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The Realities of Primary Care

Variation in Quality of Care Across Nine Countries in Sub-Saharan Africa

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Abstract

The COVID-19 pandemic has highlighted the centrality of primary care in protecting people's health and well-being during and beyond crises. It has also provided an opportunity to strengthen and redesign primary care so that it will better serve its purpose. However, to-date there is limited evidence on the quality of service delivery in primary care. Service Delivery Indicators surveys have attempted to fill this gap. Using Service Delivery Indicators surveys of 7,810 health facilities and 66,151 health care providers in nine Sub-Saharan African countries, this paper investigates the quality of care across five domains to understand a citizen's experience of primary care in his/her country. The results indicate substantial heterogeneity in the quality of primary care service delivery between and within countries. The availability of basic equipment, infrastructure, and essential medicines varies—public facilities, facilities in rural areas, and non-hospitals are more lacking compared with private facilities, urban facilities, and hospitals. In terms of patient care, health care providers' ability to correctly diagnose and treat common health conditions is low and variably distributed. COVID-19 has catalyzed a long overdue health system redesign effort, and the Service Delivery Indicators surveys offer an opportunity to examine carefully the quality of service delivery, with an eye toward health system reform.

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The Realities of Primary Care:
Variation in Quality of Care Across Nine Countries in Sub-Saharan Africa

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1. Introduction

Over 40 years ago, the Alma Ata declaration articulated the importance of primary health care (PHC) and called on governments, development partners, and the global community at large to protect and promote the health of all the people of the world.[2] Since then, health system reform has been at the center of global efforts, including the Millennium Development Goals and, more recently, the Sustainable Development Goals, which emphasized expanding population access to health services, strengthening health services and ultimately improving population health outcomes.[3] Strong primary care systems are also the foundation for achieving Universal Health Coverage, one of the key investments made by governments and development partners, including the World Bank, to ensure affordable access to care.[4]

As the world grapples with the COVID-19 pandemic, it has become increasingly clear that strong health care systems are the bulwark for protecting and promoting the health and well-being of the population during and beyond this and future health crises.[5] The need to offer treatment has demonstrated that the availability of hospital care and surge capacity is important for emergency response, while primary care has been equally important in helping control the spread of local outbreaks through testing and treatment, as well as maintaining provision of essential health services to communities.[6] In the current pandemic, medical professionals have faced serious risks, and their determination to provide quality care at the patient-level should be met with an equal determination to provide improvements at the system-level.

The COVID-19 pandemic has opened a window of opportunity for redesigning and strengthening health care systems to ensure they are prepared for both current challenges and the decade ahead. Massive investment is now being made globally in the health sector with the objective of health system strengthening at an accelerated pace. For example, the World Bank is providing significant support to the world's poorest countries and making rapid progress in directing up to $160 billion to countries in need in the form of COVID-19 emergency response.[7] As these investments are made, balancing immediate needs during the pandemic with long-term interests is imperative, or else shortsighted programs will run the risk of inefficient use of resources, altering service delivery such that it is no longer well-designed for non-pandemic health needs. Strategic investments can move the global community closer to more resilient health systems which are able to both address longstanding vulnerabilities and inequalities of the system and sustainably respond to a range of future crises.[8]

One of the most critical bottlenecks in realizing this aspiration is the limited actionable evidence on the current state of health systems. In recent years, there has been global momentum towards improving not just access to, but quality of, health services available to populations globally.[9] There is global consensus that improving the quality of health services should be guided by the experience of its intended users. With this guidance and using a large sample of health facilities from nearly decade of data collection efforts in Sub-Saharan Africa, we explore two distinct, but interlinked, questions in this paper. First, what is the average state of the health care system across nine countries in Sub-Saharan Africa? And second, to enhance health system resilience and guide

[2] UNICEF and WHO (1978).
[3] United Nations (2011); UN General Assembly (2015).
[4] WHO (2013); WHO & OECD (2018).
[5] WHO (2020).
[6] PHCPI – World Bank (2020).
[7] World Bank (2020a).
[8] English et al. (2020); Kruk et al. (2015).
[9] Kruk et al. (2018).

investment for long-term benefits in this region, what actionable lessons can be learned from an analysis of the variation in citizen experiences within the health care system?

2. The Service Delivery Indicators initiative

The SDI surveys were developed to directly respond to the need for accountability in social sector service delivery. The SDI initiative began in 2008 when researchers and practitioners at the World Bank Group, in partnership with the African Economic Research Consortium (AERC), the William and Flora Hewlett Foundation and the African Development Bank, developed novel survey tools and methodology to comprehensively measure primary health care and primary education service delivery.

