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AVERTING MATERNAL DEATH AND DISABILITY

Availability and distribution of, and geographic access to emergency obstetric care in Zambia

Sabine Gabrysch^{a,*}, Virginia Simushi^b, Oona M.R. Campbell^c^a Institute of Public Health, University of Heidelberg, Heidelberg, Germany^b Ministry of Health, Lusaka, Zambia^c London School of Hygiene and Tropical Medicine, London, UK

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ABSTRACT

Objective: To assess the availability and coverage of emergency obstetric care (EmOC) services in Zambia. **Methods:** Reported provision of EmOC signal functions in the Zambian Health Facility Census and additional criteria on staffing, opening hours, and referral capacity were used to classify all Zambian health facilities as providing comprehensive EmOC, basic EmOC, or more limited care. Geographic accessibility of EmOC services was estimated by linking health facility data with data from the Zambian population census. **Results:** Few Zambian health facilities provided all basic EmOC signal functions and had qualified health professionals available on a 24-hour basis. Of the 1131 Zambian delivery facilities, 135 (12%) were classified as providing EmOC. Zambia nearly met the UN EmOC density benchmarks nationally, but EmOC facilities and health professionals were unevenly distributed between provinces. Geographic access to EmOC services in rural areas was low; in most provinces, less than 25% of the population lived within 15 km of an EmOC facility. **Conclusion:** A national Health Facility Census with geographic information is a valuable tool for assessing service availability and coverage at national and subnational levels. Simultaneously assessing health worker density and geographic access adds crucial information.

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1. Introduction

Without functioning and accessible emergency obstetric care (EmOC) services to treat the complications that kill women in pregnancy, childbirth, and the postpartum, no country can expect maternal mortality to decline significantly. The 1997 UN Guidelines for Monitoring the Availability and Use of Obstetric Services and the 2009 UN handbook for monitoring EmOC [1,2] promote 6 process indicators for assessing EmOC availability and, to some degree, EmOC performance.

The first 2 indicators address availability and coverage of EmOC facilities. The UN handbook suggests that there should be at least 5 EmOC facilities per 500 000 population (or 20 000 births), of which at least 1 should be a comprehensive EmOC (CEmOC) facility, for the national level (indicator 1), and for all subnational areas to ensure equitable geographic distribution (indicator 2) [2].

Reviews of the UN process indicators and their application show that monitoring the geographic distribution of EmOC facilities has been neglected [3,4]. Studies have not always sampled sufficient facilities to provide reliable subnational estimates, and so far few have had geographic information on the location of facilities. An assessment in 2006 found that “[l]acking the technology (digital maps,

geographic information systems), most projects have difficulty in assessing and expressing this important indicator of equity” [3].

As in most other Sub-Saharan African countries, maternal mortality in Zambia remains high. According to the newest UN estimates, the maternal mortality ratio is 470 maternal deaths per 100 000 live births (uncertainty range, 250–680) [5], without much change over recent decades. Challenges to reducing maternal mortality in Zambia include a critical shortage of health professionals [6,7] and a low population density.

Knowledge of the availability and geographic distribution of EmOC services is, therefore, a valuable decision-making tool for policy-makers in Zambia. The 2005 Zambian Health Facility Census (HFC) provides most of the necessary data because it collected information on geographic location, staffing, and service provision of almost all Zambian health facilities, thus enabling subnational disaggregation at any level desired. Used in combination with the population census, population coverage of services can be estimated. Although such a general HFC does not enable as detailed a verification of service provision as an EmOC needs assessment, using existing HFC data for EmOC assessments is very resource efficient.

The present study assessed the first 2 EmOC process indicators for Zambia. In particular, it described the following nationally and for the 9 provinces of Zambia: which EmOC functions were available in hospitals and health centers; how the density of EmOC facilities compared with UN benchmarks; how health professionals were

* Corresponding author at: Institute of Public Health, Im Neuenheimer Feld 324, 69120 Heidelberg, Germany. Tel.: +49 6221 56 5086; fax: +49 6221 56 5948.

E-mail address: sabine.gabrysch@uni-heidelberg.de (S. Gabrysch).

distributed; and what proportion of the population had adequate geographic access to an EmOC facility.

