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A tale of 22 cities: utilisation patterns and content of maternal care in large African cities

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ABSTRACT

Introduction Globally, the majority of births happen in urban areas. Ensuring that women and their newborns benefit from a complete package of high-quality care during pregnancy, childbirth and the postnatal period present specific challenges in large cities. We examine health service utilisation and content of care along the maternal continuum of care (CoC) in 22 large African cities.

Methods We analysed data from the most recent Demographic and Health Survey (DHS) since 2013 in any African country with at least one city of ≥1 million inhabitants in 2015. Women with live births from survey clusters in the most populous city per country were identified. We analysed 17 indicators capturing utilisation, sector and level of health facilities and content of three maternal care services: antenatal care (ANC), childbirth care and postnatal care (PNC), and a composite indicator capturing completion of the maternal CoC. We developed a categorisation of cities according to performance on utilisation and content within maternal CoC.

Results The study sample included 25 326 live births reported by 19 217 women. Heterogeneity in the performance in the three services was observed across cities and across the three services within cities. ANC utilisation was high (>85%); facility-based childbirth and PNC ranged widely, 77%–99% and 29%–94%, respectively. Most cities showed inconsistent levels of utilisation and content across the maternal CoC, Cotonou and Accra showed relatively best and Nairobi and Ndjamena worst performance.

Conclusion This exploratory analysis showed that many DHS can be analysed on the level of large African cities to provide actionable information about the utilisation and content of the three maternal health services. Our comparative analysis of 22 cities and proposed typology of best and worst-performing cities can provide a starting point for extracting lessons learnt and addressing critical gaps in maternal health in rapidly urbanising contexts.

Summary box

What is already known?

- Over 60 million births will occur annually in urban areas in low-income and middle-income countries by 2030.
- Sign of erosion of the 'urban advantage' in maternal and newborn survival is a sign that improvements to accessibility and quality of care demand close attention to specificities of urban settings.

What are the new findings?

- This exploratory analysis of 22 large African cities showed that few achieved good performance across the three services within the maternal continuum of care, and those which did, do not share the same patterns of provision in terms of level or sector of health facilities.
- Most cities have clear gaps in the continuity of care between antenatal, childbirth and postnatal care and/or content of this care.
- Some of the continuity and quality gaps identified show patterns consistent with prioritising care provision to women with complications.

What do the new findings imply?

- The lack of common patterns in maternal health utilisation across the continuum of care shared by cities with relatively good performance requires further research to understand drivers of success.
- The initial typology of cities proposed in this paper can identify sites for future study of factors contributing to improvements in maternal health utilisation, provision and well-being, including by addressing the gaps in care continuity and quality identified by this analysis.
- A more in-depth understanding of the link between city performance and country-level versus city-level policies and decision-making is needed to derive such lessons, especially in the guidelines for care provision and resource availability

INTRODUCTION

Despite a remarkable decline of 38% in global maternal mortality ratio between 2000 and 2017, Africa was home to more than 70% of the estimated 295 000 global maternal deaths in 2017.[1] Most of these deaths occur due to preventable or treatable causes that could be mitigated by ensuring access to high-quality

antenatal, intrapartum and postnatal care (PNC).[2] However, with the current pace, the world is off-track to achieve the Sustainable Development Goal (SDG) target of reducing the global maternal mortality ratio to less than 70 per 100 000 live births by 2030.[3] Most pregnant women in low and middle-income countries (LMICs) receive some maternal health service, with over half giving birth in health facilities.[4] Yet, research consistently shows that antenatal, intrapartum and PNC frequently fall below evidence-based standards.[5] In many African countries, facility-based childbirth rates are increasing,[6–8] but without commensurate improvements in quality of care translating into declines in maternal mortality.[9] The result is that more deaths are attributable to poor quality of care than to the lack of access to care.[10]

While issues leading to suboptimal care coverage and quality need to be addressed on the national level, there is also a strong case to focus specifically on urban areas. For example, in a study from multiple LMIC settings, health facility service readiness was not consistently better in urban health centres and hospitals compared with those situated in rural areas.[11] More critical is the population for which services in urban areas are meant to cater. As per recent United Nations estimates, two-thirds of the world's population will live in urban areas by 2050. Nearly 90% of the projected additional 2.5 billion urban residents will concentrate in Africa and Asia by 2050.[12] By 2030, over 60 million births will occur annually in urban areas in LMICs.[13] The scale and speed of urbanisation challenge healthcare provision in a variety of ways. First, rapid population increase can quickly outpace the ability of urban areas to absorb new arrivals and provide essential health services to its residents. Consequently, the availability of evidence-based life-saving maternal health interventions in health facilities in urban areas in Africa may stall or even regress. High population density can improve accessibility of care, but without a rapidly adaptive health service, provision also produces overcrowding in public health facilities and related service delivery challenges, such as limited availability of space for service infrastructure.[14 15] Studies have shown that the 'urban advantage' of proximity to services, drugs and medical supplies for maternal and perinatal healthcare is already non-existent in some settings.[16–18] Theoretically, access to health facilities—including distance and travel time to providers of routine outpatient and emergency obstetric care—should be better in urban compared with rural areas,[19 20] but especially in resource-limited settings, this is not always the case. Traffic and poor road conditions, complexities of urban governance for health and living environments of slums and informal settlements further challenge access to critical maternal and newborn health services, especially for the urban poor.[17 21 22]

Many African cities struggle to provide their residents with high-quality public healthcare.[23] The result is a 'know-do' gap in maternal and perinatal care,[24] with the phenomena of 'too little too late' and 'too much too soon' occurring in parallel.[25 26] Although large cities also tend to have tertiary care such as teaching hospitals,[17] urban populations differ hugely in terms of their ability to pay for healthcare and other essential services, which in part has contributed to the growth of a diversity of private providers—for-profit and not-for-profit, formal and informal—targeting various population groups in cities. The presence of different categories of providers, while alleviating some pressure on public services,[16] creates challenges for regulating care quality standards across the variety of providers and ensuring affordable, high-quality care within the umbrella of universal health coverage.[27–29] Particularly, the urban poor frequently rely on for-profit, unqualified and unregulated providers, thus widening inequalities in healthcare.[30]

Challenges to both access to and quality of care require close and renewed attention to specificities of urbanisation. In the absence of responsive and system-oriented actions, the rapid pace of urbanisation in Africa could worsen maternal health inequalities by jeopardising the quality of care and worsening the three delays associated with maternal mortality as a result (delay in deciding to seek care, delay in reaching a health facility and delay in receiving adequate treatment in health facility).[31 32] Additionally, limited health system capacity to provide maternal health services in urban settings further increases the mismatch between service coverage and content of care received by pregnant women.[33 34] This disproportionately affects women with low socioeconomic status as they cannot opt for better quality services offered through private facilities.[35] There is increasing emphasis on the needs of local governments and policymakers to gain a deeper understanding of how they can improve healthcare provision to meet the needs of vulnerable women with low education, living in informal settlements (slums) lacking proper planning and regulations, recent migrants or adolescents.[27 36 37] Such an understanding can help in planning and targeting models of service delivery in these settings[38] and when introducing innovation in service delivery within cities.[39]

The objective of this paper is to produce and compare key indicators of maternal healthcare use, provision and content in large cities in Africa. We use these findings to propose a typology of large cities in Africa in terms of maternal health service across the continuum of care (CoC) and to identify gaps and lessons learnt.

METHODS

Data

We used data from the most recent Demographic and Health Survey (DHS) conducted since 2013 in any African country. The DHS is cross-sectional, nationally representative household surveys which use a multilevel cluster sampling survey design. In the first stage of sampling, a country is typically stratified by the first administrative units, and into urban and rural areas. Samples of enumeration areas (EAs, also referred to as clusters) are selected with probability proportional to EA size in each

stratum. Then, a random sample of households in each of the selected clusters is drawn for inclusion in the survey. Household and individual survey weights are needed in analysis to adjust for the sample design and for non-response. The DHS sampling procedure includes sample size calculation to provide sufficient statistical power for estimation of different population and health indicators at the national level as well as at the level of the first administrative region. The first administrative regions of a country are then typically further divided into 2–4 smaller administrative subdivisions that are hierarchically nested within the level(s) above. Most large cities tend to be at the level of third or fourth administrative region.[40]

Inclusion of cities

In each included country, we selected the most populous city with population size of ≥1 million inhabitants as of 2015.[41] This inclusion strategy (the largest city per country) was based on saturation needed in order to assess the feasibility of analysing maternal health data from the DHS on a city level and to capture a variety of city sizes to construct a preliminary typology. We included all survey clusters classified by DHS as being in urban areas within the boundary of each included city. The delineation of city boundaries was based on Database of Global Administrative Areas[42] and Google Maps (Alphabet, Mountain View, California) as well as through discussions with coauthors familiar with the area. Cluster locations, recorded as the longitude and latitude coordinates, are provided by the DHS. We note, however, that for urban clusters, the recorded global positioning system (GPS) locations are randomly displaced by up to 2 km to preserve respondent anonymity and confidentiality.[43] The details are in online supplemental material 1.

Population

We analysed the characteristics of maternal healthcare in a sample of live births in the 5-year period before each survey reported by women of reproductive age (15–49 years) at the time of survey who lived in the included DHS clusters.

Definitions

To define indicators of maternal health utilisation and content, we constructed measures of antenatal, childbirth and PNC as well as overall continuity of care. These indicators were constructed based on availability of data in the included DHS data sets, global maternal health indicator definitions, WHO recommendations in place during the recall period of the majority of included surveys and literature using the DHS to compare maternal health utilisation, provision and content across countries.

Antenatal care

We analysed antenatal care (ANC) utilisation, type of provider and content of care received for the most recent live birth to women with a live birth in the 5-year recall period of the survey. Women were asked where they received ANC (multiple providers/locations were allowed) and the number of ANC visits attended during pregnancy. Women who reported having had at least one ANC visit were asked to report the types of providers from which they sought care (response options include indication of both facility level and ownership). We defined public-sector providers as public, government or social security health facilities; private sector providers included private hospitals, private clinics, private doctors, non-government organisations, faith-based providers and other non-public providers.[44] Women were also asked whether they received specific ANC contents (yes/no) at any time during their pregnancy. We examined three ANC care contents (occurring at least once during pregnancy) captured consistently in all included surveys: having had blood pressure measured, having had a blood sample taken and having had a urine sample taken. We calculated the percentage of women who had at least one ANC visit and who had at least four ANC visits (table 1). Among women who had at least one ANC visit (users of ANC), we calculated the percentage who sought ANC from any public provider, public hospital and any private (non-public) provider, and percentage who received all three ANC care elements.

Childbirth care

We analysed childbirth care utilisation and content of care for all live births to women in the 5 years of preceding the survey. Women were asked the place of childbirth, and if the birth was by a caesarean section (CS). The response options for place of childbirth in the questionnaires and the categorisation of the level and sector of facilities used in this analysis are similar to those for ANC. We calculated the percentage facility-based delivery (FBD)—childbirths in any types of health facility and in any sector (table 1). To capture utilisation of different facilities for childbirth, we calculated the percentage of births in public hospitals among the FBDs. We also estimated the percentage of facility births occurring in public and in private facilities. We calculated the percentage of births by CS. We attempted to disaggregate CS rates by public and private sector, but there was only sufficient sample size in five cities, so we do not present this. Women were asked whether they received specific care content after childbirth (yes/no). Among a subset of live births in the 2 years preceding the survey, we calculated the percentage of births for which women reported receipt of the following three care contents: breastfeeding initiated within an hour of childbirth, newborn having been weighed at birth and whether the newborn was put directly on the skin of the mother immediately after birth (skin-to-skin). The 2-year analysis subset was required as one of the variables (initiation of breastfeeding) was only collected for this restricted recall period.