The SDI initiative is premised on the concept of making services work for the poor, as outlined in the World Development Report 2004.[10] The report emphasizes the idea of accountability and of enabling clients to give feedback directly to providers of services. By creating measures of service provision through the SDI, health care providers can be held accountable for providing quality services and individuals in the community can use the results to demand improvements. Through this "short route to accountability", health systems can be improved not just through government decisions but by an active process involving citizen engagement. This focus is echoed in the recent Lancet Commission on High Quality Health Systems, which noted that "governments and civil society should ignite demand for quality in the population to empower people to hold systems accountable and actively seek high-quality care."[11]

The SDI health facility survey offers a set of indicators for benchmarking of health system performance. These indicators focus on potential determinants of the quality of services provided: the knowledge of medical providers; their effort towards patient care; and the availability of necessary equipment, supplies, and medicines. The survey adopts the perspective of an average patient, meaning that the focus is on indicators of provider knowledge of common conditions, and physical inputs required for commonly-used services. This information is collected through enumerator visits to a representative sample of health facilities in each country undertaking an SDI survey. The majority of the data collection is based on a survey administered to the facility manager, and also includes direct observation of the availability and functioning of infrastructure, equipment, medicines and other physical assets.

3. Data description and methodology

3.1 Sample

The SDI health surveys have been implemented for over 10 years across 13 countries in Sub-Saharan Africa and this paper presents data combined from across this period. Four surveys were excluded, either because they were pilots (Senegal 2010) or because they were not yet complete and data were not publicly available (Guinea Bissau 2018, Cameroon 2019, Malawi 2019). In countries with multiple SDI surveys, we include only the most recent survey, excluding Kenya 2012 and Tanzania 2010/2014. The resulting data set includes information on nine countries, covering 7,810 health facilities. The data include results from the following country surveys: Kenya (2018), Madagascar (2016), Mozambique (2014), Niger (2015), Nigeria (2013), Sierra Leone (2018), Tanzania (2016), Togo (2013) and Uganda (2013).

In each country, the sample of facilities is selected based on a complete listing of health facilities provided by the Ministry of Health. This includes facilities operated by private entities or non-governmental organizations (NGOs), and facilities at all levels of care, including hospitals, health clinics and health posts (or the national

[10] World Bank (2004).
[11] Kruk et al. (2018).

equivalent). Sample selection is stratified by rural/urban location and by facility-type. The proportion of private/NGO facilities varies, from 1% of the sample in Mozambique to 42% of the sample in Kenya, and the proportion of rural facilities also varies, from 49% of the sample in Madagascar to 88% in Mozambique. All surveys are designed to be nationally representative, except for Nigeria, where data were collected in 12 of 36 states due to logistical constraints and Kenya, where data were representative at the county-level. Details of the sample are listed in **Table 1**.

Table 1: Full sample

	All countries		Niger 2015		Mozambique 2014		Sierra Leone 2018		Madagascar 2016		Togo 2013		Uganda 2013		Tanzania 2016		Kenya 2018		Nigeria 2013	
GDP per capita in survey year			$1,048		$1,328		$1,604		$1,634		$1,761		$2,033		$3,227		$3,461		$5,980	
	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)
Total facilities	7810	-	255	-	195	-	536	-	444	-	180	-	394	-	383	-	3038	-	2385	-
Rural	5276	68%	192	75%	172	88%	377	70%	218	49%	126	70%	285	72%	222	58%	2249	74%	1435	60%
Urban	2534	32%	63	25%	23	12%	159	30%	226	51%	54	30%	109	28%	161	42%	789	26%	950	40%
Hospitals	872	11%	16	6%	38	19%	30	6%	37	8%	16	9%	9	2%	30	8%	285	9%	411	17%
Health clinics	2823	36%	67	26%	157	81%	109	20%	316	71%	46	26%	133	34%	91	24%	594	20%	1458	61%
Health posts	4115	53%	172	67%	0	0%	397	74%	91	20%	118	66%	252	64%	262	68%	2159	71%	516	22%
Public	5805	74%	220	86%	193	99%	493	92%	289	65%	143	79%	236	60%	266	69%	1762	58%	2203	92%
Private/NGO	2005	26%	35	14%	2	1%	43	8%	155	35%	37	21%	158	40%	117	31%	1276	42%	182	8%

3.2 Indicators

The SDI provides information on a wide variety of indicators and this paper highlights selected variables measuring service readiness, provider ability and effort. Brief descriptions of each variable are provided below, with further detail on the calculation of each in **Appendix Table A1**.

3.2.1 Infrastructure availability

Adequate infrastructure is a prerequisite for high quality care, and includes safe water, sanitation and hygiene (WaSH). The SDI measures the presence of an improved toilet and an improved water source, per JMP guidelines.[12] Running water is necessary for handwashing, cleaning and disinfecting. Toilets are a basic part of sanitation and help ensure patient dignity in facilities and while preventing open defecation, which can lead to infections. Both WaSH measures are necessary for infection prevention and control, ensuring the safety of both patients and health care providers and these metrics are particularly important for pandemic preparedness. In addition, the SDI measures the availability of electricity, necessary for maintaining the vaccination cold chain over longer periods and for operating diagnostic equipment, for example. Overall infrastructure availability is defined as the availability and functioning of all three inputs: an improved toilet, an improved water source and electricity.