2. Methods

The HFC [8], developed by the Japan International Cooperation Agency (JICA), is a national-level assessment of the functionality of health system assets, providing extensive information usable for health system planning. There is no sampling; instead, information is collected on every facility. Data include the precise location (using GPS), availability, and condition of physical infrastructure and equipment, availability of services, and head counts of health workers.

The Zambian HFC 2005 [9] was carried out by the Zambian Ministry of Health, with support from JICA, and covered all public and semi-public (e.g. mission and nongovernmental organization) facilities in the country, as well as some larger private for-profit facilities. Functionality in terms of EmOC was assessed using reported capacity to perform 8 EmOC signal functions: injectable antibiotics; injectable oxytocics; injectable anticonvulsants; manual removal of placenta; manual removal of retained products; assisted vaginal delivery; cesarean delivery; and blood transfusion.

The literature on EmOC generally uses actual performance of these signal functions in the previous 3 months [2], but this was not ascertained in the Zambian HFC. Because reported theoretic capability overestimates actual functioning [1,10] and because there were no data on use in the past 3 months, criteria were added to the EmOC classification on opening hours, staffing, electricity availability, and referral capacity.

Two main levels of care were defined corresponding typically to hospitals and health centers: CEmOC services include provision of all 8 signal functions; and basic EmOC (BEmOC) services include the first 6 [1]. We also allowed for the signal function of assisted vaginal delivery, using either forceps or vacuum extractor, to be absent because it has been considered misleading to discount facilities as EmOC if they lack this signal function—which is not always routinely taught and performed [11]. These facilities are referred to as “BEmOC-1” or “CEmOC-1” [4,11]. Two further levels of care were defined for facilities not providing EmOC but some useful services, termed BEmOC-2 and BEmOC-4 (lacking 2 or 4 unspecified basic signal functions, respectively) [4].

Table 1 presents the criteria for determining the EmOC functioning levels of the 90 hospitals, 990 health centers, and 50 health posts nationwide that were recorded as offering delivery care in the HFC dataset.

To study health workers, we considered all professional cadres with the potential to conduct deliveries who were registered at facilities providing delivery care—namely, doctors, clinical officers, nurses, and midwives. In the Zambian HFC, nurse and midwife numbers were aggregated in a single category and could not be distinguished. However, there was information on 24-hour presence and on-call availability of midwives/doctors and other staff with midwifery skills.

The latest decennial Zambian Census of Population and Housing was conducted in 2000 by the Central Statistical Office [12]. The census contains population numbers down to ward level, with geographic data on administrative boundaries (provinces, districts, constituencies, and wards). It also provides figures of annual population growth rates by district, calculated by projecting growth between 1990 and 2000; thus, projected mid-year population figures can be calculated for the years following the census. The information on fertility, including crude birth rates for each province, enables numbers of births to be estimated.

In rural Zambia, motorized transport is owned by only 1% of households [13], and public transport is scarce. Thus, geographic accessibility was estimated as the proportion of the population within 15 km of services—to conform to the UN benchmark of 3 hours of travel time [2], assuming a walking speed of 5 km per hour. We mapped health facilities and ward areas in the geographic information system platform ArcGIS 9.2 (Esri, Redlands, CA, USA) and created circles of 15-km radius around each delivery facility and around EmOC facilities to calculate the proportion of total area covered. Assuming an even spatial distribution of the population, the proportion within 15 km of services was calculated.

3. Results

The 2005 HFC collected facility information on 1421 health facilities in Zambia; sufficient data were available to enable EmOC classification for 1370. Of these, 1131 were recorded as offering delivery services: 21 second- and third-level hospitals; 69 first-level hospitals; 117 urban health centers; 873 rural health centers; and 50 health posts (1 facility lacked information on facility type).

3.1. EmOC functioning of health facilities

Nearly all of the 90 hospitals had the capacity to provide the EmOC signal functions, although only 65 (72%) offered all 8 functions simultaneously. Fewer hospitals fulfilled the additional staffing

Table 1
EmOC classification of Zambian health facilities, Zambian Health Facility Census 2005.

