs) (8). Pregnant women at low

76 risk of complications are encouraged to stay at a MWH and deliver at a health centre, while those

77 with risk factors should be referred to hospital (9). Even if risk selection is successful, 20% of low-risk

78 pregnancies result in life-threatening complications requiring emergency treatment (10). Immediate

79 access to basic emergency obstetric care (BEmONC) should therefore be guaranteed at health

80 centres. In addition, a well-functioning referral system is essential to provide access to

81 comprehensive care.

82

83 Previous EmONC assessments in Ethiopia have shown that only 1 to 2% of health centres in 2008 and

84 2011 had provided all required life-saving services or "signal functions" (see Table 1) (11,12). This

85 study was undertaken at health centres in the Eastern Gurage Zone, Southern Ethiopia. In 2008,

86 there were three functioning health centres in this zone, where in total 369 births took place (13).

87

88 The objective of this study was to assess progress of BEmONC signal function provision, following

89 major public investments to upgrade service delivery. We also aimed to assess knowledge of health

90 workers regarding risk factors in pregnancy to assess feasibility of risk selection. Lastly, we aimed to

91 determine the zone's referral capacity to establish if women in need of comprehensive care have

92 appropriate access. Results from this study may help to further improve quality of BEmONC

93 throughout the region. If Ethiopia and other countries in sub-Saharan Africa are successful in

94 enhancing quality of BEmONC, women's utilization of these services may increase, and maternal and

95 neonatal mortality are likely to further decrease (14).

96

97 **Methods**

98 **Design and study area**

99 A cross-sectional survey was conducted at 20 health centres in the Eastern Gurage Zone, Ethiopia, in

100 March and April 2015.

101

102 **Setting**

103 The study took place in the Eastern Gurage Zone, a pre-dominantly rural and partly mountainous

104 area in the Southern Nations and Nationalities and Peoples Region in Ethiopia. In Ethiopia, a zone is a

105 mid-level administrative division of the country between region and district. The Eastern Gurage

106 Zone is made up of four districts. During the study period, the zone had an estimated population of

107 over 500,000 of whom nearly 119,000 were women in the reproductive age group (e-mail from Sahle

108 Kibru, Zonal Health Bureau Welkite (sahlekibru@yahoo.com) 2015 May 2 [cited 2017 June 29]). The

109 national Crude Birth Rate was 31.8 births per 1,000 people; no regional data were available (5).

110 Ethiopia's health care system is three-tier, comprising tertiary level (specialized hospitals), secondary

111 level (general hospitals) and primary level (primary hospitals, health centres and health posts). At the

112 time of the study, there were two hospitals (one government and one faith-based), 20 health centres

113 and 119 health posts in the Eastern Gurage Zone. The hospitals had the option to refer to a tertiary

114 hospital located in the capital, Addis Ababa, a three-hour drive by ambulance.

115

116 The study took place in health centres. A health centre is a primary health care facility that serves a

117 population of up to 25,000 people. Staff working at a health centre include mid-level health-care

118 providers: health officers, midwives and nurses. The minimum staffing level at a health centre, set by

119 the Ethiopian Standard Agency, is two health officers, three midwives and five nurses, alongside

120 specialized supporting personnel (e.g. laboratory and pharmacy technicians) (15). In addition to

121 routine preventive and curative maternal and neonatal health services, health centres are

122 responsible for the provision of full BEmONC services (11). Additionally, the WHO has set a minimum

123 standard of five EmONC facilities for a population of 500,000, including one that provides full

124 comprehensive emergency obstetric and newborn care (CEmONC) services (16).

125

126 **Study sites**

127 A total of 20 health centres were found in the Eastern Gurage Zone, which were all selected for the

128 study. Health centres were included in the survey if they had provided delivery services in the 12

129 months prior to our study. One health centre was excluded as it had opened only one month prior to

130 the site visit.