3.2.2 Medicine and equipment availability

The availability of adequate medicine and equipment does not guarantee system performance, but any gaps in these inputs present a limiting factor in optimizing service delivery, regardless of the technical ability and behavior of the health care providers.[13] The medicines needed for a facility depend on the complexity of care offered and the national medicine requirements at each facility type. Our definition of medicine availability focuses on 14 common medicines, a subset of WHO's Model List of Essential Medicines.[14] The metric is calculated as the percentage of those 14 medicines which are available and in-stock on the day of the facility visit. The list of equipment necessary for a fully functional facility also varies, depending on the level and type of care provided. The SDI reports on four basic pieces of equipment (a thermometer, stethoscope, blood pressure cuff and weighing scale) which should be expected in any facility offering preventative and curative health care services. Equipment availability is reported as the percent of facilities with all four pieces of equipment available, while medicine availability is reported as the average percent of the 14 medicines available at facilities.

3.2.3 Caseload

Good care depends on having facilities adequately staffed, with the right type and number of health care providers. The SDI measures caseload, defined as the number of outpatient visits per health care provider per day, and this indicator is intended to measure the burden of care placed on each provider and the relative utilization of each facility. The indicator is calculated based on the number of outpatient visits within the last three months, the number of days per week that the facility is open, and the number of health care providers (including all types of providers that regularly offer outpatient consultations). The denominator is adjusted for the presence of providers to reflect the total number of health care providers available to provide care.

3.2.4 Provider absence rate

In order to provide quality care, doctors, nurses and other medical staff must be available at the facility. The SDI collects a full roster of staff during the initial survey data collection visit and then measures the presence or absence of up to 10 randomly selected staff during an unannounced second visit. The absence rate is calculated as the percent of randomly selected staff who are absent from the facility on the day of the second visit, out of

[12] UNICEF (2019).
[13] Leslie et al.(2017).
[14] WHO (2017).

the total number of randomly selected staff. Reasons for absence are also collected and are categorized as either authorized or unauthorized, to better understand the nature of health care provider absence from health facilities.

3.2.5 Diagnosis and treatment accuracy

In recent years, quality of care has received more attention in the health research community, with an increasing recognition that good health outcomes depend not just on patient access to care but on the competence and skill of the health care provider. Accurate diagnosis and treatment are important for the health outcomes of patients and can also influence future patterns of health care utilization.[15,16] The SDI survey includes clinical vignettes which are administered to health care providers. This is an innovative addition which measures the quality of clinical care, rather than the inputs-focused perspective that earlier surveys had taken.[17] Clinical vignettes may be less reliable for assessing quality of care than other methods, such as the use of standardized patients, but are easier to implement, less expensive and less disruptive to health facility operations. Overall, clinical vignettes have been shown to be "a valid and comprehensive method that directly focuses on the process of care provided in actual clinical practice."[18]

The standardized clinical vignettes assess health care providers' ability to diagnose and treat common outpatient conditions.[19] Vignettes are administered by two enumerators, who conduct the simulations privately with a clinician after walking the provider through an example case. The first enumerator imitates a patient presenting with an initial complaint and a basic description of the associated symptoms. The health care provider is encouraged to ask follow-up questions around symptoms and presentation of illness, and to request the results of various medical and laboratory tests. The first enumerator offers pre-specified responses to those questions and the second enumerator records how well the physician adheres to clinical guidelines in the questions asked and clinical actions undertaken. By the end of the vignette, the health care provider must provide a diagnosis and proposed treatment for the clinical case.

In the SDI surveys considered in this paper, health care providers are tested on five core vignettes: childhood diarrhea with dehydration, childhood pneumonia, adult tuberculosis (TB), adult diabetes mellitus, and childhood malaria with anemia. Additionally, countries may choose to add specific vignettes and occasionally remove vignettes (such as in Kenya where the malaria with anemia vignette was not administered). These vignettes represent common clinical cases that a health care provider would face in the low- and middle-income country (LMIC) context. These diseases also reflect some of the highest burden conditions, making up 30% of all-age disability-adjusted life years (DALYs) in Sub-Saharan Africa.[20] Each provider is scored on the percent of vignettes for which they provide the correct diagnosis and treatment. Correct treatment is not made conditional on correct diagnosis, so providers may occasionally recommend the correct treatment without a correct diagnosis.

To shed further light on clinical capacity to address maternal and child health issues, the SDI includes two additional vignettes designed to assess providers' responses to more urgent medical conditions: neonatal asphyxia and post-partum hemorrhage. Both of these conditions have a clear set of guidelines and recommended actions that the providers should undertake. For the purposes of scoring, providers are assessed on seven actions for neonatal asphyxia (calling for help, placing the baby in a neutral position, checking the baby's heartrate, checking

[15] Rao & Sheffel (2018).
[16] Escamilla et al. (2018).
[17] Das & Leonard (2006).
[18] Peabody et al. (2000).
[19] Das et al. (2008).
[20] Diarrhea at 7.6% of DALYs, Malaria at 7.9%, Diabetes at 1.3%, lower respiratory infections at 8.7%, tuberculosis at 3.3% and anemia at 1.4%, based on IHME (2020).