Postnatal care

We analysed PNC utilisation among most recent live births in 5 years before the survey, by place of delivery (in a health facility or not). Women who gave birth in a

Table 1 Definitions of indicators calculated for sampled women/live births during the 5-year survey recall period

Indicator	Numerator	Denominator
	Antenatal care (ANC)	
Utilisation	At least one ANC visit (ANC1)	Women's most recent live birth
	At least four ANC visits (ANC4)	Women's most recent live birth
Provision	At least one ANC visit in a public hospital‡	Women's most recent live birth and ANC1=1
	At least one ANC visit in a public health facility‡	Women's most recent live birth and ANC1=1
	At least one ANC visit at a private health facility‡	Women's most recent live birth and ANC1=1
Content	Received all three measured elements of care during ANC visits (had blood pressure, a blood sample, and urine sample taken)	Women's most recent live birth and ANC1=1
	Childbirth care	
Utilisation	Childbirth in a health facility (facility-based delivery, FBD)	All live births
Provision	Childbirth in a public hospital	All live births and FBD=1
	Childbirth in a public health facility	All live births and FBD=1
	Childbirth in a private health facility	All live births and FBD=1
Content	Childbirth by caesarean section (CS)	All live births
	Breastfeeding initiated within an hour of childbirth*	Most recent live birth and FBD=1
	Baby weighed at birth*	Most recent live birth and FBD=1
	Skin-to-skin contact immediately after birth*	Most recent live birth and FBD=1
	Postnatal care (PNC)	
Utilisation	Woman had a PNC≤48 hour of childbirth*	Women's most recent live birth
Content	Stayed ≥24 hours in facility after vaginal delivery*	Women's most recent live birth if FBD=1 and vaginal birth
	Stayed ≥72 hours in facility after caesarean section*	Women's most recent live birth if FBD=1 and CS birth
	Continuum of care	
Utilisation content	Received minimum continuum of care* (At least four ANC visits (ANC4) *and* Received all three measured elements of care during ANC *and* Childbirth in a health facility (FBD) *and* Woman had a PNC≤48 hour of childbirth *and* (Stayed ≥24 hours in facility after vaginal delivery *or* Stayed ≥72 hours in facility after CS])	Women's most recent live birth

*Analysis restricted to 2-year recall period before the survey.
†Not available in six included cities due to questionnaire adaptations.
‡Respondents could report several providers of ANC.

health facility are asked about the time they spent in the facility after the birth; depending on the answer, length of stay (LOS) is recorded in hours, days or weeks. We adopted the approach used by Campbell and colleagues and converted the reported LOS into number of hours.[45] Women were also asked if anyone checked on their health while they were still in the facility (a predischarge PNC check). Women who gave birth outside of a health facility were asked whether they received a postnatal check after birth, and if yes, the timing of this check. For both facility-based and non-facility births, we defined PNC utilisation as the percentage of women who received a PNC check within 48 hours of childbirth. Among the facility-based non-CS births, we calculated the percentage who stayed at least 24 hours; and among the facility-based CS births, we calculated the percentage that stayed at least 72 hours (table 1).[46] In order to improve accuracy of recall and consistency of measurement with childbirth content of care, we estimated all three PNC indicators among live births in the 2-year period preceding the surveys.

Continuum of care

We combined six individual indicators into a proxy for care utilisation and content *across* the maternal CoC. Among a subset of women's most recent live births in the 2 year period before the surveys (for which

all necessary indicators were available), we defined completed minimum CoC as women receiving all the following: at least 4 ANC visits, all three measured elements of care during ANC, gave birth in a health facility, received a PNC check ≤48 hour of childbirth and, depending on mode of delivery, stayed in the health facility ≥24 hours (vaginal) or ≥72 hours (CS) (table 1). Women who reported not receiving any or all these care components were considered not to have completed the CoC.

Other variables

Individual sociodemographic characteristics at the time of survey interview were used in descriptive analysis, including women's age, marital status, age at first cohabitation, level of education, employment status, parity and unmet need for family planning.[47]

Statistical analysis

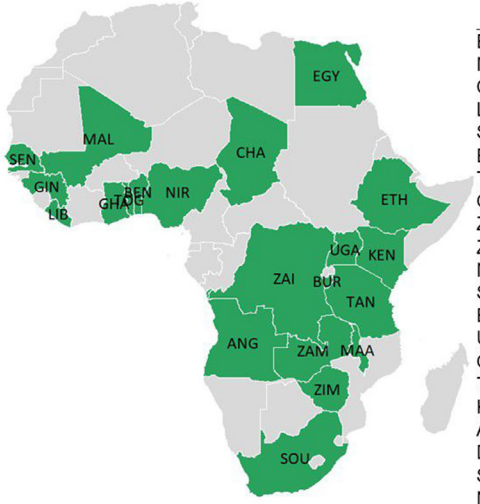
We used Stata (V.15.0, Stata Corporation, College Station, Texas) to conduct the analyses. The complex, multilevel cluster survey design used in the DHS was accounted for in the analysis. We estimated city-level percentages and associated 95% CIs, taking the sample design of DHS into account. Missing data were recoded as not having received care. Two authors (KW and LB) independently assessed the relative levels of each indicator across the included cities using the distribution (means, medians, outliers) and scatterplots. These two categorisations were then compared, and further developed iteratively in discussion with all coauthors; we did not strictly apply any quantitative cut-offs.[48] The first focus was care coverage and content, and secondary focus on sector and level of care. We developed a final categorisation of cities into three groups according to care coverage and content across the CoC: 1) good across all three services; 2) inconsistent (good in some, poor in others); and 3) poor across all three services.

Patient and public involvement

Patients or the public were not involved in the design, or conduct, or reporting or dissemination plans of our research.

RESULTS

Of the 54 countries and areas on the African continent according to the African Development Bank Group (figure 1), we included 22 cities with available DHS data (table 2). The year of data collection ranged from 2013 to 2018. The smallest cities, in population size, were Bujumbura (1 million), Lilongwe (1.1 million), Monrovia and Ndjamena (1.2 million), and the largest cities were Kinshasa (7.3 million), Johannesburg (8.3 million),



Country	Population* (million in 2015)	Most populous city	Population (million)	Share of population (%)
Burundi	10.2	Bujumbura	1.0	(9.8%)
Malawi	16.7	Lilongwe	1.1	(6.6%)
Chad	14.1	Ndjamena	1.2	(8.5%)
Liberia	4.5	Monrovia	1.2	(26.7%)
Sierra Leone	7.2	Freetown	1.5	(20.8%)
Benin	10.6	Cotonou	1.5	(14.2%)
Togo	7.3	Lome	1.7	(23.3%)
Guinea	11.4	Conakry	2.2	(19.3%)
Zimbabwe	13.8	Harare	2.3	(16.7%)
Zambia	15.9	Lusaka	2.4	(15.1%)
Mali	17.4	Bamako	2.8	(16.1%)
Senegal	14.6	Dakar	3.1	(21.2%)
Ethiopia	101	Addis Ababa	3.7	(3.7%)
Uganda	38.2	Kampala	3.8	(9.9%)
Ghana	27.8	Accra	4.5	(16.2%)
Tanzania	51.5	Dar es Salaam	5.3	(10.3%)
Kenya	47.9	Nairobi	5.9	(12.3%)
Angola	27.9	Luanda	7.0	(25.1%)
DR Congo	76.2	Kinshasa	7.3	(9.6%)
South Africa	55.4	Johannesburg	8.3	(15.0%)
Nigeria	181	Lagos	11.8	(6.5%)
Egypt	92.4	Cairo/Giza	23.0	(24.9%)

Sub-Saharan African countries with DHS since 2013 but excluded from this analysis

Countries with DHS since 2013 but without a city of ≥1 million population

Country	Country population (million in 2015)	Most populous city	Population in the most populous city (million in 2015)	Reason of exclusion
Gambia	2.1	Serrekunda	0.8	No city with ≥1 million population
Lesotho	2.1	Maseru	0.3	No city with ≥1 million population
Namibia	2.3	Windhoek	0.4	No city with ≥1 million population
Rwanda	11.4	Kigali	2.2	Unable to determine the clusters that are in Kigali City (see SM1)

Sub-Saharan African countries without DHS since 2013

Algeria, Botswana, British Indian Ocean Territory, Burkina Faso, Cabo Verde, Cameroon, Central African Republic, Comoros, Congo, Cote d'Ivoire, Djibouti, Equatorial Guinea, Eritrea, Eswatini, Gabon, Guinea-Bissau, Libya, Madagascar, Mauritania, Mauritius, Morocco, Mozambique, Niger, Sao Tome and Principe, Seychelles, Somalia, South Sudan, Sudan, Tunisia

*Source:
https://data.worldbank.org/indicator/SP.POP.TOTL?end=2015&most_recent_year_desc=true&start=1960

Figure 1 Twenty-two countries with cities included in the current analysis (in green). DHS, Demographic and Health Survey.

Table 2 Cities included in the analysis; number of DHS clusters (also known as enumeration areas), and number of women with births during the 5-year survey recall period

Most populous city		First administrative division where the city is located	DHS year	Number of clusters sampled in the first administrative division			Number in the final analysis sample		
Name	Population in 2015 (million)			Total	Urban	City	Women 15–49 years in sample	Women with livebirths in recall period	Livebirths in recall period
Bujumbura	1.0	Bujumbura Mairie Province	2016	33	33	33	1304	477	662
Lilongwe	1.1	Lilongwe District	2015	37	14	14	1643	679	813
Ndjamena	1.2	N'Djamena Region	2014	50	50	50	1627	786	1307
Monrovia	1.2	Montserrado County	2019	44	36	35	2917	1203	1443
Freetown	1.5	Western Urban District	2019	52	52	52	2373	847	998
Contonou	1.5	Littoral Department	2017	51	51	51	958	408	579
Lome	1.7	Grande agglomeration de Lome	2013	82	82	82	2903	1188	1573
Conakry	2.2	Conakry Region	2018	51	51	51	1917	677	901
Harare	2.3	Harare Province	2015	44	32	32	1684	709	880
Lusaka	2.4	Lusaka Province	2018	63	41	39	2254	946	1183
Bamako	2.8	Bamako Region	2018	47	47	46	1811	941	1325
Dakar	3.1	Dakar Region	2019	20	16	15	1827	664	819
Addis Ababa	3.7	Addis Ababa City	2016	56	56	56	930	198	244
Kampala	3.8	Greater Kampala	2016	45	45	45	1025	445	580
Accra	4.5	Greater Accra Region	2014	47	42	42	1693	586	761
Dar es Salaam	5.3	Dar es Salaam Region	2015	37	37	37	1536	634	772
Nairobi	5.9	Nairobi County	2014	56	56	56	3770	1657	2051
Luanda	7.0	Luanda Province	2015	66	63	63	5395	2598	3593
Kinshasa	7.3	Kinshasa Province	2013	36	36	36	2255	888	1306
Johannesburg	8.3	Gauteng Province	2016	96	88	34	748	275	329
Lagos	11.8	Lagos State	2018	52	49	47	2726	1061	1432
Cairo/Giza	23.0	Cairo/Giza Governorates	2014	153/108	153/79	153/79	2890	1350	1775

DHS, Demographic and Health Survey.

Lagos (11.8 million) and Cairo (23 million). We excluded the 2013 Gambia DHS as GPS data were not collected. Lesotho and Namibia were excluded as they did not have a city with at least 1 million inhabitants in 2015. We also excluded the 2014/5 Rwanda DHS due to unclear delineation of urban and rural clusters in Kigali (online supplemental material 1). In five of the included 22 surveys, some urban clusters in the first administrative area were considered to be outside of the respective city—1 each in Monrovia, Bamako and Dakar, 2 in Lagos and Lusaka and 54 in Johannesburg (online supplemental material 1 and table 2) and were excluded from the study sample. The total study sample in the 22 cities included 25 326 live births reported by 19 217 women.

Sociodemographic characteristics of the sample

The mean age of women who had a live birth during the 5-year survey recall periods living in the 22 included cities was between 27 and 32 years (online supplemental material 2). At least 55% of the respondents in included cities were ever married at the time of interview. The mean age at first cohabitation ranged between 16.7 years in Ndjamena and 23.9 in Lagos. The mean number of years of education received was lowest in Bamako and Dakar (≤5 years) and highest in Harare, Cairo, Lagos, Johannesburg and Nairobi (>10 years). In both Bamako and Conakry, nearly 50% of women reported receiving no formal education. In Accra, Cairo, Harare, Johannesburg, Kampala, Kinshasa, Lagos and Lusaka, on the other hand, more than two-thirds of women completed secondary or higher education. Between 12% (Cairo) and over 80% (Cotonou and Lagos) of women reported working at the time of survey. Mean parity at the time of survey interview was between 2.0 (Addis Ababa) and 4.0 (Ndjamena). The level of unmet need for family planning ranged between under 10% in Harare to over 40% in Cotonou, Lomé and Accra.

Utilisation and content of care

Figure 2 shows the distribution of the maternal health indicators across the included cities. Table 3 presents the levels of all indicators for each city, with colour coding indicating relative levels of each indicator within the included cities in relation to the median of the 22 included cities.