Facility functioning level (No.)	Signal functions ^a	24-hour service every day	Staffing ^b	Referral
CEmOC (30)	All 8 functions (+ electricity)	Midwife/doctor present 24 hours	≥ 3 doctors registered; ≥ 1 doctor on duty	Not required
CEmOC-1 (24)	All 8 or all except assisted vaginal delivery (+ electricity)	Midwife/doctor present or on call 24 hours	≥ 2 doctors registered; ≥ 1 doctor on duty	Not required
BEmOC (42)	All 6 basic functions	Midwife/doctor present 24 hours	≥ 3 health professionals registered; ≥ 1 health professional on duty	Offer referral ^c , provide vehicle for referral ^d
BEmOC-1 (39)	All 6 basic or all except assisted vaginal delivery	Midwife/doctor present or on call 24 hours	≥ 3 health professionals registered; ≥ 1 health professional on duty	Offer referral ^c , provide vehicle ^d , or have communication tool
BEmOC-2 (155)	At least 4 functions	Midwife/doctor present or on call 24 hours	≥ 2 health professionals registered; ≥ 1 health professional on duty	Offer referral ^c , provide vehicle ^d , or have communication tool
BEmOC-4 (375)	At least 2 functions	Any health professional with midwifery skills present or on call 24 hours	≥ 1 health professional on duty	Offer referral ^c , provide vehicle ^d , or have communication tool
Substandard delivery service (466)	No functions required	No opening hours required	No staff required	No referral vehicle or communication tool required

Abbreviations: BEmOC, basic EmOC; CEmOC, comprehensive EmOC; EmOC, emergency obstetric care.

^a Six basic signal functions: injectable antibiotics; injectable anticonvulsants; injectable oxytocics; manual removal of placenta; manual removal of retained products; assisted vaginal delivery. Two comprehensive signal functions: cesarean delivery; blood transfusion.

^b Health professional: doctor; nurse; midwife; clinical officer. Registered: recorded as working in the facility. On duty: present at day of visit.

^c Not required if CEmOC functions available.

^d Not required if next door to a facility with CEmOC functions.

Table 2
Percentage of Zambian hospitals with delivery services offering certain EmOC functions, Zambian Health Facility Census 2005.

Functions	Hospitals, % (n = 90)
Injectable antibiotics	98
Injectable oxytocics	97
Injectable anticonvulsants	97
Manual removal of placenta	97
Removal of retained products	98
Assisted vaginal delivery	91
Cesarean delivery	80
Blood transfusion	87
All 8 signal functions	72
Electricity	96
Doctor/midwife on call 24/7	96
At least 2 doctors registered	64
At least 1 doctor on duty at visit	83
All of the above except assisted vaginal delivery (CEmOC-1)	59
Doctor/midwife present 24/7	73
At least 3 doctors registered	42
All of the above (CEmOC)	33

Abbreviations: CEmOC, comprehensive EmOC; EmOC, emergency obstetric care.

criteria; therefore, only 53 hospitals (59%) were classified as offering at least CEmOC-1 and 30 (33%) as offering full CEmOC (Table 2).

Table 3 shows the percentages of health centers and posts providing the basic signal functions and fulfilling additional criteria—for Zambia as a whole and disaggregated by province. Few lower-level facilities fulfilled EmOC criteria (Fig. 1).

Only 135 (12%) of the 1131 delivery facilities were classified as being at least BEmOC-1, and the vast majority of facilities offered very limited or substandard services: 155 (14%) were classified as BEmOC-2; 375 (33%) as BEmOC-4; and 466 (41%) as substandard (i.e. did not fulfill even BEmOC-4 criteria) (Table 1).

3.2. EmOC facility density

Table 4 compares the number of EmOC facilities with benchmarks in the UN guidelines and handbook [1,2]; Zambia nationally exceeded the number required to meet the benchmark of 1 CEmOC facility per

Table 3
Percentage of Zambian health centers and posts with delivery services offering certain EmOC functions, Zambian Health Facility Census 2005.