the baby's breathing, drying the baby, keeping the baby warm and initiating resuscitation with a bag/mask) and five actions for post-partum hemorrhage (determining the cause, providing bimanual uterine massage, placing a foley catheter, running an IV and providing oxytocin or similar drugs). Providers are scored on the number of actions that they propose. Further information on the clinical vignettes is available in **Appendix Table A2** and **Appendix Table A3.**

Finally, the SDI survey also collects information on inappropriate antibiotic use, defined as providers that prescribe an antibiotic during the tuberculosis vignettes (aside from the antibiotics recommended as part of the tuberculosis regimen) or any antibiotics for the diarrhea vignettes (for which antibiotics are not indicated given the patient examination). Inappropriate antibiotic usage is calculated as the percentage of health care providers that inappropriately prescribe antibiotics among all health care providers to whom the clinical vignettes are administered.

3.3 Methods

Summary statistics and estimates are reported using facility-level weights, which are created based on the inverse probability of being sampled. Facility-level sample weights are unavailable for Mozambique so the unweighted results are reported. Provider-level weights are also incorporated for health care provider absence and all vignette-based variables. More details on the sampling and weights are provided in **Appendix Table A4**. The sample includes a mix of facilities in terms of location (urban/rural), ownership (public and private) and facility levels (hospitals, health clinics and health posts). In all figures, countries are ordered by increasing GDP per capita to demonstrate how performance on health service indicators may correlate with country income. The estimates of GDP per capita (based on purchasing power parity in current international dollars) are from World Bank Open Data and the GDP value corresponds to the year of the survey in each country.[21]

While much can be gleaned already from cross tabulations, multivariate regressions are used to describe the relationship between each variable and the characteristics of the facilities or health care providers, controlling for potential confounders. For example, private facilities are more frequently located in urban areas, whereas public facilities are more frequently located in rural areas. Regression analyses are able to help tease out the location versus ownership effects and show which is most strongly correlated with the dependent variable. For facility-level indicators, such as equipment, medicine and infrastructure availability, the independent variables are public/private, rural/urban, facility level (hospital/health clinic/health post) and country-level fixed effects. For provider-level indicators, such as diagnostic accuracy, treatment accuracy and unauthorized absence, the independent variables are the same as above, plus provider cadre, education, age and sex. The regression results are shown in **Appendix Table A5** and **Appendix Table A6**.

To measure performance across all the variables, a composite indicator is created using a principal components analysis (PCA) on six variables: diagnostic accuracy, treatment accuracy, staff presence, equipment availability, medicine availability[22] and infrastructure availability. Since the variables are correlated with one another at the facility level, PCA is useful as a dimension reduction technique, taking into account the correlation between variables and producing a single metric that preserves as much variation as possible. This composite indicator is intended as a proxy for overall facility performance and allows for the identification of high and low performers within and across countries. In turn, identifying these high and low performers allows for exploration of their characteristics, with the aim of distilling generalizable evidence on the correlates of high-performing facilities.

[21] World Bank (2020b).

[22] One of the variables, medicine availability (based on 14 common medicines) is unavailable for Kenya, Uganda and Nigeria. For the purposes of creating the PCA index, medicine availability is calculated for these three countries based on their individual listings of medicines.

4. Results

4.1 Infrastructure availability

Infrastructure availability—defined as the availability of an improved water source, improved toilet, and electricity—varies from a country average of 77.2% in Kenya to 21.0% in Niger. Infrastructure availability is significantly higher in urban areas, driven partly by the higher rates of electricity availability. Infrastructure availability is also significantly higher at private facilities than at public facilities across all countries. While sample sizes for higher-level facilities such as hospitals are smaller than for lower-level, availability of basic infrastructure is generally highest at hospitals and lowest at health posts across countries. **Table 2** shows results for overall infrastructure availability. More detailed breakdowns of the components of infrastructure availability are presented in **Appendix Table A7**. Overall infrastructure availability does not appear to increase in lockstep with country GDP per capita. While three-quarters of overall variance (74.0%) is attributable to within-country differences, only one-quarter is attributable to between-country differences. Results of variance decompositions for all variables are reported in **Appendix Table A8**.

Figure 1 shows infrastructure availability by country and the rural/urban differentials. In all countries, urban facilities have much greater infrastructure availability, but this gap varies across the sample. Niger has the greatest gap with 84.6% of urban facilities having basic infrastructure, compared to 17.6% of rural facilities. **Figure 2** highlights which components are lacking in facilities and when multiple components are missing. In Mozambique, 38.9% of facilities are missing a single component and 9.3% of facilities are missing multiple components, whereas in Niger, 24.8% of facilities are missing a single component and 57.6% of facilities are missing multiple components. Similarly, the SDI reveals that lack of access to electricity is a problem across all countries, whereas lack of improved toilet and improved water are more common in Nigeria and Tanzania, respectively.