131

132 **Procedure**

133 A structured questionnaire was adapted from the Averting Maternal Death and Disability (AMDD)

134 EmONC needs assessment tool, developed by Columbia University, New York, and various partners of

135 the United Nations (17). This extensively tested tool has proven successful in both country-wide and

136 regional assessments (18-20). The purpose of the tool is to determine the existing capacity of health

137 facilities to provide necessary life-saving care to pregnant women and neonates when complications

138   occur. Our aim was to interview both the head of the health centre and the head of the maternity

139   ward. In all but one health centre both were present during the interview; at one health centre we

140   only interviewed the head of the maternity ward. Consequently, staff in all 19 health centres

141   responded to our survey. Based on their performance in the three months prior to the survey,

142   facilities were either classified as non-EmONC facility (no signal functions performed), BEmONC

143   facility (first seven signal functions performed), or CEmONC facility (nine signal functions performed)

144   (Table 1). Facilities that performed between one and six signal functions were classified as 'partial-

145   BEmONC' facilities. In addition, modules were included on facility infrastructure and staffing. The

146   availability of a labour ward, number of beds for obstetric patients, number of delivery beds, and

147   availability of a Maternity Waiting Room or Home were checked through observation. We recorded

148   the number of medical doctors, health officers, midwives and nurses at each facility. Data on the

149   number of attended deliveries, maternal deaths, intra-uterine foetal deaths and early neonatal

150   deaths in the 12 months prior to the survey were obtained using the health centres' monthly reports

151   to the District Health Bureau, which are based on the health centres' labour ward registers.

152   Furthermore, specific questions were formulated with regard to knowledge of pregnancy-related risk

153   factors. Respondents were asked to spontaneously mention which women they would describe as

154   being at risk of complications. In addition, they were asked which pregnant women they would admit

155   to a MWH and which types of high-risk pregnancies they encounter most frequently. Respondents'

156   answers were recorded and coded using a multiple-response set of 11 options (antepartum

157   haemorrhage, hypertensive disorders, malpresentation, previous caesarean section, non-obstetric

158   medical problems, breech presentation, distance from the facility, grand multiparity, anaemia,

159   previous stillbirth and multiple pregnancy). Multiple choice questions were avoided since these may

160   be vulnerable to guessing and do not test explicit knowledge. Lastly, a module was included on the

161   facility's referral capacity. The questionnaire was originally drafted in English and then translated in

162   Amharic, the national language of Ethiopia. It was then translated back into English to check for

163   consistency. The questionnaire was pilot-tested on three employees of Butajira General Hospital.

164

165 The data collection team consisted of the first author and an experienced data collector from Butajira

166 town. The data collector received additional training comprising the study objectives and methods,

167 maternal health related topics, interviewing skills and ethical aspects of the study.

168

169 **Data analysis**

170 Completed questionnaires were checked for completeness and consistency on site. Data were

171 entered into SPSS version 22 by the first author. Means and standard deviations were calculated for

172 continuous variables; frequencies and percentages for categorical variables. Simple linear regression

173 was calculated to determine the relationship between the number of performed signal functions

174 (dependent variable) and the number of attended deliveries (independent variable), using a 95%

175 confidence interval.

176

177 **Ethical approval and consent to participate**

178 Ethical approval was obtained from the Southern Nations Nationalities and People Regional State

179 Health Bureau in Hawassa, Ethiopia on February 4, 2014, with reference number 1-1/9466.

180 Additional written permission to conduct a health centre assessment in the Eastern Gurage Zone was

181 given by the Zonal Health Bureau in Welkite, Ethiopia. Written informed consent was obtained from

182 all respondents after explaining the purpose of the study, the importance of their contribution and

183 the right to refuse participation. Questionnaires were stored anonymously to ensure respondents'

184 confidentiality.