Antenatal care

Across the 22 cities, the percentage of women who had at least one ANC visit for their most recent birth was lowest in Ndjamena (85%) and >99% in Bujumbura, Dakar, Lilongwe and Lusaka, with a median across cities being 98%. Compared with at least one ANC visit, the percentage of women who had four or more ANC visits dramatically decreased and ranged from 51% in Bujumbura to 95% in Lagos (with a median of 75% across the cities). Freetown and Accra had the highest percentage of ANC users reporting use of public hospitals (>50% of women with ANC1+). The contribution of the public sector overall to ANC care was extremely high in Cotonou, Freetown and Lusaka (>90%); conversely, the private sector contribution to ANC was high (around 50%) in Kinshasa and Lagos, and predominant in Cairo (82%)—with a median across cities of 21%. ANC visits 'at home' were >5% of ANC users only Lagos (9% of women

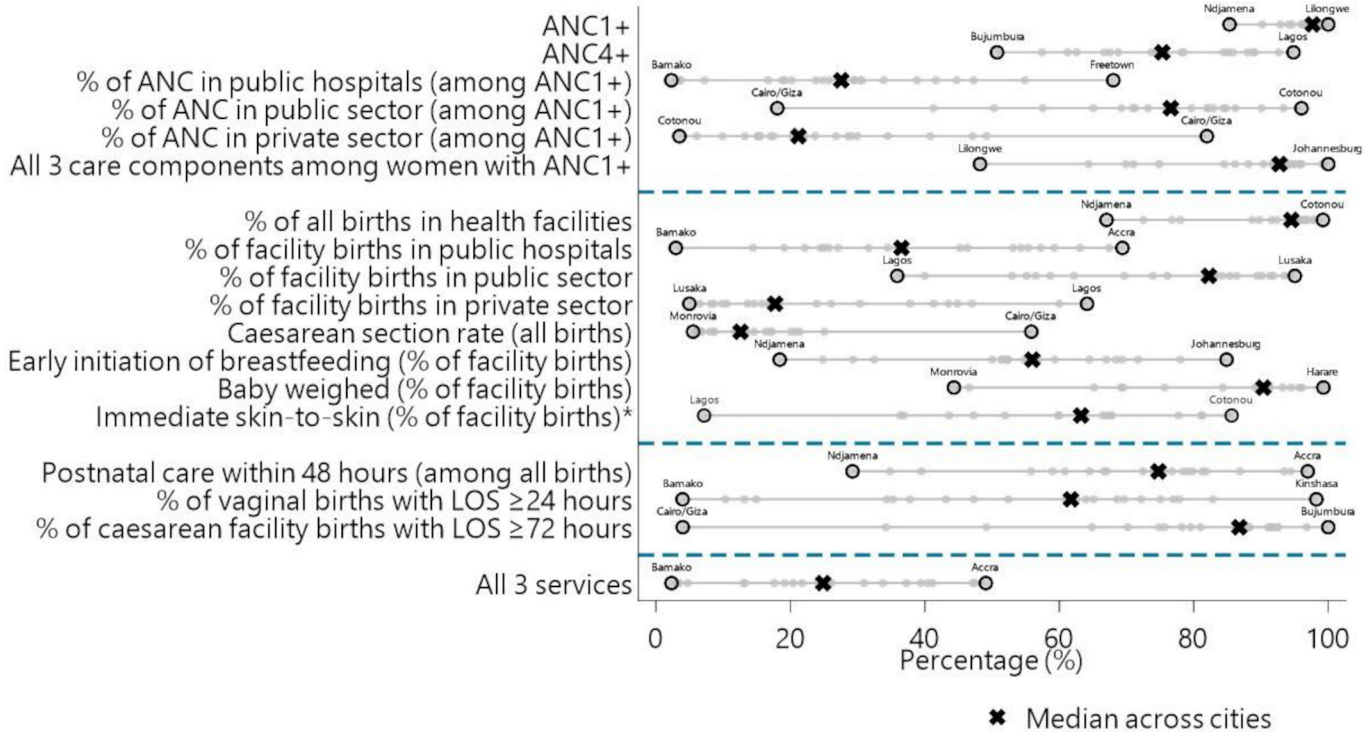


Figure 2 Levels (range and median) of utilisation, provider and content of care indicators for antenatal care, childbirth and postnatal care across included cities (each included city is a grey circle). ANC, antenatal care; LOS, length of stay.

Table 3 Heatmap of levels and patterns of indicators across included cities (listed according to population size)

		Antenatal care						Childbirth								Postnatal care			CoC
		Utilisation		Provision			Content	Utilisation	Provision			Content				Utilisation	Content		
City	Pop in mil	ANC 1+	ANC4+	% of ANC in public hospitals (among ANC1+)	% of ANC in public sector (among ANC1+)	% of ANC in private sector (among ANC1+)	All three care components among women with ANC1+	% of all births in health facilities	% of facility births in public hospital	% of facility births in public sector	% of facility births in private sector	Caesarean section rate (all births)	Early initiation of breastfeeding (% of facility births)	Baby weighed (% of facility births)	Immediate skin-to-skin (% of facility births)	Postnatal care within 48 hours (among all births)	% of vaginal facility births with LOS ≧24 hours	% of caesarean facility births with LOS ≧72 hours	All three care services
Bujumbura	1	99.8	50.7	41.6	70.9	29.1	69.9	95.1	63.1	84.2	15.8	16.3	78.0	95.7	36.9	76.8	77.9	100.0	26.1
Lilongwe	1.1	100.0	66.7	44.7	82.9	17.1	48.2	97.8	57.2	82.8	17.2	11.9	54.9	93.2	66.4	66.6	82.9	92.4	24.1
Ndjamena	1.2	85.3	61.2	84.3	76.5	20.3	71.0	67.0	55.4	90.1	9.9	6.7	18.4	65.2	n/a	29.2	14.9	49.1	3.5
Monrovia	1.2	98.1	88.8	47.3	64.0	40.8	95.9	76.8	46.3	58.7	41.3	5.5	67.0	44.3	47.3	75.5	68.6	91.6	17.6
Freetown	1.5	92.9	85.1	68.0	92.0	9.9	95.0	92.3	67.4	91.4	8.6	8.0	56.8	84.3	67.8	94.4	72.2	70.2	47.1
Cotonou	1.5	98.6	85.8	29.5	96.0	3.5	92.7	99.2	27.1	55.2	44.8	14.6	51.7	90.7	85.6	81.8	75.1	91.1	47.1
Lomé	1.7	98.7	75.0	30.6	69.2	30.0	93.3	95.6	36.7	69.6	30.4	12.7	59.3	90.0	n/a	81.3	65.1	86.6	39.4
Conakry	2.2	96.1	62.6	24.8	76.7	22.1	94.0	89.8	24.5	76.1	23.9	5.9	56.8	89.2	43.6	74.0	10.3	74.9	4.7
Harare	2.3	94.7	74.6	16.7	82.2	17.5	84.6	91.6	22.1	85.4	14.6	8.6	52.4	99.3	51.9	60.9	77.0	88.1	30.9
Lusaka	2.4	99.1	57.5	25.7	93.3	6.1	74.9	94.3	53.1	95.0	5.0	8.7	71.7	98.9	81.3	86.9	37.8	81.0	13.1
Bamako	2.8	96.0	78.2	2.3	82.0	15.6	92.8	96.6	3.0	86.4	13.6	6.1	64.5	69.2	36.3	79.8	4.0	75.7	2.3
Dakar	3.1	99.4	68.8	3.5	84.9	15.2	94.6	96.2	14.5	91.8	8.2	17.2	32.5	91.1	67.6	79.1	61.0	87.0	33.8
Addis Ababa	3.7	96.8	89.1	19.2	76.0	23.7	95.7	96.6	36.4	73.9	26.1	21.4	68.4	91.3	66.9	55.8	34.3	79.5	21.7
Kampala	3.8	97.9	67.5	33.9	71.3	28.6	64.4	94.3	34.5	62.2	37.8	12.5	69.3	94.5	81.1	78.4	64.0	92.5	25.6
Accra	4.5	98.8	92.7	54.9	79.7	20.3	99.1	95.5	69.4	83.2	16.8	25.0	55.4	89.6	n/a	96.9	47.3	88.3	49.1
Dar es Salaam	5.3	97.7	75.6	18.8	73.2	26.8	91.7	94.2	54.3	81.8	18.2	17.0	52.3	99.2	60.0	59.0	43.1	64.9	19.1
Nairobi	5.9	98.3	73.7	30.4	65.1	34.5	96.0	88.7	45.3	56.5	43.5	20.7	29.3	46.6	n/a	34.8	35.3	34.2	20.4
Luanda	7.0	97.7	84.4	29.4	86.2	13.2	94.1	72.5	25.7	93.5	6.5	6.8	50.0	96.1	77.7	39.5	52.4	91.2	13.2
Kinshasa	7.3	97.5	74.3	23.8	50.3	49.2	90.4	97.9	25.0	53.0	47.0	5.9	51.4	99.2	n/a	64.5	98.2	91.6	41.1
Johannesburg	8.3	94.1	78.5	7.2	84.8	15.2	100.0	96.9	59.2	89.5	10.5	20.1	84.9	89.7	59.8	67.1	69.6	78.2	40.4
Lagos	11.8	96.6	94.8	20.2	41.3	47.1	86.1	78.0	19.1	35.9	64.1	13.4	56.6	75.7	7.2	72.4	62.4	96.8	37.2
Cairo	23.0	90.2	88.0	3.7	18.1	81.9	88.1	94.7	31.7	40.0	60.0	55.8	24.8	69.5	n/a	93.4	13.2	4.0	3.2

Orange—lowest levels; Pink—below mean/median; light blue—around mean/median; light green; above mean/median or approaching 100%; green—highest levels or near 100%.
COC, Continuum of care, defined as all of the following: 1. At least four ANC visits and received all 3 measured elements of ANC and 2. Childbirth in a health facility (FBD) and 3. Woman had a PNC ≤48h of childbirth and stayed ≥24 hours in facility after vaginal delivery* or Stayed ≥72 hours in facility after caesarean section).
ANC, antenatal care; Coc, Continuum of care; LOS, length of stay; n/a, not available; Pop, Population size.

with ANC1+ reported this location of service provision). In terms of content of ANC, receipt of all three elements of care measured among women with at least one ANC visit was lowest in Lilongwe (48%) and Kampala (64%), and near universal in Johannesburg and Accra, with a median of 93% across the 22 cities.

Childbirth care

The percentage of women who gave birth in a health facility ranged from 67% in Ndjamena to 99% in Cotonou, with a median of 95%. With the exception of Lagos and Cairo, a majority of these births took place in public sector facilities, with the highest use of public facilities reported in Lusaka and Luanda (median across cities of 82% of facility births). Cities varied in the percentage of facility births in governmental hospitals from 3% in Bamako to 69% in Accra, with a median of 37%. Private sector facilities cared for between 5% (Lusaka) and 64% (Lagos) of facility births, with a median of 18%. The CS rates across cities ranged from 6% in Monrovia, Conakry, and Kinshasa to 56% in Cairo, with a median of 13%. Content of childbirth care varied across cities and by indicator. Early initiation of breastfeeding was highest in Johannesburg (85%) and lowest in Ndjamena (18%), with a median across cities of 56%. The percentage of babies weighed after birth ranged from 44% in Monrovia to universal levels (>99%) in Harare, Dar es Salaam and Kinshasa, with a median of 90%. For the 16 cities with data available on immediate skin-to-skin contact, the median level was 63%, ranging from 7% in Lagos to 86% in Cotonou.

Postnatal care

The percentage of women reporting receiving PNC within 48 hours of birth (regardless of location of childbirth) ranged from 29% in Ndjamena to 97% in Accra, and a median level of 75%. Among women who gave birth in health facilities, the percentage of those with a vaginal birth who reported staying at least 24 hours ranged from 4% in Bamako to 98% in Kinshasa, with a median of 62%. Among women who gave birth by CS, the percentage with a LOS of at least 72 hours ranged from 4% in Cairo to >95% in Bujumbura and Lagos; the median was 87%.

Continuum of care

The percentage of women who received all components within the CoC ranged from <4% in Bamako, Ndjamena and Cairo to nearly half in Accra, Cotonou and Freetown. The median across included cities was 25%.

Patterns in the services across the continuum of maternal care

Table 4 presents a typology of the patterns of care coverage, provision and content across the maternal CoC. Two of the included cities achieved ANC4+ levels of above 90%; in Accra, the majority of ANC was provided through the public sector, and particularly in public hospitals, in Lagos with relatively high levels of private sector use and low level of public hospital use for ANC (20%). The 14 cities with >90% levels of care content during ANC did not share any obvious patterns of care provision (level or sector of facility).

Childbirth care in the included cities was predominantly facility based, but with variable provision modalities: mainly in public hospitals (eg, Accra, Freetown), mainly public lower level facilities (eg, Bamako, Dakar, Harare, Luanda) or mainly in private sector facilities (eg, Lagos, Cairo). The percentage of births occurring by CS, while ranging from borderline low to extremely high, did not appear to share a pattern with the level or sector of care provision, or with the percentage of births occurring in health facilities. For example, Bamako and Kinshasa had high rates of births in health facilities but fairly low rates of CS. In terms of content of childbirth care, Lusaka and Kampala achieved relatively high levels on all three components; conversely, Nairobi, Lagos and Cairo showed relatively poor performance. However, we found high levels of inconsistency within cities across the three measures of care content, for example, Bujumbura (high percentage of early breastfeeding initiation, low percentage of immediate skin-to-skin), Harare (high percentage of newborns weighed, low percentage of immediate skin-to-skin) and Dar es Salaam (high percentage of newborns weighed, low percentage of early breastfeeding initiation). Consistently high levels of all three measures of content of childbirth care did not appear to be linked with the level or sector of provision.

Regarding PNC, extremely low levels of coverage given the level of facility-based childbirth were notable in Nairobi, Ndjamena, Harare, Addis Ababa, Dar es Salaam, Luanda, Kinshasa and Johannesburg. All cities with the exception of Freetown, Nairobi, Kinshasa and Cairo had higher percentages of women with a CS staying 72 hours compared with women with a vaginal birth staying 24 hours. Cotonou was the only city with high PNC coverage and high levels of sufficient LOS for both vaginal and CS births. Conversely, Kinshasa, which had a very high percentage of births occurring in health facilities and nearly universal sufficient LOS after both vaginal and CS births, but a low coverage of PNC, meaning that women who gave birth in facilities were staying long enough to receive care, but this care was not being provided. In contrast, Lusaka, Bamako and Cairo achieved a high coverage of PNC while having a low percentage of women staying the minimal period of time in facilities after childbirth.