Figure 1: Availability of basic infrastructure (improved water, improved sanitation, electricity) in public facilities by urban/rural and country, ordered by increasing GDPpc

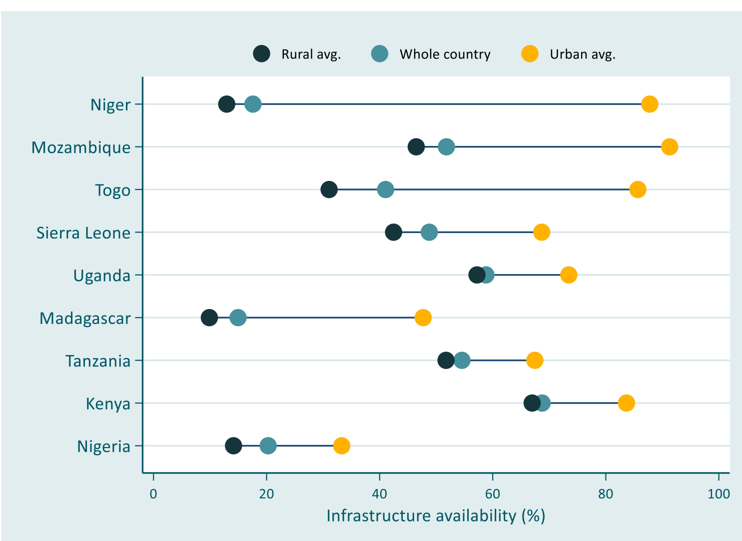


Figure 2: Breakdown of infrastructure availability (improved water source, improved sanitation, electricity) in public facilities by country, ordered by increasing GDPpc

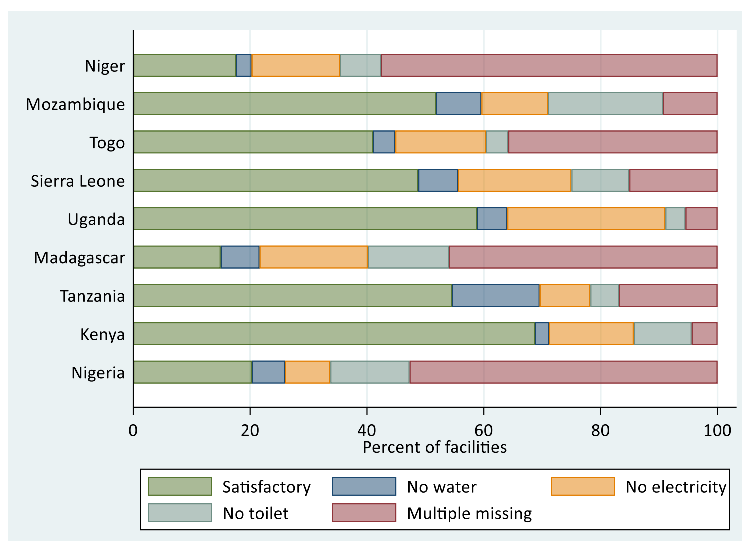


Table 2: Infrastructure availability

Indicator	Country	(1) All facilities	(2) Public	(3) Private	(4) Rural	(5) Urban	(6) Hospital	(7) Health center	(8) Health post
All three basic components of infrastructure available	Niger	21.0	17.6	84.6	14.3	88.1	98.4	52.1	5.5
		(15.9, 26.1)	(12.4, 22.7)	(72.2, 97.0)	(9.2, 19.3)	(79.9, 96.3)	(91.8, 100.0)	(39.8, 64.4)	(2.0, 8.9)
	Mozambique	52.3	51.8	100.0	47.1	91.3	84.2	44.6	
		(45.1, 59.5)	(44.6, 59.0)	(100.0, 100.0)	(39.5, 54.7)	(79.3, 100.0)	(72.2, 96.2)	(36.6, 52.5)	
	Togo	63.2	41.1	97.8	36.1	96.3	81.3	91.3	54.2
		(56.0, 70.4)	(32.8, 49.3)	(92.9, 100.0)	(27.5, 44.7)	(91.1, 100.0)	(61.1, 100.0)	(82.9, 99.7)	(45.0, 63.4)
	Sierra Leone	51.1	48.8	78.1	42.5	71.2	84.7	73.1	43.3
		(46.8, 55.4)	(44.3, 53.3)	(65.3, 90.9)	(37.4, 47.6)	(64.0, 78.4)	(71.3, 98.1)	(64.5, 81.6)	(38.3, 48.3)
	Uganda	72.7	58.8	86.9	65.0	86.8	100.0	81.9	66.3
		(68.2, 77.2)	(52.4, 65.2)	(81.5, 92.2)	(59.3, 70.6)	(80.3, 93.3)	(100.0, 100.0)	(75.2, 88.6)	(60.3, 72.2)
	Madagascar	27.3	15.0	76.6	15.2	66.6	75.0	30.2	13.0
		(23.1, 31.6)	(10.8, 19.2)	(69.8, 83.4)	(10.3, 20.0)	(60.3, 72.9)	(60.6, 89.4)	(25.0, 35.3)	(5.9, 20.1)
	Tanzania	60.5	54.6	76.3	52.7	76.9	98.8	74.2	56.3
		(55.5, 65.5)	(48.4, 60.7)	(68.4, 84.2)	(46.0, 59.4)	(70.2, 83.5)	(94.9, 100.0)	(65.0, 83.5)	(50.2, 62.4)
	Kenya	77.2	68.7	87.0	71.7	89.1	91.8	82.4	73.8
		(75.7, 78.8)	(66.5, 70.9)	(85.2, 88.9)	(69.8, 73.6)	(86.9, 91.4)	(88.6, 95.1)	(79.3, 85.5)	(71.9, 75.7)
	Nigeria	28.5	20.3	65.2	19.6	44.7	61.6	25.8	5.5
		(26.7, 30.4)	(18.6, 22.0)	(58.2, 72.3)	(17.5, 21.7)	(41.4, 47.9)	(56.8, 66.4)	(23.5, 28.1)	(3.5, 7.6)