Functions	Zambia, % (n = 1040)	Copperbelt, % (n = 102)	Central Province, % (n = 98)	Eastern Province, % (n = 147)	Luapula, % (n = 107)	Lusaka, % (n = 57)	Northwestern Province, % (n = 99)	Northern Province, % (n = 138)	Southern Province, % (n = 172)	Western Province, % (n = 120)
Injectable antibiotics	75	80	79	67	73	55	81	76	82	69
Injectable oxytocics	61	79	60	58	64	56	67	53	54	63
Injectable anticonvulsants	45	60	46	50	45	49	32	45	49	25
Manual removal of placenta	71	72	81	63	74	69	66	82	68	70
Removal of retained products	58	36	75	47	67	47	49	61	56	82
Assisted vaginal delivery	42	38	57	54	47	38	42	39	39	24
All of the above except assisted vaginal delivery (5 basic functions)	18	18	28	12	24	15	13	17	18	18
All of the above (6 basic functions)	11	14	21	9	16	5	7	10	13	6
Doctor/midwife on call 24/7	43	73	52	46	17	56	21	48	54	19
At least 2 health professionals registered	51	84	64	51	36	77	32	40	59	25
At least 3 health professionals registered	28	63	37	23	11	61	15	22	33	10
At least 1 health professional on duty at visit	83	97	91	90	72	91	76	81	87	66
Vehicle provided for referral or working communication tool	74	73	80	90	43	67	60	87	75	79
All of the above except assisted vaginal delivery (BEmOC-1)	5	12	10	3	4	14	2	5	4	2
Doctor/midwife present 24/7	32	67	16	39	13	44	11	38	45	13
Vehicle for referral	50	60	42	83	34	37	54	52	54	17
All of the above (BEmOC)	3	11	2	3	1	5	0	1	3	1

Abbreviations: BEmOC, basic EmOC; EmOC, emergency obstetric care.

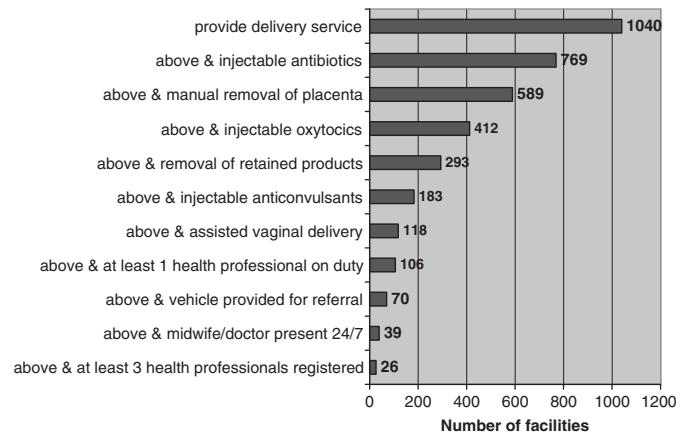


Fig. 1. Cumulative presence of basic emergency obstetric care (BEmOC) functions in Zambian health centers and posts with delivery services, Zambian Health Facility Census 2005. Availability of the most commonly provided BEmOC function is shown first, availability of the next most common function, in addition to the first function, is shown beneath, the next most common function is added beneath, and so forth. In total, 118 facilities (11%) provided all 6 BEmOC functions, and 26 facilities (2.5%) also fulfilled the additional criteria.

20 000 births and was very close to meeting the benchmark of 5 EmOC facilities per 20 000 births (exceeding it using the less strict EmOC-1 criteria). There were differences between provinces—Copperbelt exceeded the EmOC benchmark, whereas some other provinces fell short.

Applying the more stringent benchmarks of the WHO World Health Report (WHR) 2005 [14]—at least 2 EmOC facilities, of which 1 is a CEmOC facility, per 3600 births—provides a different picture, with none of the provinces meeting the benchmark and only Copperbelt coming close.

3.3. Health professionals

According to the HFC, there were 883 doctors, 7288 nurses/midwives, and 941 clinical officers registered as working in delivery

Table 4Number of EmOC facilities in Zambia compared with UN benchmark requirements ^a, Zambian Health Facility Census 2005 and Zambia Census of Population and Housing 2000.