To summarise, considering both coverage and content of ANC across included cities, Monrovia, Freetown, Dakar, Addis Ababa, Accra and Luanda showed best results; Bujumbura, Lilongwe, Ndjamena, Lusaka and Kampala showed worst results. Second, in terms of the coverage and content of childbirth care, Lilongwe, Cotonou, Lomé, Addis Ababa, Lusaka, Kampala, Kinshasa and Johannesburg showed best results; and Ndjamena, Monrovia, Bamako, Nairobi, Lagos and Cairo showed poor results. Third, looking at the levels of PNC coverage and content, Cotonou, Lomé, Freetown, Dakar, Kampala,

Table 4 Patterns of coverage and content across the maternal continuum of care

City	Pop (mil)	ANC coverage and content	Childbirth coverage and content	PNC coverage	Continuum of care	Additional notes across continuum of care, especially on level and sector of care
Bujumbura	1	Low coverage of ANC4 visits (highest relative drop-off between ANC1 to ANC4), low content of care	High coverage, inconsistent content	Medium level of PNC, medium LOS24, high LOS72 (one of largest differences between LOS vaginal vs caesarean section)		High public hospital use (childbirth)
Lilongwe	1.1	Low coverage of ANC4 +visits (high drop-off between ANC1 to ANC4), lowest content of care	High coverage, medium content	Low PNC, both LOS24 and LOS72 above average		High public hospital use
Ndjamena	1.2	Lowest ANC1, low ANC4, low content of care	Low coverage, low content	Low PNC, low LOS24, medium LOS72	Low	
Monrovia	1.2	High coverage of ANC4 and high content of care	Low coverage, low content	Medium to high PNC, high LOS24, high LOS72		High hospital use, low CS rate
Freetown	1.5	High coverage of ANC4, high content of care	Medium coverage, medium content	highest PNC, high LOS24, low LOS72	High	High public hospital use (ANC)
Cotonou	1.5	High coverage of ANC4, medium content of care	High coverage, high content	High PNC, medium LOS24 and LOS72	High	Mix of sectors (ANC—public, childbirth private)
Lomé	1.7	Medium coverage of ANC4, medium content of care	High coverage, medium content	Above average both LOS		
Conakry	2.2	Low coverage of ANC4 (high drop-off between ANC1 to ANC4), medium content of care	Low coverage, low content	Medium PNC, very low LOS24, medium LOS72	Low	Low hospital use, low CS rate
Harare	2.3	Medium coverage and content	Medium coverage, inconsistent content	Low PNC, both LOS above average		High use of lower level public facilities in childbirth
Lusaka	2.4	Low coverage of ANC4 (high drop-off between ANC1 to ANC4), low content of care	Medium coverage, high content	Good PNC with short LOS		High public sector use in ANC and childbirth
Bamako	2.8	Medium coverage of ANC4, medium content of care	High coverage, low content	High PNC, very low both LOS	Low	High use of public lower-level facilities (ANC and childbirth)
Dakar	3.1	High coverage of ANC4 and high content of care	High coverage, inconsistent content (mostly medium)	High PNC, medium level of both LOS		High use of public lower-level facilities (ANC and childbirth)
Addis Ababa	3.7	High coverage of ANC4 and high content of care	High coverage, medium content	Low PNC, low LOS		
Kampala	3.8	Low coverage of ANC4 (high drop-off between ANC1 to ANC4), lowest content of care	Medium coverage, high content	High PNC, medium LOS		High private sector use (ANC and childbirth)
Accra	4.5	High coverage of ANC4 and high content of care	High coverage, medium content	High PNC, medium to low LOS	High	High use of public hospitals for ANC and childbirth care
Dar es Salaam	5.3	Medium coverage of ANC4, medium content of care	Medium coverage, inconsistent content	Low PNC, below average both LOS		
Nairobi	5.9	Medium coverage of ANC4 (high drop-off between ANC1 to ANC4), high content of care	Low coverage, low content	Low PNC, medium/below average both LOS		Largest drop between FBD and PNC48
Luanda	7	High coverage of ANC4 and high content of care	Low coverage, high content	Low PNC, low LOS24, high LOS72		

Continued

Table 4 Continued

City	Pop (mil)	ANC coverage and content	Childbirth coverage and content	PNC coverage	Continuum of care	Additional notes across continuum of care, especially on level and sector of care
Kinshasa	7.3	Medium coverage of ANC4, high content of care	High coverage, medium content	Low PNC, very high LOS24		High private sector use (ANC and childbirth), while low CS rate
Johannesburg	8.3	Medium coverage of ANC4, high content of care	High coverage, high content	Low PNC good LOS24, low LOS72		
Lagos	11.8	High coverage of ANC4 (low drop off between ANC1 and ANC4), medium content of care	Low coverage, low content (outlier low skin-to-skin)	Medium PNC, good both LOS		High private sector use (ANC and childbirth)
Cairo	23	High coverage of ANC4 (low drop off between ANC1 and ANC4), medium content of care	Medium coverage, low content (outlier high CS)	High PNC, outlier low LOS	Low	High private sector use (ANC and childbirth), very high CS rate

Green—best performing cities; orange—poorest performing cities.
ANC, antenatal care; CS, Caesarean section; FBD, facility-based delivery; LOS, length of stay; PNC, postnatal care.

Accra, Lagos, followed by Bujumbura and Monrovia, showed good results. Conversely, Addis Ababa, Nairobi, Ndjamena and Dar es Salaam had relatively poor results. Across the three maternal health services, we identified three general patterns in the 22 included cities. First, (1) cities which achieved relatively high coverage and content on all or most services (**Cotonou and Accra**), (2) cities with variability across the three services (most cities in this analysis) and (3) cities performing relatively poorly in most or all three services (**Ndjamena and Nairobi**). The CoC indicator, which captures the percentage of women receiving the three services, also identified Cotonou and Accra as the best performing and Ndjamena as one of the poorest performing cities.

DISCUSSION

This study examined recent representative and comparable data capturing self-reported maternal healthcare experiences of nearly 20 thousand women from 22 cities in Africa with a combined total of over 100 million inhabitants. We found different patterns of the three main services (ANC, childbirth and PNC) across the cities when looking at coverage, sector and level of health facilities providing care and content of care. The main finding of this exploratory analysis is the large heterogeneity in the performance of cities in regard to these three services. We highlight the existence of two types of attrition—or continuity gaps—in the coverage and content of care, leading to suboptimal performance. First were gaps within the constituent services, such as those between initial coverage and sufficient coverage (eg, from one ANC visit to four or more), between coverage and content (eg, ANC4+ visits vs receiving all ANC components), between measures of content (eg, variability in three components of childbirth care) and in the content provided to various users (eg, coverage of sufficiently long LOS in health facilities postnatally among women with vaginal vs CS births). Second, we found large gaps across the maternal CoC between the three services (eg, high coverage of ANC but low FBD, high FBD but low PNC). Among the cities included in the analysis, we were able to identify two cities—Cotonou and Accra—which were relatively successful in bridging the services and minimising gaps. Furthermore, we described the differences in the patterns of maternal care provision across cities by facility level (hospital or lower) and sector of ownership (public or private), finding that various modalities of service use and provision did not seem consistently linked to high or low levels of coverage and content.

Previous analyses within the Countdown to 2030 initiative using DHS data documented large subnational disparities in reproductive, maternal, newborn and child health coverage in several sub-Saharan African countries, with the composite coverage index higher in main cities (capital cities for most).[49] This points to the fact that there is an urban advantage when it comes to coverage of essential services along the maternal CoC or at the least a 'capital city' advantage. What the findings of this study show is that despite leading nationally in terms of coverage, large cities on the African continent struggle with major gaps. Our analysis has an innovative perspective—comparing large cities on the same continent, not urban–rural differentials within and across sub-Saharan African countries.[50] Thus, we bring to the fore the specificity of healthcare provision in urban settings in general and large cities in particular. There are many dynamic and interdependent challenges to the provision of high-quality maternal care in rapidly growing cities, which might partly explain the findings. We focus on three critical dimensions here in an effort to guide future research and implementation activities.

First, we highlight the critical importance of population-related and socioeconomic determinants of healthcare utilisation in large cities. This includes issues of population size and distribution, such as the extent of daily, seasonal and permanent migration, which makes planning for and monitoring of sufficient health system capacity difficult. Approaches from rural areas, such as

delineating health facility catchment areas[51] and estimating demand for maternal health services,[52] are far more complex in cities, demanding ongoing focused effort and funding. We did not find clear differences in patterns within the three maternal health services or across the care continuum related to city size, even though the included cities varied from a population of 1 million to >20 million and the relative size of the city compared with country size ranged from 4% (Addis Ababa) to around one-quarter (Monrovia, Lomé, Luanda, Cairo).

The characteristics of urban living environments, specifically the extent and nature of urban poverty, are also potential factors in the relative successes and failures of cities to ensure universal coverage of maternal healthcare.[53] This includes, for example, the relative inaccessibility—both geographic and financial—of public health facilities to women living in slums,[54 55] resulting in use of poor-quality commercial outlets[56] and pharmacies.[57] Some of the poor performance identified in Nairobi and Dar es Salaam might be explained by the high proportion of urban poor. Around 46% of the urban population in Kenya lived in slums as of 2018 and 40% in Tanzania, concentrating predominantly in the capital cities of Nairobi and Dar es Salaam.[58] However, the percentage of urban poor population does not tell the full story as other, relatively larger cities with higher percentage of urban poor population such as Addis Ababa had higher care coverage and quality performance.

Second, we posit that a substantial part of the variability we detected between cities is due to differences at the country level, including in health system attributes such as financing and human resources, policies and guidelines for maternal care provision as well as their successful implementation and monitoring. While we did not systematically examine these links in our analysis, we found that some of the poorly performing cities (Ndjamena, Conakry, Bamako) are in countries with overall poor performance as far as reproductive and maternal health is concerned. The national composite coverage index of reproductive, maternal and child health interventions in the three countries was below 40%, compared with a sub-Saharan average of 61%.[59] Suboptimal levels and spending of domestic and international health financing[60] and high out-of-pocket expenditures[61] might have impeded achievements in utilisation and provision of maternal services. Additionally, health system shocks such as the Ebola epidemic in Guinea,[62] conflict in Chad[63] and Mali[64] or political instability in Egypt[65] further threaten chronically under-funded public health systems.

Importantly, national policies and guidelines for the provision of maternal health services vary. This is most relevant to variability detected in the percentage of births occurring in health facilities (not all countries aim to make this a universal goal, focusing rather on coverage by skilled birth attendant) and in the measures of care content. Furthermore, implementation of care content guidelines can be compromised by crowding in health facilities, shortage of health workers and women's preferences and financial means. For example, the variable capturing LOS in a health facility after birth might differ across countries, not just in the recommended minimum specified in guidelines but also in the extent to which such timing is known, applied and monitored by the various providers and the health system. Providers might be prioritising care for women and newborns with complications or risk factors; this might be happening in cities where women stay very short after a vaginal birth but a high percentage of women after a CS stay a minimum of 72 hours (eg, Addis Ababa, Luanda, Lagos). This pattern might be compounded by the fact that in some settings with concerningly low levels of CS (Luanda, Conakry), only women in a critical state are able to access this life-saving procedure and consequently require relatively long inpatient stay for recuperation.

Third, the various patterns we document in the included cities can arise in part due to the specificity and complexity of maternal health provision in urban settings. Reducing preventable maternal and perinatal morbidity and mortality requires all levels of a health system, from routine outpatient care, which can be provided in health centres or in the community, to intensive care available in hospitals. The unpredictable nature of obstetric complications and rapid deterioration common to emergencies such as postpartum haemorrhage or obstructed labour require timely detection and effective linkage to a capable, staffed and equipped clinical setting. Furthermore, urban health systems relying on understanding geographic accessibility of care by using distances[66] can underestimate travel time several fold; this is due to specificities such as on-peak and off-peak traffic flows, unpredictable road conditions[67] and road repairs, security issues and checkpoints, seasonal weather conditions and availability of ambulances or other private motorised transport.[14] This means that the distribution of capable health facilities, effective referral networks, financial affordability of care and the extent to which time travel to health facilities is minimised are key components of a city-level ecosystem of maternal health services capable of saving lives. Indeed, the cities with lowest percentage of all births in health facilities were those in countries that have particularly poor road infrastructure, including Ndjamena in Chad and Monrovia in Liberia.[67] Unlike ANC and PNC, childbirth is particularly sensitive to any challenges with geographical access, as in most cases, a woman in labour needs to be at a health facility immediately, while the other two routine outpatient services are not commonly time sensitive.