185

186 **Results**

187 In total, 37 persons were interviewed. Eighteen were head of the health centre, of whom 17 were

188 male. Out of the other 19 respondents, 14 were midwives, three were nurses, one was a health

189   officer and one was designated as 'other'. Of these 19 respondents, 14 were female. The median age

190   of the heads of the health centre was 27.5 years and they had a median 45 months of professional

191   experience as a health worker. The other respondents had a median age of 24 years, while their

192   median professional experience was 24 months.

193

194   **Infrastructure and staffing**

195   Table 2 summarizes health centres' infrastructure and staffing. A total of 36 health officers, 41

196   midwives and 155 nurses were employed at the 19 health centres. Only three (15.7%) health centres

197   met the recommended staffing norm of two health officers, three midwives and five nurses. Ten

198   thousand and four deliveries were attended to ($\bar{X}$ = 527 ± 301 deliveries), one to two deliveries per

199   day per health centre on average. The number of deliveries attended ranged between 88 and 1,086.

200   Nineteen intra-uterine fetal deaths and 13 early neonatal deaths were registered, corresponding to

201   an institutional perinatal mortality rate of 3.2 per 1,000 births, as well as eight maternal deaths,

202   corresponding to an institutional MMR of 80 per 100,000 live births.

203

204   **Performance of BEmONC signal functions**

205   No health centre had performed all seven basic signal functions in the three months prior to the

206   survey, with a mean performance of 3.7 ± 1.2 signal functions. Results regarding provision of

207   BEmONC signal functions are found in Table 3 and Figure 1. In general, the most commonly cited

208   reason for not performing a signal function was 'lack of a patient with an appropriate indication'.

209   Health workers mentioned lack of training and supplies for not performing administration of

210   parenteral anticonvulsants (3/15.8% and 5/26.3% respectively) and for not performing assisted

211   vaginal delivery (6/31.6% and 8/41.1% respectively). The commonest reasons for not administering

212   antibiotics were 'lack of a patient with an appropriate indication' (10/90%) and lack of supplies

213   (3/27%). The number of performed signal functions did not correlate significantly with the number of

214   attended deliveries (F (1, 17) = 2.297, p < 0.148, with an R^2 of 0.119).

215

Knowledge of risk factors for complications

217 On average, 3.9 ± 1.4 risk factors for complications during labour or delivery were mentioned by

218 respondents (Figure 2). Two of the three risk factors mentioned most frequently were also said to be

219 the most commonly encountered: hypertensive disorders (8/42.1%) and antepartum haemorrhage

220 (6/31.6%). Distance from health facility (16/84.2%) and hypertensive disorders (13/68.4%) were

221 stated most often as indications for MWH admission. At eight health centres (42.1%), at least one

222 health worker ($\bar{X} = 2.0 \pm 1.1$) had received training on how to diagnose high-risk pregnancies. Of the

223 41 midwives, 11 (26.8%) had received training for this purpose.

224

Referral capacity

226 Eighteen (94.7%) health centres had referred high-risk pregnant and labouring women to a higher-

227 level facility. For referral purposes, staff used their own mobile phones, as only five (26.3%) had a

228 working land-line telephone and one (5.3%) facility owned a mobile phone. In total, five ambulances

229 were available for the Eastern Gurage Zone population. Two ambulances were stationed at health

230 centres, three were stationed at District Health Offices and shared among the other 17 health

231 centres. When ambulances were not available, nine (47.4%) health centres indicated using public

232 transport to transfer labouring women. The majority of health centres (10/52.6%) were difficult to

233 access as these were located in mountains or arid lowlands, accessible by unpaved roads only. The

234 median distance to Butajira General Hospital, the referral hospital used by all health centres, was

235 16.5 kilometres.