4.2 Medicine and equipment availability

Medicine and equipment availability are shown in **Table 3**. Medicine availability is notably lower at health posts (ranging from 24.3 to 41.6%) and health clinics (from 33.5 to 66.8%) compared to hospitals (from 52.0 to 74.8%). Medicines are also less available at public facilities (29.0% to 46.7%) compared to private facilities (from 42.7 to 67.5%). In the multivariate regression, there is not a significant difference in availability between rural and urban areas. Equipment availability varies significantly between countries, from 50.1% in Niger to 89.0% in Tanzania. Within countries, it follows a similar pattern to medicine availability, with lower availability in public facilities than in private facilities and lower availability in health clinics and health posts than in hospitals. Again, there is no significant difference between rural and urban facilities in the multivariate regression. For both medicine and equipment however, three-quarters of the variation in availability is again attributable to within- rather than between-country differences, as shown in **Appendix Table A8**.

Figure 3 shows the fraction of medicines available in public versus private facilities and indicates higher medicine availability in private facilities in all countries. The difference between private and public facilities varies by country, from a 6-percentage point difference in Togo to 29 percentage point difference in Tanzania. **Figure 4** shows how often facilities are missing just one of four of the pieces of equipment (thermometer, stethoscope, sphygmomanometer and scale) versus missing two or more pieces of equipment. In Nigeria, Niger, and Uganda, over 20% of facilities are missing multiple pieces of equipment. However, in Sierra Leone and Madagascar, for example, addressing a single missing piece of equipment could increase availability of all four items in health facilities from just over 60% to closer to 80% or 90%. In general, there is no clear relationship between availability of equipment or medicine and GDP per capita.

Figure 3: Percent of the 14 basic medicines available in facilities by ownership and country, ordered by increasing GDPpc

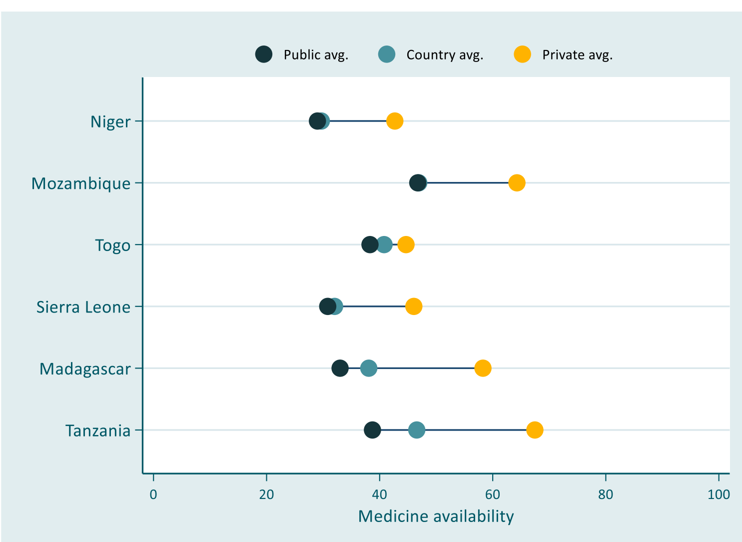


Figure 4: Breakdown of equipment availability in public facilities by country, ordered by increasing GDPpc