We also recognise the critical importance of women's perceptions of the quality of care and trust in the various health facilities to cities achieving high coverage and optimal content of care. This is obvious when looking at the sequence of the three maternal health services; use of ANC is universal in most cities, declining for FBD and further still for PNC. It is the lack of success and a missed opportunity in retaining women in the

CoC, which causes poor overall performance. Some of the issues contributing to lack of continuity and trust in facility-based maternal healthcare are well documented and include verbal and physical abuse, informal out-of-pocket payments, lack of privacy in overcrowded facilities, lack of respect for women's time, lack of maternity protections and social support in general, poor clinical quality of care and the lack of basic conditions for dignified care provision such as water, soap, sanitation, beds and waiting areas.[68–70]

Limitations

There are several limitations to consider in interpreting our findings. First, while the DHS does not aim to collect data representative of cities, we conducted a thorough triangulation of evidence from multiple sources, including digital and local knowledge to delineate city boundaries for inclusion of sampled clusters. In addition, we do not know whether the services accessed by women in our sample were located in the same city as their residence. Second, considering that this study was only exploratory, we did not include all cities >1 million covered by the DHS, only the largest city per country. We do not believe this translates to substantial shortcomings in our findings related to variability across cities and the typology, especially as we considered all eligible cities in Africa, not only sub-Saharan Africa. Third, we made a choice to compare cities to one another in this analysis. However, this means that we did not compare included cities to their respective countries (overall, other urban areas or rural areas) and cannot report on examples of cities which perform better than the rest of the country while still average/below average in comparison to other cities. For relative performance of cities in our analysis, we used a simple method of pattern identification, trying to capture both absolute and relative levels. While we believe this was sufficient to identify basic typologies and best-worst performers, we acknowledge that this is not based on a rigorous statistical exercise. Fourth, the national surveys used in this study captured maternal indicators from a range of years (5-year period before 2013 and 2019). Given secular trends of improvement in coverage, cities with more recent surveys might show better performance. Furthermore, we would not have captured more complex dynamics between increasing coverage, potentially leading to poor content of care in the short term due to insufficient supply of care. As with many other studies, which use DHS data, the validity of women's recall of care use and content is a limitation; we attempted to minimise this issue by focusing on most recent live birth and recall period of 2 years for several indicators. The extent of missingness on variables used was minimal. Last, the DHS contain limited number of variables capturing content of care, and we do not know the extent to which these elements of care were proxies for good quality care (eg, whether a woman with high blood pressure during ANC was managed correctly).

CONCLUSION

In this exploratory comparative analysis of maternal health service utilisation and content in large African cities, we identified some cities which are underperforming as well as better-performing on the three various service types and across the CoC. This can be helpful in identifying sites for future study of success factors contributing to high and low performance.[71] Such future studies should be contextualised within each country, to understand the impact of country-level policies and health provision vis-à-vis the situation in the city(ies) studied. While there were no clear overarching patterns linking utilisation, sector, level of provision and content with city characteristics, there were several points that this study has helped bring to the fore. We noted two critical *missed opportunities*: to convert women's initial use of care towards a complete CoC and towards ensuring optimal content of care. On the other hand, we also identified *opportunities taken*—in cities with best relative performance and also on a more granular level, of what appears to be signs of prioritising care to women who at highest risk of complications in a setting with scarce resources. Future studies might benefit from the typology proposed in this study to select cities for further in-depth examination of lessons on how to improve urban maternal health service utilisation and provision. There is also a case for including cities from additional countries as well as additional cities in each country to understand the determinants of their performance, within the broader agenda of prioritising issues of maternal health in Africa in the remaining SDG era.[72]

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REFERENCES

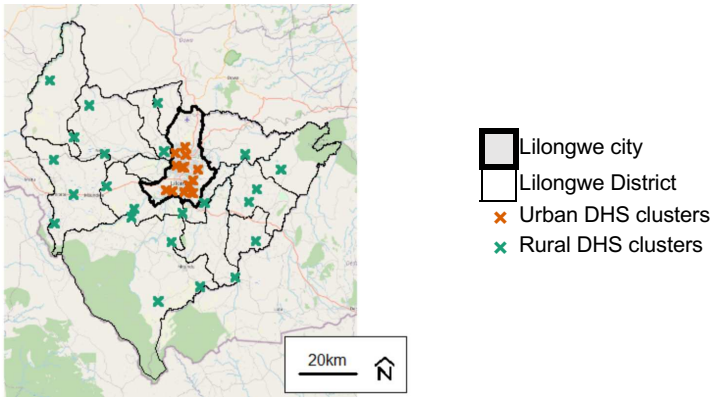
1 World Health Organization. Trends in maternal mortality 2000 to 2017: estimates by who, UNICEF, UNFPA, world bank group and the United nations population division, 2019. Available: https://www.unfpa.org/sites/default/files/pub-pdf/Maternal_mortality_report.pdf
2 Say L, Chou D, Gemmill A, *et al*. Global causes of maternal death: a who systematic analysis. *Lancet Glob Health* 2014;2:e323–33.
3 Chou D, Daelmans B, Jolivet RR, *et al*. Ending preventable maternal and newborn mortality and stillbirths. *BMJ* 2015;351:h4255–22.
4 Campbell OMR, Benova L, MacLeod D, *et al*. Family planning, antenatal and delivery care: cross-sectional survey evidence on levels of coverage and inequalities by public and private sector in 57 low- and middle-income countries. *Trop Med Int Health* 2016;21:486–503.
5 Benova L, Tunçalp Özge, Moran AC, *et al*. Not just a number: examining coverage and content of antenatal care in low-income and middle-income countries. *BMJ Glob Health* 2018;3:e000779. doi:10.1136/bmjgh-2018-000779
6 Doctor HV, Radovich E, Benova L. Time trends in facility-based and private-sector childbirth care: analysis of demographic and health surveys from 25 sub-Saharan African countries from 2000 to 2016. *J Glob Health* 2019;9:020406.
7 Pugliese-Garcia M, Radovich E, Campbell OMR, *et al*. Childbirth care in Egypt: a repeat cross-sectional analysis using demographic and health surveys between 1995 and 2014 examining use of care, provider mix and immediate postpartum care content. *BMC Pregnancy Childbirth* 2020;20:46.
8 Cresswell JA, Assarag B, Meski F-Z, *et al*. Trends in health facility deliveries and caesarean sections by wealth quintile in Morocco between 1987 and 2012. *Trop Med Int Health* 2015;20:607–16.
9 Gabrysch S, Nesbitt RC, Schoeps A, *et al*. Does facility birth reduce maternal and perinatal mortality in Brong Ahafo, Ghana? A secondary analysis using data on 119 244 pregnancies from two cluster-randomised controlled trials. *Lancet Glob Health* 2019;7:e1074.
10 Kruk ME, Gage AD, Joseph NT, *et al*. Mortality due to low-quality health systems in the universal health coverage era: a systematic analysis of amenable deaths in 137 countries. *Lancet* 2018;392:2203–12. doi:10.1016/S0140-6736(18)31668-4
11 Leslie HH, Spiegelman D, Zhou X, *et al*. Service readiness of health facilities in Bangladesh, Haiti, Kenya, Malawi, Namibia, Nepal, Rwanda, Senegal, Uganda and the United Republic of Tanzania. *Bull World Health Organ* 2017;95:738–48.
12 United Nations. World urbanization prospects: the 2018 revision (report no: ST/ESA/SER.A/420), 2019. Available: https://population.un.org/wup/Publications/Files/WUP2018-Report.pdf
13 United Nations. Population 2030: demographic challenges and opportunities for sustainable development planning, 2015. Available: https://www.un.org/en/development/desa/population/publications/pdf/trends/Population2030.pdf
14 Banke-Thomas A, Wong KLM, Ayomoh FI, *et al*. "In cities, it's not far, but it takes long": comparing estimated and replicated travel times to reach life-saving obstetric care in Lagos, Nigeria. *BMJ Glob Health* 2021;6:e004318.
15 Banke-Thomas A, Balogun M, Wright O, *et al*. Reaching health facilities in situations of emergency: qualitative study capturing experiences of pregnant women in Africa's largest megacity. *Reprod Health* 2020;17:145.
16 Matthews Z, Channon A, Neal S, *et al*. Examining the "urban advantage" in maternal health care in developing countries. *PLoS Med* 2010;7. doi:10.1371/journal.pmed.1000327. [Epub ahead of print: 14 Sep 2010].
17 Banke-Thomas A, Wong KLM, Collins L, *et al*. An assessment of geographical access and factors influencing travel time to emergency obstetric care in the urban state of Lagos, Nigeria. *Health Policy Plan* 2021;36:1384–96. doi:10.1093/heapol/czab099
18 Norris M, Klabbers G, Pembe AB, *et al*. A growing disadvantage of being born in an urban area? analysing urban-rural disparities in neonatal mortality in 21 African countries with a focus on Tanzania. *BMJ Glob Health* 2022;7.
19 Ouma PO, Maina J, Thuranira PN, *et al*. Access to emergency hospital care provided by the public sector in sub-Saharan Africa in 2015: a geocoded inventory and spatial analysis. *Lancet Glob Health* 2018;6:e342–50.
20 Kanyangarara M, Chou VB, Creanga AA, *et al*. Linking household and health facility surveys to assess obstetric service availability, readiness and coverage: evidence from 17 low- and middle-income countries. *J Glob Health* 2018;8:10603.
21 Ahmed S, Adams AM, Islam R, *et al*. Impact of traffic variability on geographic accessibility to 24/7 emergency healthcare for the urban poor: a GIS study in Dhaka, Bangladesh. *PLoS One* 2019;14:e0222488. doi:10.1371/journal.pone.0222488
22 Kruk ME, Kujawski S, Moyer CA, *et al*. Next generation maternal health: external shocks and health-system innovations. *Lancet* 2016;388:2296–306.
23 Resnick D. Urban governance and service delivery in African cities: the role of politics and policies. *Development Policy Review* 2014;32:s3–17.
24 Semrau KEA, Hirschhorn LR, Marx Delaney M, *et al*. Outcomes of a Coaching-Based who safe childbirth checklist program in India. *N Engl J Med* 2017;377:2313–24. doi:10.1056/NEJMoa1701075
25 Arsenault C, Jordan K, Lee D, *et al*. Equity in antenatal care quality: an analysis of 91 national household surveys. *Lancet Glob Health* 2018;6:e1186–95. doi:10.1016/S2214-109X(18)30389-9
26 Miller S, Abalos E, Chamillard M, *et al*. Beyond too little, too late and too much, too soon: a pathway towards evidence-based, respectful maternity care worldwide. *Lancet* 2016;388:2176–92. doi:10.1016/S0140-6736(16)31472-6
27 Das J, Hammer J. Money for nothing: the dire Straits of medical practice in Delhi, India. *J Dev Econ* 2007;83:1–36. doi:10.1016/j.jdeveco.2006.05.004
28 Fernandez A, Mondkar J, Mathai S. Urban slum-specific issues in neonatal survival. *Indian Pediatr* 2003;40:1161–6.
29 Boex J, Malik AA, Brookins D. *Dynamic Cities? The Role of Urban Local Governments. - Google Scholar*. Washington, DC: Urban Institute, 2016.
30 Bakibinga P, Ettarh R, Ziraba AK, *et al*. The effect of enhanced public-private partnerships on maternal, newborn and child health services and outcomes in Nairobi-Kenya: the PAMANECH quasi-experimental research protocol. *BMJ Open* 2014;4:e006608.
31 Kyei-Nimakoh M, Carolan-Olah M, McCann TV. Access barriers to obstetric care at health facilities in sub-Saharan Africa-a systematic review. *Syst Rev* 2017;6:110.