236

Discussion

238 In response to a very low proportion of facility births, the main strategy of the Ethiopian Ministry of

239 Health has been to scale up the number of health centres, as illustrated by a more than six-fold

240 increase in the number of such facilities in just seven years in this specific zone. Our study provides

241   insight into whether these facilities (are able to) provide life-saving BEmONC services. Moreover, our

242   study is the first facility-based BEmONC assessment in rural Ethiopia since the introduction of MWHs

243   aimed at enhancing uptake of facility-based birth care. Our results indicate that, although most

244   health centres provide delivery care on a daily basis, none could be classified as fully functional

245   BEmONC facilities. In addition, lack of knowledge about pregnancy-related risk factors among health

246   workers and a resource-constrained referral system prevent women from arriving at the appropriate

247   level of care in case they require CEmONC.

248

249   Compared to the 2008 national EmONC assessment, the number of health centers in the Eastern

250   Gurage Zone increased from three to twenty and the number of ambulances from one per eight

251   health centres to one per four (13). The number of professional health staff also increased, from 31

252   to 234. However, the average staffing level per health centre remained the same and most health

253   centres did not meet the 2012 staffing norms (15). Women are increasingly seeking facility-based

254   birth care, since the average annual number of attended births per health centre has increased by

255   five times. The three health centres that were functional in 2008 did not improve with regard to the

256   number of performed signal functions (four to five). Overall performance in the zone was low, with

257   an average of 3.7 signal functions performed. Poorest performance was found on administration of

258   parenteral anticonvulsants and assisted vaginal delivery. These findings are largely in line with earlier

259   EmONC assessments in Ethiopia, the main difference being that our surveyed health centres

260   performed better on neonatal resuscitation (11,12,21). Our findings also correlate with EmONC

261   assessments in other countries. Between 2009 and 2011, 218 health facilities that were expected to

262   provide BEmONC services were surveyed in six countries with medium to high maternal mortality.

263   Only five (2.3%) of the health facilities provided all BEmONC services. In three countries, none of the

264   surveyed health facilities provided full BEmONC (22). In this study, the most frequently mentioned

265   reason for non-performance was lack of patients with the appropriate indication. However, no

266   relationship was found between the number of attended deliveries and the number of signal

267 functions performed. Underperformance therefore likely also reflects lack of knowledge and

268 competence (or confidence) to recognize and treat complications. Given the recent expansion of

269 health facilities and health workers in Ethiopia, focus on quality of care should now be urgently

270 intensified. This is especially important since women are encouraged to stay at MWHs at health

271 centre level. If women are given the option to stay at a MWH, immediate access to emergency care

272 must be guaranteed, both from a medical and an ethical perspective (10).

273

274 Health centre staff play a crucial role in risk selection, to ensure that women give birth at the right

275 level of care. Health workers are expected to select low-risk pregnant women for a two-week stay at

276 their MWH to await birth in close proximity to skilled care, and refer high-risk pregnant women to

277 stay at a MWH adjacent to hospital. Respondents in our survey scored worse on knowledge of high-

278 risk pregnancies than those in the 2008 assessment (3.9 risk factors out of 14 options compared to

279 3.4 risk factors out of 8 options). While the two surveys used different options and only three options

280 were exactly the same, our results show that improving knowledge among staff of risk during

281 pregnancy and labour is a key priority (13). Even if risk selection is successful and full BEmONC

282 services are provided, referral options are needed when women need comprehensive care. Since

283 2012, the Ethiopian government has distributed one ambulance per district, and two for larger

284 districts. Utilization of these ambulances has reduced pregnancy-related deaths (23,24). Our study

285 area met the target number of one ambulance per district. We recommend further expanding the

286 number of ambulances in areas that are difficult to access, such as the Eastern Gurage Zone.