Province	Population (2005)	Births (2005)	EmOC benchmark	EmOC facilities	EmOC(−1) ^b facilities	CEmOC benchmark	CEmOC facilities	CEmOC(−1) ^c facilities
Zambia	11 207 123	403 984	101	96	135	20.2	30	54
Central	1 176 770	43 541	11	9	19	2.2	2	5
Copperbelt	1 640 517	45 935	11	24	26	2.3	8	12
Eastern	1 489 102	61 054	15	11	12	3.1	2	3
Luapula	905 019	38 009	10	7	10	1.9	2	4
Lusaka	1 649 337	47 830	12	6	12	2.4	2	3
Northern	1 473 378	58 936	15	9	15	2.9	2	6
Northwestern	671 469	26 188	7	8	11	1.3	2	7
Southern	1 359 452	53 019	13	14	19	2.7	8	9
Western	842 079	29 472	7	8	11	1.5	2	5

Abbreviations: BEmOC, basic EmOC; CEmOC, comprehensive EmOC; EmOC, emergency obstetric care.

^a Benchmarks according to UN guidelines [2]: EmOC benchmark, 5 EmOC facilities per 20 000 births; CEmOC benchmark, 1 CEmOC facility per 20 000 births.^b EmOC(−1): EmOC or EmOC-1 (i.e. BEmOC-1 or better).^c CEmOC(−1): CEmOC or CEmOC-1.

facilities. Only one-third of facilities employed more than 2 health professionals and only 42% of hospitals employed more than 2 doctors (Table 5). Thus, most delivery facilities were not staffed sufficiently to provide EmOC 24 hours every day, assuming that at least 3 health professionals on 8-hour shifts are needed for 24/7 coverage.

Comparing the number of health professionals with the benchmarks suggested in the WHR 2005 [14] shows that, overall, Zambia had more than twice the minimum number of doctors but that most of them worked in Lusaka and Copperbelt Provinces, whereas Luapula, Northern, Central, and Eastern Provinces fell short of the benchmark of 3 doctors per 3600 births (Table 6). Further disaggregation by district shows that the distribution of doctors was highly unequal

within provinces (Fig. 2). Some districts had more than 20 doctors per 3600 births, whereas others employed few or no doctors.

It is more difficult to judge how Zambia performed in terms of midwives because the HFC did not count this cadre separately and information is lacking on how many nurses and clinical officers were skilled in delivery care. The total number of nurses, midwives, and clinical officers was far in excess of the suggested benchmark, again with unequal distribution between provinces (Table 6).

3.4. Geographic access

Nationally, 86% of the Zambian population was within 15 km of a facility offering any type of delivery care, and 48% lived within 15 km of an EmOC facility.

More than 70% of the urban Zambian population in all provinces (4.15 million in 2005) lived within 15 km of EmOC services. Although most of the rural population (7.06 million in 2005) was within reasonable distance of delivery care, access to EmOC in rural areas was poor. In most provinces, less than 30% of the rural population lived within 15 km of an EmOC facility.

Table 5Distribution of total health professionals registered in all delivery facilities and of doctors registered in hospitals with delivery service in Zambia, Zambian Health Facility Census 2005.^a

Total health professionals ^b	Delivery facilities	Doctors	Hospitals
0	130 (12)	0	12 (12)
1	378 (34)	1	20 (22)
2	232 (21)	2	20 (22)
3–4	125 (11)	3–4	18 (20)
5–10	99 (9)	5–10	10 (11)
>10	159 (14)	>10	10 (11)
Total	1122 (100) ^c	Total	90 (100)

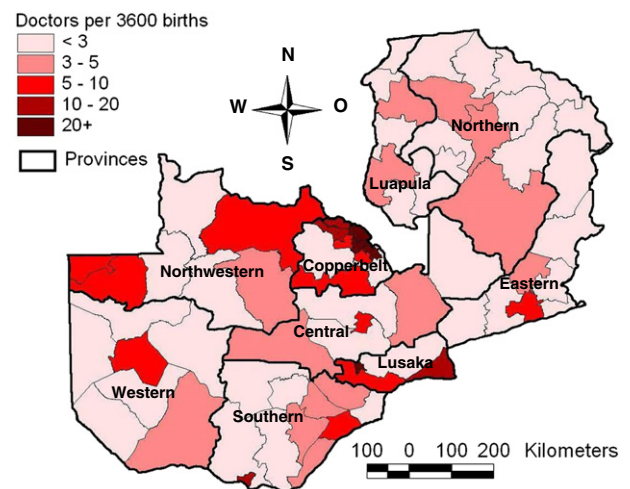
^a Values are given as number or number (percentage).^b Doctors, nurses/midwives, and clinical officers.^c Human resource information was missing for 9 delivery facilities.**Table 6**Number of health professionals in Zambia compared with World Health Report 2005 benchmarks ^a, Zambian Health Facility Census 2005.