32 Eckardt M, Harp HL, Ahn R, *et al*. Maternal Health Innovations and Urbanization. In: *Innovating for healthy urbanization*, 2015: 3–18.
33 Carvajal–Aguirre L, Amouzou A, Mehra V, *et al*. Gap between contact and content in maternal and newborn care: an analysis of data from 20 countries in sub–Saharan Africa. *J Glob Health* 2017;7:20501.
34 Elsey H, Agyepong I, Huque R, *et al*. Rethinking health systems in the context of urbanisation: challenges from four rapidly urbanising low-income and middle-income countries. *BMJ Glob Health* 2019;4:e001501.
35 Kruk ME, Leslie HH, Verguet S, *et al*. Quality of basic maternal care functions in health facilities of five African countries: an analysis of national health system surveys. *Lancet Glob Health* 2016;4:e845–55.
36 Anastasi E, Ekanem E, Hill O, *et al*. Unmasking inequalities: Sub-national maternal and child mortality data from two urban slums in Lagos, Nigeria tells the story. *PLoS One* 2017;12:e0177190.
37 Ziraba AK, Madise N, Mills S, *et al*. Maternal mortality in the informal settlements of Nairobi City: what do we know? *Reprod Health* 2009;6:6.
38 Coast E, McDaid D, Leone T. *What are the effects of different models of delivery for improving maternal and infant health outcomes for poor people in urban areas in low income and lower middle income countries?* London and New York, 2012. http://eprints.lse.ac.uk/41908/1/What_are_the_effects_of_different_models_of_delivery_for_improving_maternal_and_infant_outcomes_for_poor_people_in_urban_areas_in_low_income_and_lower_middle_income_countries_(LSERO).pdf
39 Oduro-Mensah E, Agyepong IA, Frimpong E, *et al*. Implementation of a referral and expert advice call center for maternal and newborn care in the resource constrained health system context of the greater Accra region of Ghana. *BMC Pregnancy Childbirth* 2021;21:56.
40 Janocha B, Donohue RE, Fish TD. *Guidance and recommendations for the use of indicator estimates at Subnational administrative level 2*, 2021. https://dhsprogram.com/pubs/pdf/SAR20/SAR20.pdf
41 Africapolis. Africapolis: Visualise urbanisation in Africa, 2021. Available: https://africapolis.org/en [Accessed 10 Oct 2021].
42 Global Administrative Areas. Boundaries without limits, 2017. Available: http://www.gadm.org/ [Accessed 14 Dec 2017].
43 Burgert CR, Colston J, Roy T. Geographic displacement procedure and Georeferenced data release policy for the demographic and health surveys. In: *DHS spatial analysis reports report no: 7*. Calverton, Maryland, USA, 2013.
44 Footman K, Benova L, Goodman C, *et al*. Using multi-country household surveys to understand who provides reproductive and maternal health services in low- and middle-income countries: a critical appraisal of the demographic and health surveys. *Trop Med Int Health* 2015;20:589.
45 Campbell OMR, Cegolon L, Macleod D, *et al*. Length of stay after childbirth in 92 countries and associated factors in 30 low- and middle-income countries: compilation of reported data and a cross-sectional analysis from nationally representative surveys. *PLoS Med* 2016;13:e1001972.
46 Benova L, Owolabi O, Radovich E, *et al*. Provision of postpartum care to women giving birth in health facilities in sub-Saharan Africa: a cross-sectional study using demographic and health survey data from 33 countries. *PLoS Med* 2019;16:e1002943.
47 Bradley Sarah EK, Croft Trevor N, Fishel Joy D, *et al*. *Revising unmet need for family planning. DHS analytical studies No. 25*. Calverton, Maryland: ICF International, 2012.
48 Crochemore I, Da Silva M, Everling F. Does women's age matter in the SDGs era: coverage of demand for family planning satisfied with modern methods and institutional delivery in 91 low-and middle-income countries. *Reproductive Health* 2020;17.
49 Faye CM, Wehrmeister FC, Melesse DY, *et al*. Large and persistent subnational inequalities in reproductive, maternal, newborn and child health intervention coverage in sub-Saharan Africa. *BMJ Glob Health* 2020;5:e002232.
50 Ronsmans C, Etard JF, Walraven G, *et al*. Maternal mortality and access to obstetric services in West Africa. *Trop Med Int Health* 2003;8:940–8.
51 Macharia PM, Ray N, Giorgi E, *et al*. Defining service catchment areas in low-resource settings. *BMJ Glob Health* 2021;6:e006381.
52 WHO, UNFPA. *Unicef, averting maternal deaths and disabilities. monitoring emergency obstetric care: a Handbook*. Geneva, Switzerland: WHO Press, 2009.
53 Babajide O, Martins DC, Maani N, *et al*. Improving decision-making for population health in Nonhealth sectors in urban environments: the example of the transportation sector in three Megacities-the 3-D Commission. *J Urban Health* 2021;98:60–8.
54 The World Bank. Data Population living in slums (% of urban population) - Sub-Saharan Africa, 2021. Available: https://data.worldbank.org/indicator/EN.POP.SLUM.UR.ZS?locations=ZG&most_recent_value_desc=true [Accessed 10 Oct 2021].
55 Atusiimire LB, Waiswa P, Atuyambe L, *et al*. Determinants of facility based-deliveries among urban slum dwellers of Kampala, Uganda. *PLoS One* 2019;14:e0214995.
56 Gowayed H, Beňová L. This is all Koosa: Health-seeking for children in a Cairo slum: balancing need money and mistrust. *CiteSeerX* 2009.
57 Pariyo GW, Ekirapa-Kiracho E, Okui O, *et al*. Changes in utilization of health services among poor and rural residents in Uganda: are reforms benefitting the poor? *Int J Equity Health* 2009;8:39.
58 The World Bank. Data Population living in slums (% of urban population) - Kenya, Tanzania, 2021. Available: https://data.worldbank.org/indicator/EN.POP.SLUM.UR.ZS?locations=KE-TZ&view=map [Accessed 10 Oct 2021].
59 Wehrmeister FC, Fayé CM, da Silva ICM, *et al*. Wealth-related inequalities in the coverage of reproductive, maternal, newborn and child health interventions in 36 countries in the African region. *Bull World Health Organ* 2020;98:394–405.
60 Grollman C, Arregoces L, Martínez-Álvarez M, *et al*. 11 years of tracking aid to reproductive, maternal, newborn, and child health: estimates and analysis for 2003-13 from the countdown to 2015. *Lancet Glob Health* 2017;5:e104–14.
61 Sidze EM, Mutua MK, Donfouet HP. Towards achieving equity in utilisation of maternal health services in selected sub-Saharan African countries: progress and remaining challenges in priority countries. In: *Women and sustainable human development*, 2020: 111–24.
62 Delamou A, Ayadi AME, Sidibe S, *et al*. Effect of Ebola virus disease on maternal and child health services in guinea: a retrospective observational cohort study. *Lancet Glob Health* 2017;5:e448–57.
63 Kountchou AM, Sonne SEW, Gadom DG. The Local Impact of Armed Conflict on Children's Nutrition and Health Outcomes: Evidence from Chad (HiCN Working Paper). Report No: 301, 2019. Available: https://hicn.org/wp-content/uploads/sites/10/2019/05/HiCN-WP-301.pdf
64 Ataullahjan A, Gaffey MF, Tounkara M, *et al*. *C'est vraiment compliqué*: a case study on the delivery of maternal and child health and nutrition interventions in the conflict-affected regions of Mali. *Confl Health* 2020;14:36.
65 Pugliese-Garcia M, Radovich E, Hassanein N, *et al*. Temporal and regional variations in use, equity and quality of antenatal care in Egypt: a repeat cross-sectional analysis using demographic and health surveys. *BMC Pregnancy Childbirth* 2019;19:268.
66 Maina J, Ouma PO, Macharia PM, *et al*. A spatial database of health facilities managed by the public health sector in sub Saharan Africa. *Sci Data* 2019;6:134.
67 Buys P, Deichmann U, Wheeler D, Development Research Group World Bank. Road Network Upgrading and Overland Trade Expansion in Sub-Saharan Africa [Internet]. Washington D.C (World Bank Policy Research Working Paper). Report No.: WPS4097, 2006. Available: https://documents1.worldbank.org/curated/en/441351468194327279/pdf/wps4097.pdf
68 Tiruneh GT, Worku A, Berhane Y, *et al*. Determinants of postnatal care utilization in Ethiopia: a multilevel analysis. *BMC Pregnancy Childbirth* 2020;20:549.
69 Ejigu Tafere T, Afework MF, Yalew AW. Antenatal care service quality increases the odds of utilizing institutional delivery in Bahir Dar City administration, North Western Ethiopia: a prospective follow up study. *PLoS One* 2018;13:e0192428.
70 Wright K, Banke-Thomas A, Sonoiki O, *et al*. Opinion of women on emergency obstetric care provided in public facilities in Lagos, Nigeria: a qualitative study. *Health Care Women Int* 2017;38:527–43.
71 Sequeira D'Mello B, Bwile P, Carmone AE, *et al*. Averting maternal death and disability in an urban network of care in Dar ES Salaam, Tanzania: a descriptive case study. *Health Syst Reform* 2020;6:e1834303.
72 Urban health post-2015. *Lancet* 2015;385:745.

Supplementary Material 1.

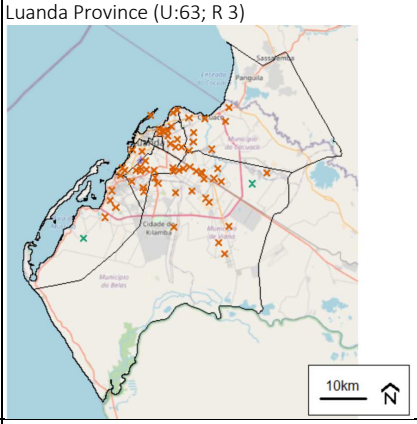
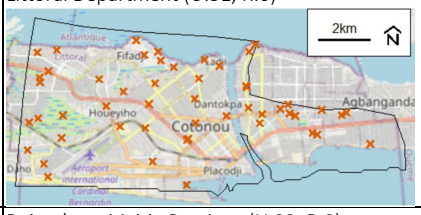
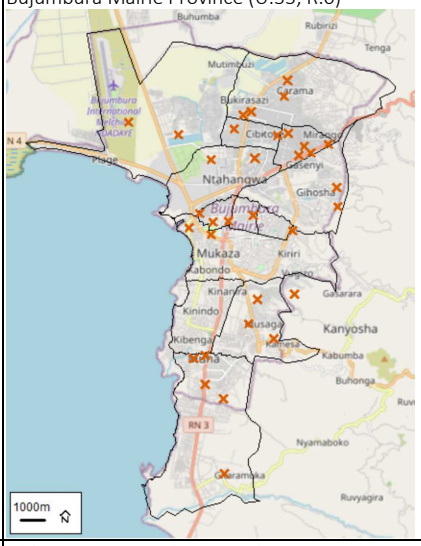
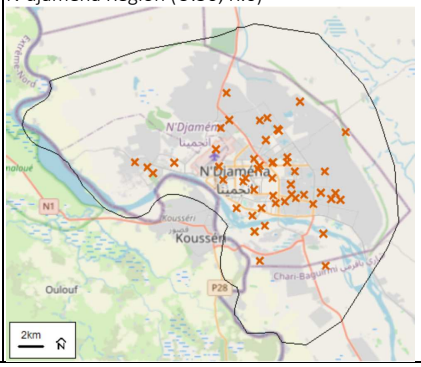
The DHS sampling procedure includes sample size calculation to provide sufficient statistical power for estimation of different population and health indicators at the national level, as well as at the level of the first administrative region. The first administrative regions are usually further divided into 2-4 smaller administrative subdivisions that are hierarchically nested within the level(s) above. Cities are typically at the level of a third- or fourth- administrative region; and the use of a subset of observations from a DHS sample for estimation at the level of a subdivision may be underpowered.

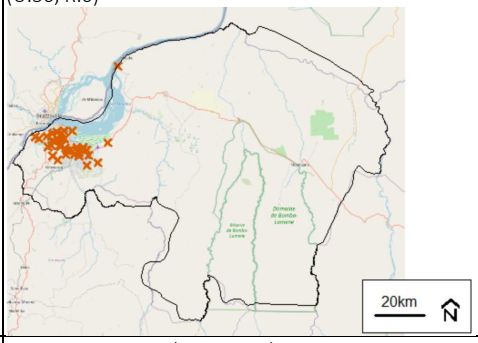
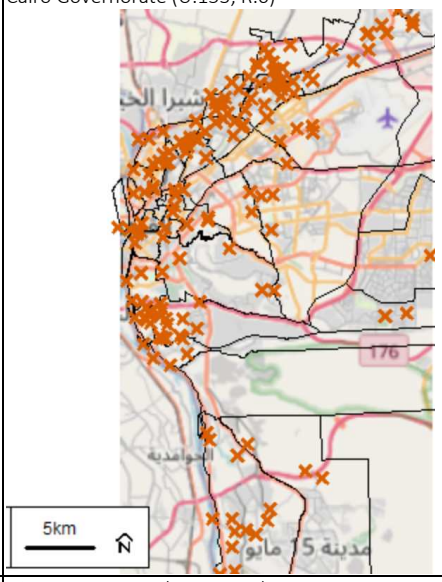
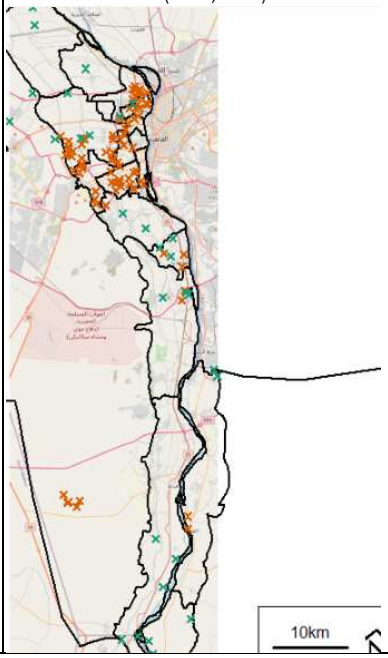
Lilongwe city, for instance, is the most populous city in Malawi, and is located within the Lilongwe District (see Figure below). In the Malawi 2015/6 DHS, 37 of all the 1631 clusters/EAs in the Lilongwe District (first administrative region) were sampled to provide enough power for estimation for the district. Among these 37 sampled clusters, 14 (all urban) were located within the area of Lilongwe city and the other 23 (all rural) outside. In this study, we consider the 14 urban clusters inside of the city boundaries as the study sample for Lilongwe city.