287

288 Based on the national Crude Birth Ratio of 31.8 per 1,000 people and an estimated population of

289 500,000, an expected 15,900 deliveries occurred in one year in the Eastern Gurage Zone. This study

290 reported 10,004 health centre births. Between 2011 and 2014, the average number of deliveries at

291 Butajira Hospital was 2,368 [Braat 2017, unpublished data]. This would correspond to an institutional

292   delivery rate in the zone of at least 78%, which is substantially higher than the reported 26% in the

293   EDHS for 2016. Further research into this discrepancy is needed.

294

295   The WHO has indicated that one of the greatest challenges LICs face are implementation challenges

296   (25). We evaluated BEmONC provision, knowledge of high-risk pregnancies and referral options at all

297   health centres in one area in Ethiopia. By including multiple aspects of delivery care services,

298   stakeholders can take targeted action to improve quality of care on different levels within the

299   Eastern Gurage Zone.

300

301   A small-scale assessment such as this study is a time- and resource-efficient means to monitoring

302   progress throughout the wider region. It is unlikely that in similar facilities in other areas results

303   would be much different. However, our findings should be interpreted with caution because

304   interviews with health centre staff are vulnerable to recall bias, and the assessed health centres are

305   limited in number and to one zone only. It should also be noted that while we make comparisons

306   between our study and the 2008 EmONC assessment, the region we studied had only three

307   functioning health centres in 2008 compared to twenty health centres in 2015. The comparisons are

308   made between the twenty health centres we surveyed and a total of 650 health centers surveyed in

309   2008. This should be considered a limitation. However, the findings in our study are consistent with

310   other assessments done in Ethiopia and other low-income countries. We therefore think that our

311   findings can be extrapolated to other low-income countries with high maternal mortality rates. Re-

312   assessments should capture performance on the newly proposed signal functions by Gabrysch et al,

313   which were introduced following the growing consensus that more focus is needed on routine care

314   to prevent complications. These include the use of the partograph, active management of third stage

315   of labour, and infection prevention measures (26,27). Checking (non-) availability of supplies, drugs

316   and equipment would also provide a more comprehensive understanding of EmONC performance

317   and the challenges involved in providing quality care. Re-assessments should also include a more

318 thorough examination of the referral system. This study did not capture information about the

319 efficient use of ambulances and other resources, pre-referral treatment or timeliness of referrals.

320

Conclusion

321

322 Conducting regular systematic assessments of EmONC at health facilities is important in order to

323 evaluate the availability of essential lifesaving services to mothers and newborns. While most health

324 centres in our study area provided delivery services on a daily basis, none provided all BEmONC

325 services. This study shows that there is an urgent need to train health centre staff in the

326 identification of high-risk pregnancies and BEmONC, specifically on diagnosing and treating (pre-

327)eclampsia and performance of assisted vaginal delivery. Women who are encouraged to give birth in

328 a facility should be able to give birth safely, attended by health centre staff knowledgeable and

329 skilled to recognise high-risk pregnancies and to provide BEmONC, and have access to emergency

330 transport if more comprehensive care is needed.

331

Data sharing

332

333 The data in support of the conclusions of this paper are included in the paper. Further information on

334 the survey and dataset can be requested from the authors.

335

Competing interests

336

337 The authors declare that no competing interests exist.

338

Funding

339

343

Authors' contributions

345 MW, TV, FB, AM, AG and JS conceived and designed the study. MW led data collection. Data analysis

346 was done by MW and TV. FB, TvdA and JS helped interpret the data. MW and TV drafted a first

347 manuscript, which was then edited by all other authors. All authors read and approved the final

348 manuscript.

349

Acknowledgments

351 We wish to thank employees of the health centres and Butajira hospital for their cooperation in this

352 study.

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413

414   **Table 1. Signal functions of basic and comprehensive emergency obstetric care services**

EmONC[a] signal functions	Health centres (BEmONC[b])	Hospitals (CEmONC[c])
Administration of parenteral antibiotics	✔	✔
Administration of parenteral uterotonics	✔	✔
Administration of parenteral anticonvulsants	✔	✔
Manual removal of placenta	✔	✔
Removal of retained products	✔	✔
Assisted vaginal delivery	✔	✔
Neonatal resuscitation with bag and mask	✔	✔
Blood transfusion		✔
Obstetric surgery		✔