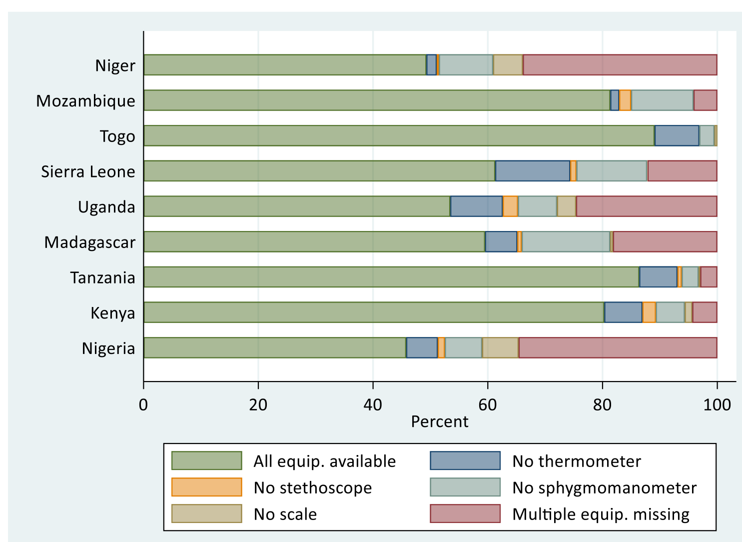


Table 3: Medicine and equipment availability

Indicator	Country	(1) All facilities	(2) Public	(3) Private	(4) Rural	(5) Urban	(6) Hospital	(7) Health center	(8) Health post
Medicine availability: Percent of 14 basic medicines in-stock*	Niger	29.7	29.0	42.7	28.3	43.7	52.0	40.6	24.3
		(27.7, 31.6)	(26.9, 31.1)	(36.8, 48.6)	(26.2, 30.4)	(39.3, 48.2)	(45.2, 58.8)	(37.3, 43.9)	(22.3, 26.4)
	Mozambique	46.9	46.7	64.3	45.9	54.7	73.3	40.5	-
		(44.0, 49.9)	(43.8, 49.7)	(21.4, 100.0)	(42.8, 49.0)	(46.4, 62.9)	(69.4, 77.2)	(37.9, 43.2)	
	Togo	40.8	38.3	44.7	37.3	45.0	58.5	56.8	35.5
		(37.9, 43.6)	(35.8, 40.8)	(36.8, 52.5)	(34.6, 40.0)	(39.0, 51.1)	(53.6, 63.4)	(53.3, 60.3)	(32.2, 38.8)
	Sierra Leone	32.0	30.8	46.1	30.6	35.3	64.8	33.5	30.1
		(30.7, 33.4)	(29.6, 32.0)	(37.6, 54.5)	(29.4, 31.9)	(32.0, 38.5)	(57.6, 72.1)	(30.3, 36.7)	(28.8, 31.3)
	Madagascar	38.1	33.0	58.3	34.5	49.6	67.1	40.1	28.8
		(35.9, 40.3)	(30.7, 35.3)	(54.2, 62.4)	(31.6, 37.4)	(46.2, 53.0)	(58.4, 75.8)	(37.6, 42.6)	(24.8, 32.7)
	Tanzania	46.6	38.7	67.5	39.1	62.3	74.8	66.8	41.6
		(44.2, 48.9)	(36.4, 41.1)	(63.8, 71.1)	(36.3, 41.8)	(59.0, 65.6)	(67.6, 81.9)	(62.4, 71.1)	(39.0, 44.2)
Equipment availability: Availability of all four pieces of equipment	Niger	50.1	49.3	64.6	46.3	88.2	100.0	87.4	32.2
		(43.8, 56.3)	(42.5, 56.1)	(48.2, 81.0)	(39.0, 53.5)	(80.0, 96.4)	(100.0, 100.0)	(79.2, 95.6)	(25.1, 39.4)
	Mozambique	81.0	81.3	50.0	79.7	91.3	97.4	77.1	-
		(75.4, 86.7)	(75.7, 87.0)	(-50.0, 100.0)	(73.5, 85.8)	(79.3, 100.0)	(92.1, 100.0)	(70.3, 83.8)	
	Togo	87.8	89.1	85.8	96.5	77.1	93.8	98.1	84.5
		(82.9, 92.7)	(83.8, 94.3)	(74.1, 97.4)	(93.3, 99.8)	(65.6, 88.7)	(81.3, 100.0)	(94.1, 100.0)	(77.8, 91.2)
	Sierra Leone	62.6	61.3	77.8	59.9	68.9	76.1	70.2	59.8
		(58.4, 66.8)	(56.9, 65.7)	(65.0, 90.6)	(54.8, 64.9)	(61.6, 76.3)	(60.3, 92.0)	(61.4, 79.0)	(54.9, 64.7)
	Uganda	65.5	53.5	77.8	59.1	77.2	80.6	85.6	54.2
		(60.7, 70.3)	(46.9, 60.0)	(71.2, 84.5)	(53.3, 64.9)	(69.2, 85.3)	(52.6, 100.0)	(79.5, 91.8)	(47.9, 60.5)
	Madagascar	66.1	59.5	92.1	61.4	81.0	86.4	69.8	55.1
		(61.6, 70.6)	(53.7, 65.3)	(87.8, 96.5)	(54.8, 68.1)	(75.7, 86.2)	(75.0, 97.9)	(64.6, 74.9)	(44.7, 65.6)
	Tanzania	89.0	86.4	95.8	85.5	96.3	100.0	97.0	87.0
		(85.8, 92.2)	(82.2, 90.6)	(92.1, 99.5)	(80.7, 90.2)	(93.3, 99.3)	(100.0, 100.0)	(93.4, 100.0)	(82.8, 91.2)
	Kenya	83.8	80.3	87.8	81.8	88.0	93.5	90.7	80.5
		(82.4, 85.1)	(78.4, 82.2)	(85.9, 89.6)	(80.2, 83.4)	(85.7, 90.3)	(90.6, 96.4)	(88.3, 93.1)	(78.8, 82.2)
	Nigeria	51.7	45.8	78.1	45.0	63.7	77.9	54.3	19.0
		(49.7, 53.8)	(43.6, 47.9)	(72.0, 84.3)	(42.4, 47.7)	(60.6, 66.9)	(73.8, 82.0)	(51.7, 56.9)	(15.5, 22.5)

*Medicine availability is calculated using 14 common medicines among six countries with comparable medicine listings.