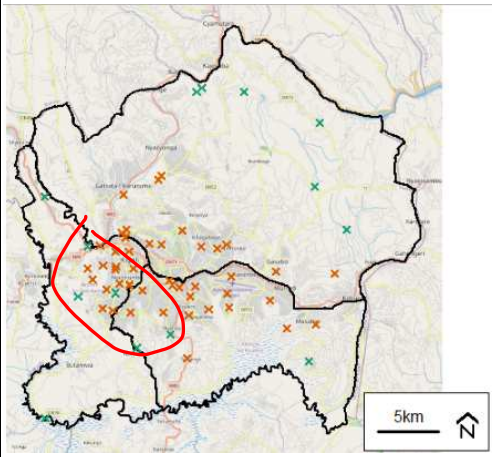
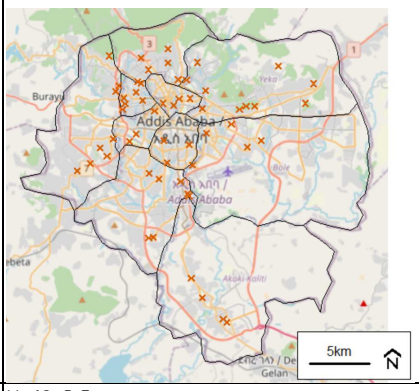
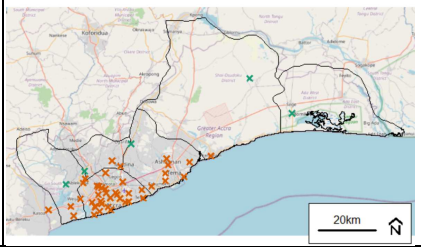


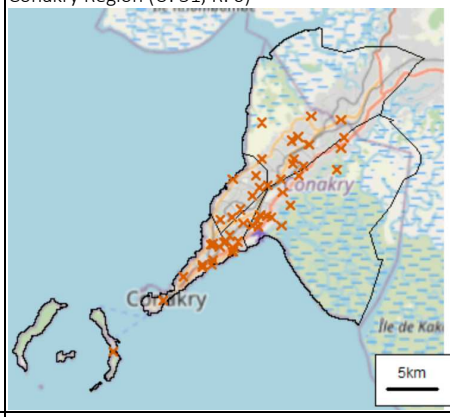
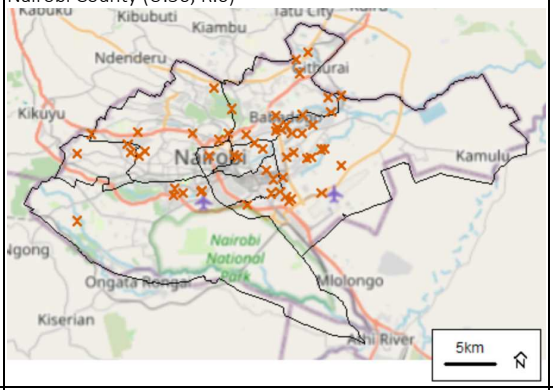
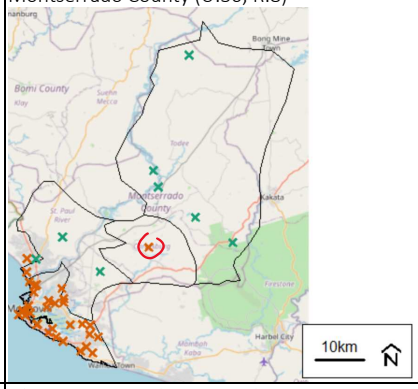
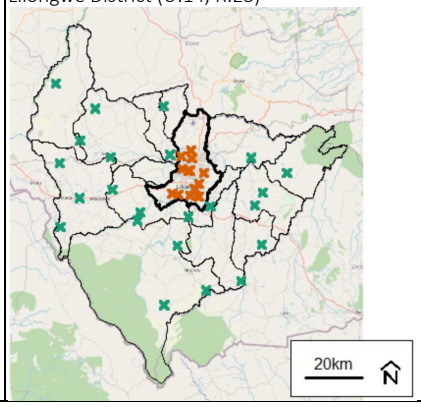
In Supplementary Material I, we present the clusters locations of all cities, and the boundaries of their respective cities. We report the number of clusters at the level of first administrative region, and the number of clusters inside the boundary of the city (Table 2)[1]. Map legend is shown on the last page of this supplementary material.

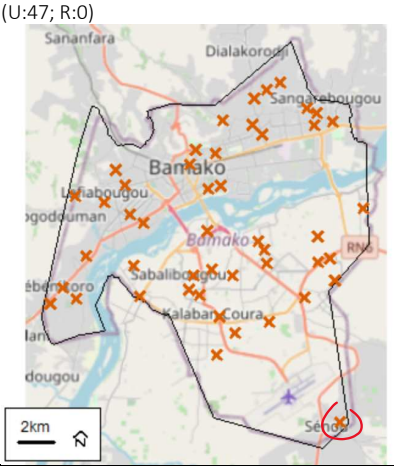
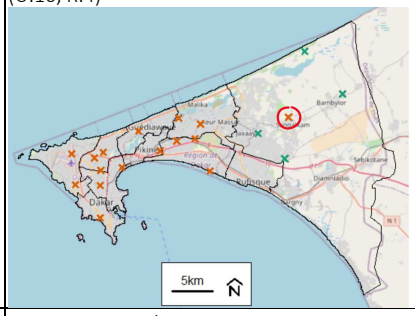
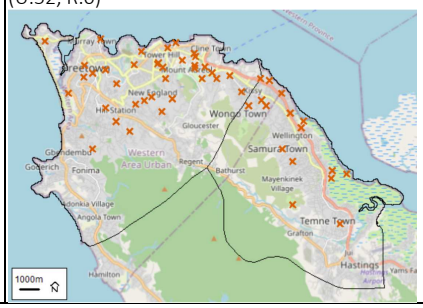
[1] Map data copyrighted OpenStreetMap contributors and available from https://www.openstreetmap.org.

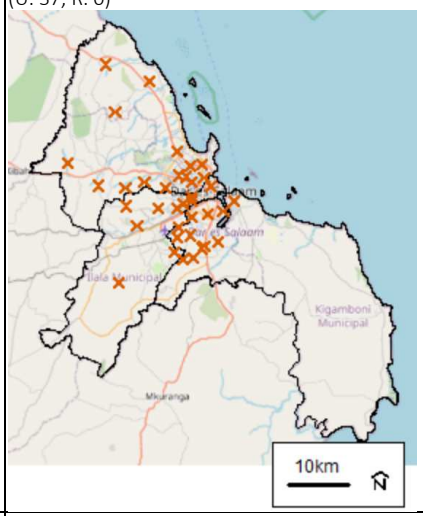
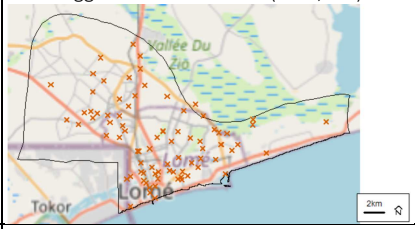
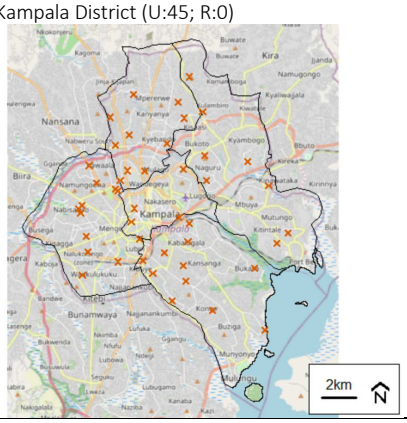
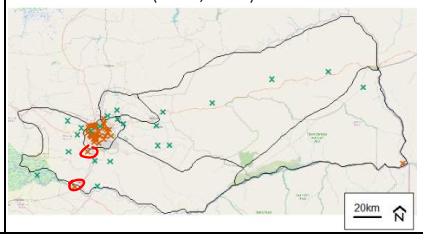
DHS	City of interest	Smallest administrative unit representative	Extent of "urban"/"city" area
Angola 2015-16	Luanda	Luanda Province (U:63; R 3) 	We consider all urban clusters as being in Luanda city.
Benin 2017	Cotonou	Littoral Department (U:51; R:0) 	Urban clusters only; we consider all urban clusters as being in Cotonou city.
2016 Burundi	Bujumbura Mairie	Bujumbura Mairie Province (U:33; R:0) 	Urban clusters only; we consider all urban clusters as being in Bujumbura city.
Chad 2014	N'djamena	N'djamena Region (U:50; R:0) 	Urban clusters only; we consider all urban clusters as being in N'djamena city.

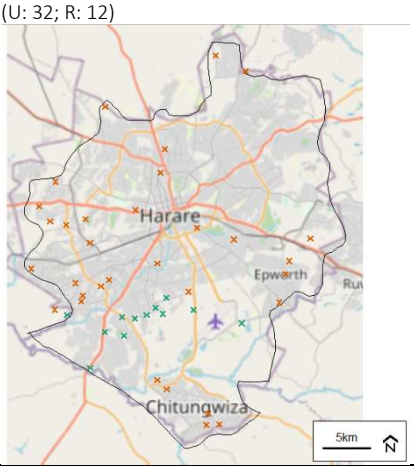
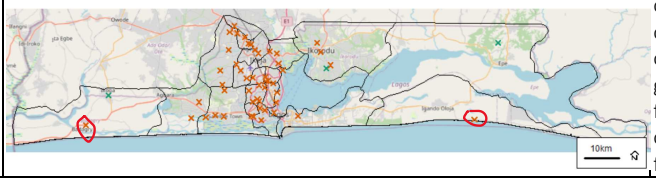
DRC 2013-14	Kinshasa	Kinshasa Province (or Ville de Kinshasa) (U:36; R:0) 	Urban clusters only; ; we consider all urban clusters as being in Kinshasa city.
Egypt 2014	Cairo	Cairo Governorate (U:153; R:0) 	We consider all urban clusters as being in Cairo city and Giza city. For Giza, we decided to include all urban clusters in our analytical sample.
Egypt 2014	Giza	Giza Governorate (U:79; R:29) 	

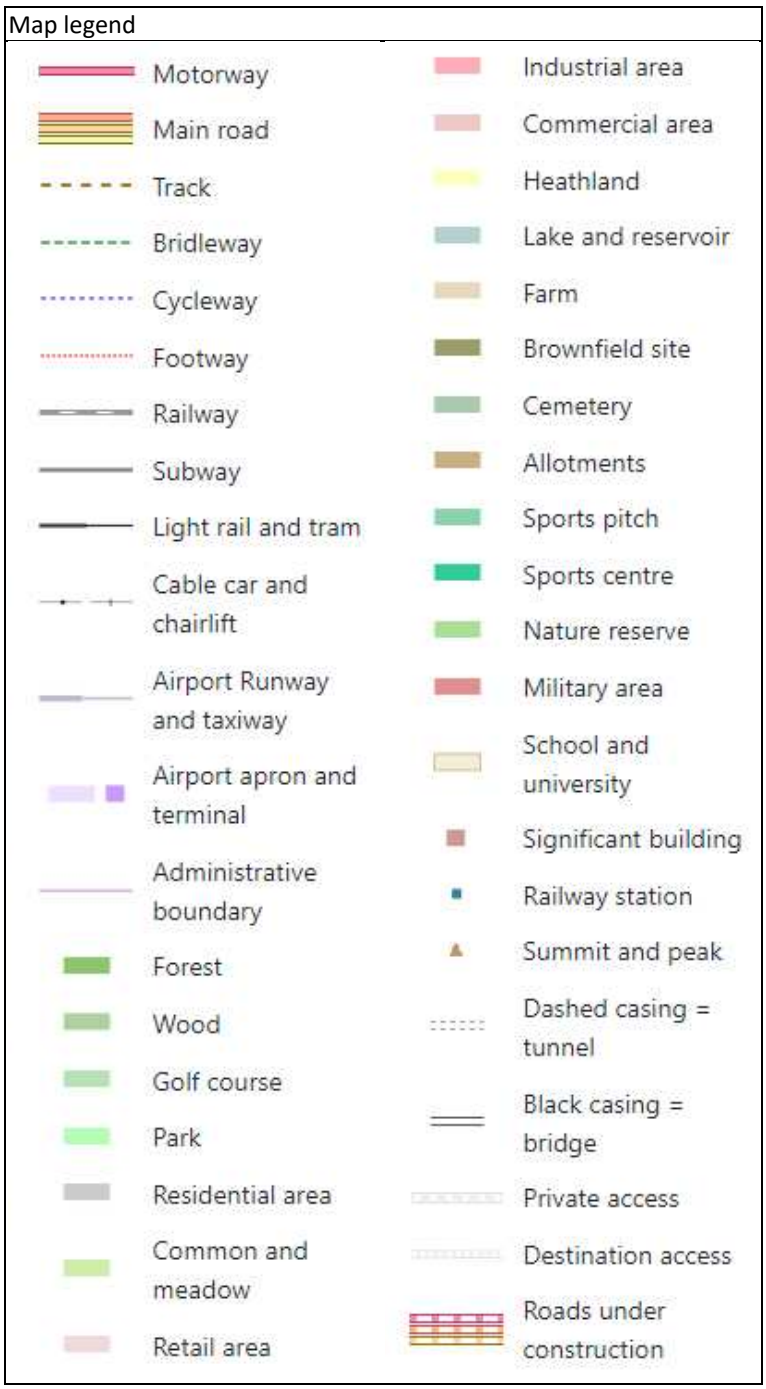
Rwanda 2014-15	Kigali	Kigali City Province (U: 46; R: 14) 	The area circle contains both urban clusters and rural clusters despite them appearing to be in vicinity of each other. We are unable to confirm if the rural clusters might be in settings similar to those classified as urban (due to displacement by DHS), and therefore decide to exclude Kigali from the analysis.
Ethiopia 2016	Addis Ababa	Addis Ababa (U:56; R:0) 	Urban clusters only; we consider all urban clusters as being in Addis Ababa city.
Ghana 2014	Accra	U: 42; R:5 	We consider all urban clusters as being in Accra city.