415   [a] EmONC = emergency obstetric and neonatal care

416   [b] BEmONC = basic emergency obstetric and neonatal care

417   [c] CEmONC = comprehensive emergency obstetric and neonatal care

418

419   **Table 2. Infrastructure & staffing at health centres (N = 19)**

Available resources [a]	Health centres
Infrastructure	
Electricity	13 (68.4)
Running water	12 (63.2)
Labour ward	19 (100.0)
Postpartum room	19 (100.0)
Beds for obstetric patients	2.3 ± 2.1
Delivery couches	2.7 ± 1.1
MWH [b] – available	9 (47.4)
MWH [b] – under construction	10 (52.6)

Available skilled providers (mean)	
Health officers	1.9 ± 2.0
Midwives	2.2 ± 1.3
Nurses	8.2 ± 3.9

420   [a] Values are given as number (percentage) or mean ± standard deviation

421   [b] MWH – maternity waiting home

422

423   **Table 3. Performance of basic signal functions at health centres (N = 19)**

Performed signal functions in the last three months[a]	Health centres
Parenteral administration of antibiotics	8 (42.1)
Parenteral administration of uterotonics	17 (89.5)
Parenteral administration of anticonvulsants	1 (5.3)
Manual removal of placenta	17 (89.5)
Removal of retained products	7 (36.8)
Assisted vaginal delivery	3 (15.8)
Neonatal resuscitation with bag and mask	17 (89.5)

424   [a] Values are given as number (percentage)

425

426   **Figure 1. Number of BEmONC[a] signal functions performd at health centres (N = 19)**

427   [a] BEmONC – basic emergency obstetric and neonatal care

428

429   **Figure 2. Knowledge at health centres regarding risk factors for high-risk pregnancies (N = 19)**

Figure 1. Number of BEmONCᵃ signal functions performed at health centres (N = 19)

ᵃ BEmONC – basic emergency obstetric and neonatal care

Figure 1. Number of BEmONCa signal functions performed at health centres (N = 19)
a BEmONC – basic emergency obstetric and neonatal care

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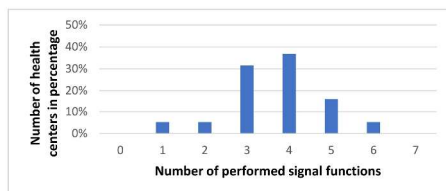41
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Figure 2. Knowledge at health centres regarding risk factors for high-risk pregnancies (N = 19)
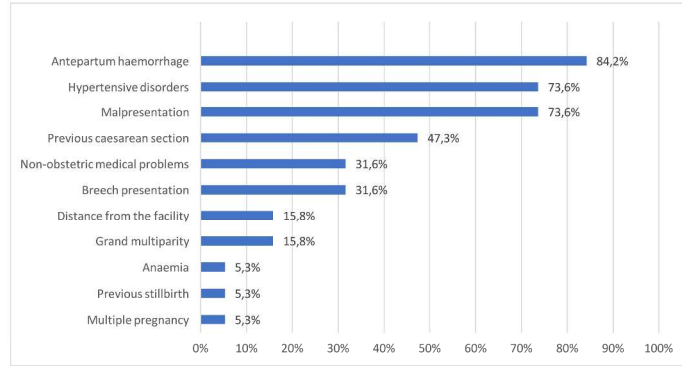
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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	n/a
Bias	9	Describe any efforts to address potential sources of bias	*7*
Study size	10	Explain how the study size was arrived at	6-7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	8
		(*c*) Explain how missing data were addressed	n/a
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	n/a
		(*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	6
		(b) Give reasons for non-participation at each stage	6
		(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	6
		(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	5-6
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	8-10
		(*b*) Report category boundaries when continuous variables were categorized	n/a
		(*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	9
Discussion			
Key results	18	Summarise key results with reference to study objectives	10-12
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	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11, 13-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	13
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	14

*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.