Province	Births (2005)	Doctor benchmark	Doctors registered	Midwife benchmark	Nurses, midwives, clinical officers registered
Zambia	403 984	337	883	2244	8229
Central	43 541	36	23	241	723
Copperbelt	45 935	38	216	255	2025
Eastern	61 054	51	41	339	879
Luapula	38 009	32	21	211	365
Lusaka	47 830	40	430	265	1546
Northern	58 936	49	31	327	615
Northwestern	26 188	22	35	145	372
Southern	53 019	44	61	295	1251
Western	29 472	25	25	164	453

^a Benchmarks according to World Health Report 2005: 3 doctors and 20 midwives per 3600 births [20].

4. Discussion

The present study showed that EmOC availability and coverage can be readily assessed from existing HFC data at national and subnational

**Fig. 2.** Doctors registered per 3600 births in Zambian districts, against the World Health Report 2005 benchmark of 3 doctors per 3600 births [20], Zambian Health Facility Census 2005.

level. It was found that, although only a small proportion of Zambian health facilities provided all EmOC signal functions and had qualified health professionals available 24/7, Zambia nationally nearly met the UN guidelines' EmOC density benchmarks (but not the WHR 2005 benchmarks). This raises some concerns about the consistency and meaningfulness of these benchmarks [15]. There were large differences in EmOC density among provinces, and even bigger differences in doctor density. Analysis of geographic access to EmOC showed that only a small percentage of the rural population was within 15 km of EmOC services.

It is crucial to disaggregate subnationally when monitoring the number of EmOC facilities, although we are less sure that we agree with the UN guidelines, which suggest that, for "areas smaller than the country as a whole," "the smaller the better" [1]. Already at provincial level in Zambia, most expected numbers of total EmOC, especially CEmOC, facilities (according to the UN benchmarks) were small (Table 4), so further disaggregation by district would lead to expected numbers of less than 1 facility in many districts. If more ambitious benchmarks were used (e.g. those suggested in the WHR 2005), further disaggregation may be more feasible.

Considering health worker density and geographic access in addition to EmOC facility density provided a more complete picture of the EmOC situation in Zambia. Health worker distribution adds crucial information, particularly because the UN guidelines and handbook do not consider facility size and, thus, small health centers are counted the same as large hospitals when computing EmOC facility density. Calculating geographic access also overcomes a problem inherent to facility density—that populations in some administrative areas are so small that less than 1 facility is needed to meet the numeric benchmark. Geographic coverage furthermore takes into account that facilities can be used across administrative boundaries.

The total number of doctors, nurses, and midwives registered in Zambia was less than half the benchmark of 2.28 total healthcare professionals per 1000 population suggested in the WHR 2006 [7] as being required for ensuring skilled attendance at delivery, indicating a critical shortage in the country. The WHR 2005 benchmarks are specific to delivery care staff and differ from the benchmark in the WHR 2006. Overall, Zambia exceeded the WHR 2005 benchmark on doctors (and midwives, if counting nurses) but showed a highly unequal distribution within the country. Because there were no data in the HFC on whether health professionals had midwifery skills and worked in delivery care, the estimates are probably too optimistic. Alternatively, the WHR 2005 benchmarks may be set too low [15].

Comparing the present results with previous studies showed some agreements and some differences. In line with an overview of the availability of signal functions in 13 low-income countries [16], antibiotics were the most available basic signal function and assisted vaginal delivery the least frequently available. The present findings also accord with the global pattern that CEmOC services are more likely to be provided in sufficient quantity than are BEmOC services because the majority of lower-level facilities lack some signal functions [10]. Previous assessments of EmOC services in Zambia's Eastern [17] and Central [18] Provinces and a national survey [19] also highlight problems with quality of care, in particular a lack of skilled staff and necessary equipment to deal with obstetric emergencies at lower-level facilities, and problems with referral services.