Guinea 2018	Conakry	Conakry Region (U: 51; R: 0) 	Urban clusters only; we consider all urban clusters as being in Conakry city.
Kenya 2014	Nairobi	Nairobi County (U:56; R:0) 	Urban clusters only; we consider all urban clusters to be in Nairobi city.
Liberia 2019	Monrovia	Montserrado County (U:36; R:8) 	We consider all urban clusters to be in Monrovia city; except for the one in circle which appears to be geographically separated from the other clusters and may represent women and births from another part of Montserrado County more than those from Monrovia city.
Malawi 2015-16	Lilongwe	Lilongwe District (U:14; R:23) 	We consider all urban clusters as being in Lilongwe city.

Mali 2018	Bamako	Bamako Capital District (U:47; R:0) 	Urban clusters only; we consider all urban clusters to be in Bamako city, except for the one in circle which appears to be geographically separated from, and may be contextually different from the other clusters.
Senegal 2019 (cont. DHS)	Dakar	Dakar Region (U:16; R:4) 	We consider all urban clusters as being in Dakar city, except for the one in circle which appears to be geographically separated from, and may be contextually different from the other clusters.
Sierra Leone 2019	Freetown	Western Area Urban (U:52; R:0) 	Urban clusters only; we consider all urban clusters to be in Freetown city.

Tanzania 2015-16	Dar es Salaam	Dar es Salaam Region (U: 37; R: 0) 	Urban clusters only; we consider all urban clusters to be in Dar es Salaam city.
Togo 2013	Lome	Grand agglomerationde Lome (U:82; R:0) 	Urban clusters only; we consider all urban clusters to be in Lome city.
Uganda 2016	Kampala	Kampala District (U:45; R:0) 	Urban clusters only; we consider all urban clusters to be in Kampala city.
Zambia 2018	Lusaka	Lusaka Province (U:41; R:22) 	We consider all urban clusters as being in Lusaka city, except for the two in circle which appear to be geographically separated from, and may be contextually different from the other clusters

Zimbabwe 2015	Harare	Harare Province (U: 32; R: 12) 	We consider all urban clusters as being in Harare city.
Nigeria 2018	Lagos	Lagos State (U: 49; R: 3) 	We consider all urban clusters as being in Lagos city, except for the two in circle which appear to be geographically separated from, and may be contextually different from the other clusters.


Map legend
Motorway
Main road
Track
Bridleway
Cycleway
Footway
Railway
Subway
Light rail and tram
Cable car and chairlift
Airport Runway and taxiway
Airport apron and terminal
Administrative boundary
Forest
Wood
Golf course
Park
Residential area
Common and meadow
Retail area
Industrial area
Commercial area
Heathland
Lake and reservoir
Farm
Brownfield site
Cemetery
Allotments
Sports pitch
Sports centre
Nature reserve
Military area
School and university
Significant building
Railway station
Summit and peak
Dashed casing = tunnel
Black casing = bridge
Private access
Destination access
Roads under construction

Supplementary Material 2. Characteristics of women living in included 22 cities in Africa who reported a live birth during the five-year survey recall period and 95% confidence interval

	Mean age	% ever married	Mean age at first cohabitation	Mean number of years	Education % None	% Primary	% Secondary	% Higher	% currently in employment	Mean parity	% with unmet need for family planning
Bujumbura	30.0 (28.9,31.0)	90.6 (87.1,94.1)	21.4 (20.7,22.1)	7.6 (6.6,8.5)	13.0 (9.7,16.4)	39.0 (32.2,45.7)	38.2 (30.2,46.2)	9.8 (5.0,14.5)	56.6 (50.0,63.2)	3.1 (2.8,3.4)	21.6 (14.9,28.4)
Lilongwe	27.6 (26.6,28.7)	94.0 (90.5,97.4)	20.0 (18.9,21.2)	9.4 (8.0,10.9)	2.3 (0.6,3.9)	36.7 (23.9,49.5)	43.4 (31.6,55.2)	17.6 (0.6,34.6)	62.4 (52.6,72.2)	2.3 (2.1,2.6)	12.1 (6.1,18.1)
Ndjamena	27.3 (26.8,27.7)	96.9 (95.6,98.3)	16.7 (16.3,17.1)	5.0 (4.3,5.7)	43.4 (37.4,49.5)	18.7 (15.4,21.9)	31.2 (26.1,36.3)	6.7 (4.7,8.6)	27.3 (21.9,32.7)	4.0 (3.7,4.2)	35.5 (31.4,39.6)
Monrovia	27.7 (26.9,28.6)	58.3 (52.0,64.6)	20.4 (19.4,21.4)	7.9 (7.2,8.5)	19.8 (16.3,23.3)	12.0 (8.6,15.5)	57.1 (51.5,62.6)	11.1 (7.5,14.8)	55.4 (48.0,62.7)	2.4 (2.2,2.6)	32.6 (27.2,38.0)
Freetown	28.0 (27.4,28.7)	77.4 (73.4,81.3)	19.8 (19.1,20.4)	6.7 (6.2,7.3)	31.5 (26.9,36.1)	10.1 (6.9,13.3)	48.3 (42.8,53.7)	10.2 (6.5,13.8)	57.1 (51.4,62.8)	2.4 (2.3,2.6)	38.0 (32.2,43.9)
Cotonou	30.3 (29.8,30.7)	94.3 (92.2,96.4)	21.3 (20.8,21.8)	5.9 (5.3,6.5)	27.1 (22.8,31.4)	29.5 (25.0,33.9)	33.0 (28.2,37.8)	10.4 (6.8,14.1)	80.1 (75.8,84.3)	2.9 (2.7,3.0)	42.4 (37.9,46.8)
Lome	29.6 (29.1,30.1)	94.2 (92.6,95.9)	20.7 (20.3,21.1)	5.8 (5.4,6.2)	19.9 (16.8,23.1)	38.5 (34.9,42.1)	36.6 (32.9,40.3)	5.0 (3.1,6.9)	77.9 (73.9,82.0)	2.6 (2.5,2.7)	42.4 (38.8,46.0)
Conakry	28.5 (27.8,29.1)	89.8 (86.0,93.7)	18.6 (18.1,19.1)	5.1 (4.4,5.7)	48.6 (43.6,53.6)	15.1 (11.6,18.5)	26.6 (22.9,30.3)	9.7 (7.1,12.4)	63.3 (57.2,69.5)	2.9 (2.8,3.1)	28.2 (23.1,33.2)
Harare	29.4 (28.7,30.2)	97.1 (95.4,98.8)	20.3 (19.8,20.8)	10.9 (10.4,11.3)	0.0 *NA*	8.1 (4.6,11.6)	80.6 (75.8,85.3)	11.3 (6.7,16.0)	57.7 (52.2,63.2)	2.5 (2.3,2.7)	8.9 (4.5,13.3)
Lusaka	28.7 (27.8,29.6)	84.2 (80.7,87.8)	19.9 (19.1,20.6)	8.8 (8.2,9.4)	4.8 (2.9,6.8)	26.2 (22.1,30.4)	57.6 (53.0,62.1)	11.4 (5.4,17.3)	50.1 (45.2,55.1)	2.7 (2.6,2.9)	14.7 (10.1,19.2)
Bamako	28.4 (28.0,28.9)	94.1 (92.0,96.2)	18.9 (18.5,19.3)	4.6 (4.0,5.1)	46.6 (41.8,51.4)	11.3 (9.3,13.3)	34.9 (31.2,38.5)	7.2 (4.6,9.8)	54.5 (48.5,60.5)	3.2 (3.0,3.4)	26.1 (20.5,31.7)
Dakar	31.1 (29.9,32.3)	96.9 (94.3,99.5)	21.4 (20.0,22.8)	5.0 (3.5,6.5)	39.7 (27.4,52.1)	28.8 (19.5,38.1)	20.7 (13.0,28.5)	10.8 (3.0,18.6)	50.4 (43.9,57.0)	2.8 (2.4,3.2)	22.3 (15.3,29.3)
Addis Ababa	29.9 (29.4,30.5)	96.3 (94.1,98.5)	21.3 (20.7,21.9)	8.8 (8.1,9.5)	10.4 (6.1,14.8)	35.0 (29.2,40.9)	29.0 (23.6,34.3)	25.5 (19.4,31.7)	48.2 (43.6,52.7)	2.0 (1.9,2.2)	13.9 (10.3,17.4)
Kampala	27.9 (27.2,28.5)	89.2 (85.3,93.0)	19.6 (19.3,20.0)	9.7 (9.3,10.2)	2.2 (0.9,3.5)	28.7 (23.4,34.0)	49.5 (44.0,55.0)	19.6 (15.2,24.0)	62.7 (56.5,69.0)	2.7 (2.5,2.8)	23.5 (19.1,28.0)
Accra	31.3 (30.4,32.2)	91.9 (88.1,95.6)	22.2 (21.4,23.0)	8.3 (7.6,9.0)	10.2 (5.2,15.2)	16.7 (11.6,21.8)	61.9 (56.1,67.7)	11.2 (6.3,16.2)	79.1 (73.5,84.6)	2.6 (2.4,2.8)	40.4 (34.5,46.4)
Dar es Salaam	29.1 (28.5,29.7)	91.7 (88.4,94.9)	20.7 (20.1,21.3)	8.0 (7.4,8.6)	5.5 (2.7,8.4)	60.3 (52.9,67.6)	30.4 (23.2,37.6)	3.8 (1.1,6.6)	67.9 (61.7,74.2)	2.4 (2.2,2.6)	19.8 (16.1,23.6)
Nairobi	27.6 (27.1,28.1)	90.9 (88.2,93.5)	20.3 (19.8,20.9)	10.4 (9.9,11.0)	1.2 (0.0,2.5)	37.3 (29.2,45.4)	40.5 (34.6,46.4)	21.0 (13.9,28.1)	64.3 (56.9,71.6)	2.1 (1.9,2.3)	11.5 (6.8,16.3)
Luanda	28.4 (27.8,28.9)	85.1 (81.9,88.3)	19.6 (19.2,20.0)	7.3 (6.7,7.9)	8.8 (6.3,11.4)	31.4 (26.2,36.7)	52.5 (47.6,57.4)	7.2 (4.1,10.4)	66.1 (61.2,71.0)	3.3 (3.1,3.5)	39.3 (35.4,43.2)
Kinshasa	29.7 (29.1,30.4)	86.7 (83.5,89.8)	20.3 (19.7,21.0)	9.6 (8.9,10.3)	1.2 (0.4,1.9)	15.6 (10.1,21.1)	72.8 (67.2,78.3)	10.5 (6.0,14.9)	63.6 (57.0,70.3)	3.2 (3.0,3.4)	27.4 (22.9,31.9)
Johannesburg	29.3 (28.0,30.6)	64.2 (54.5,73.9)	22.1 (21.1,23.2)	11.0 (10.6,11.5)	0.0 *NA*	6.6 (1.8,11.4)	80.5 (71.8,89.3)	12.9 (3.8,21.9)	30.1 (19.3,40.9)	2.3 (2.0,2.6)	17.7 (8.9,26.5)
Lagos	31.9 (31.2,32.5)	95.5 (93.3,97.8)	23.9 (23.4,24.5)	11.4 (10.4,12.3)	3.5 (1.4,5.7)	13.0 (2.6,23.4)	53.1 (48.3,58.0)	30.3 (21.0,39.7)	82.7 (78.0,87.5)	2.7 (2.5,2.9)	18.3 (13.0,23.6)
Cairo/Giza	30.1 (29.6,30.5)	100.0 (100.0,100.0)*	21.6 (21.2,22.0)	10.1 (9.5,10.7)	11.2 (8.1,14.3)	7.7 (5.9,9.5)	55.9 (51.8,60.1)	25.2 (20.3,30.2)	12.0 (9.5,14.5)	2.5 (2.4,2.6)	11.2 (8.9,13.5)

*The Egypt 2014 DHS only included ever married women as respondents to the Women's Questionnaire.
NA – not applicable