In contrast to the present study, the previous EmOC assessments in Zambia [17–19] did not classify any of their sampled health centers as providing BEmOC (0%), largely because they had not provided all 6 basic signal functions in the previous 3 months or because they lacked a confident provider and the necessary tools—the latter criteria used in the survey in Central Province. Unlike these EmOC needs assessments, we had no information on actual provision of signal functions, provider confidence, or equipment availability, so reported capacity to provide functions was used. This may have overestimated facility functioning because people tend to report what should be

instead of what is [1,10]. For this reason, criteria were added on opening hours, staffing, electricity availability, and referral capacity (Table 1). According to our classification, 26 health centers (2.5%) were considered to provide BEmOC, possibly meaning that the classification was too lenient and overestimated functioning. Alternatively, it may also be too strict to expect health centers to provide all 6 functions in the previous 3 months when caseloads in most areas are low and some complications are seen infrequently—a limitation voiced previously [4,16].

In terms of CEmOC, there was better agreement between our classification based on the HFC and the national EmOC needs assessment conducted with support from UNICEF (both in 2005). The UNICEF survey found that 44 (80%) of 55 sampled hospitals provided CEmOC, which is higher than our estimate, but the survey included all provincial hospitals and only a sample of district hospitals. Of 24 sampled district hospitals, the reported signal functions in the HFC and the verified functions in the UNICEF EmOC survey agreed in 87% (25 functions differed, of which 16 were recorded as being present in the HFC but not in the UNICEF survey). The EmOC classification agreed in 20 (83%) of the 24 district hospitals, 2 were considered CEmOC by our classification but not by the UNICEF survey, and 2 were considered CEmOC by the UNICEF survey but not by our classification.

Although the EmOC classification in the present study may not be as reliable as measuring functionality with an EmOC needs assessment, it uses a general tool to approximate this and seems to give reasonable results. The present EmOC assessment is probably the first to rely entirely on secondary data, rather than to undertake costly new data collection (which can be as much as US\$1 million per national survey). Moreover, tools such as a general HFC have the merit of being able to provide information for disease priorities other than maternal health and, thus, are more likely to become a part of routine and ongoing health information systems than are parallel disease-specific data collection efforts.

In addition to cost savings, the strengths of the present assessment are in its national scope, the subnational disaggregation, the additional information on health workers, and thus facility capacity, and the consideration of geographic access—made possible through the linkage of facility data with ward-level census data using geographic coordinates.

The analyses presented are obviously limited by the types and quality of data available, in particular the lack of verification of signal function provision. Although other criteria were added, this may have led to an overestimation of functioning. For future assessments, it would be desirable to operationalize measures of EmOC functionality better, to add a range of neonatal emergency functions—as suggested by the revised UN guidelines [2]—and to analyze actual service use, including bypassing of facilities.

The geographic analyses could be refined by using population figures for areas smaller than wards and considering geographic data on roads, rivers, and altitude. Whereas assuming an even spatial population distribution within wards will have underestimated accessibility, our choice of a 15-km maximum distance probably overestimates it because it would require 3 hours of brisk walking by heavily pregnant women.

Given the large distances and sparse populations in most of Zambia, ensuring adequate access to EmOC for all women is a huge challenge. However, even some areas with higher population density lack EmOC facilities. Since the HFC in 2005, efforts have been undertaken in Zambia to improve access to EmOC, in particular to ensure that at least 4 facilities per district provide basic emergency obstetric and newborn care, and referral links have been strengthened by providing district-level transport. However, 1 ambulance stationed at the district hospital often services a large number of health centers in all directions, thus causing delays in picking up referred patients [19]. Mapping all health facilities with

their EmOC status and staffing, together with population density and roads, could be helpful for further national- and district-level planning.

As stated, the HFC is not specific to maternal health and could also be used to assess service provision for other conditions (e.g. HIV). An HFC also has the advantage that subnational disaggregation and comparison between provinces and districts are straightforward because there is no issue of whether the sample is representative at lower levels. Furthermore, it can be linked to population census data to calculate geographic accessibility and it can be used for district-level planning to target interventions to underserved areas. Similar facility censuses with collection of geographic coordinates should be encouraged in other countries and integrated into routine health management information systems to facilitate updates. This could help tracking progress toward reducing maternal and neonatal mortality, in addition to other health priorities.

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Author contributions

OC and SG had the idea for the study. SG performed all the analyses, with general input from OC and country-specific input from VS. SG wrote the first draft.

Conflict of interest

The authors have no conflicts of interest.

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