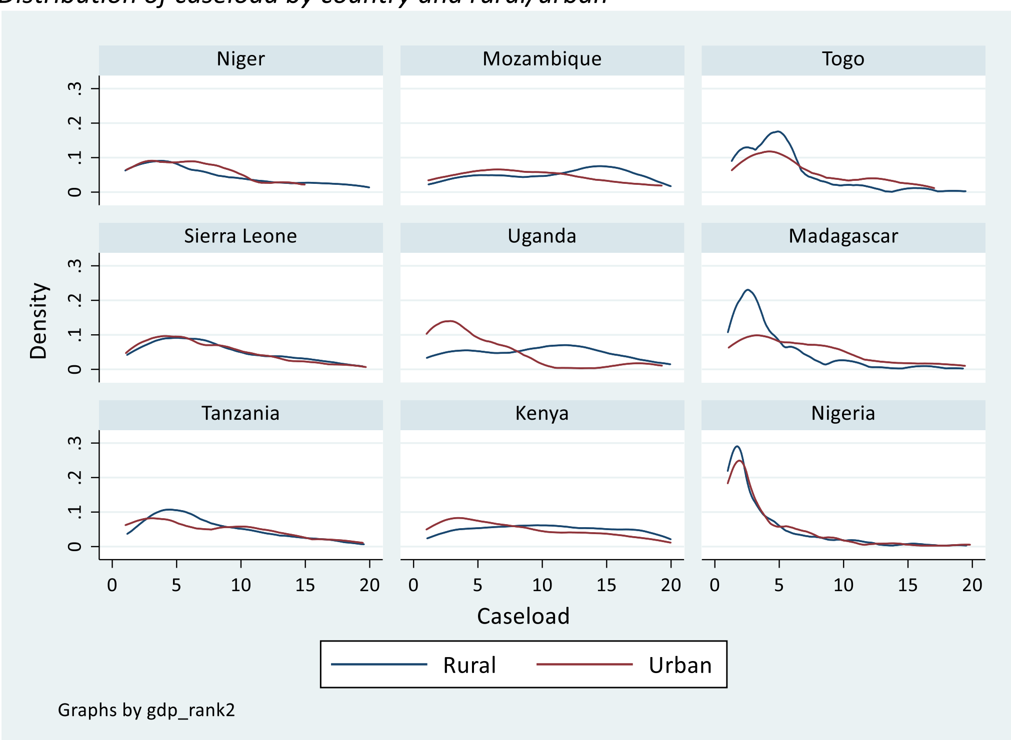
**Equipment availability is based on four basic pieces of equipment: thermometer, stethoscope, sphygmomanometer and scale.

4.3 Caseload

The SDI indicates that, on average, a health care provider in these countries attends roughly 13.3 outpatients per day (see **Table 4**). Caseload ranges from a low of 2.8 patients per provider per day in Nigeria to a high of 23.2 in Mozambique. On average, providers in public facilities attend about 14.0 patients per day, while those in private facilities attend approximately 11.5 patients daily (though this trend varies by country). Rural facilities have higher caseload on average, again with some variation by country. Among public facilities, almost half (46.7%) have a caseload below 5 patients per provider per day. Table 4 also includes results on the percent of facilities with fewer than 5 patients per provider per day, which varies from 14.0% of facilities in Mozambique to 86.0% in Nigeria. In six of the nine countries, public facilities are less likely than private facilities to have fewer than 5 patients per provider per day. Variance decomposition shows that 72.0% of the variance is attributable to within-country differences, while 28.0% is attributable to between-country differences, as shown in **Appendix Table A8**.

Figure 5 shows the distribution of caseload by rural and urban. In general, caseload is slightly higher at rural facilities, but this is not evident in all countries. Madagascar has a larger share of facilities in rural areas with a caseload below 5 patients per provider per day. Nigeria's distribution shows that the majority of their facilities have fewer than 5 patients per provider per day, regardless of urban or rural location. Some countries, such as Mozambique and Kenya, show an even distribution suggesting that both urban and rural facilities see a highly variable number of patients.

Figure 5. Distribution of caseload by country and rural/urban



The caseload data have a strong left-model skewedness. To provide a clear visualization of the center of the distribution, the x-range is restricted to facilities with 1-20 patients per provider per day.

Table 4: Health care provider caseload and percent of facilities with <5 outpatients per provider per day

Indicator	Country	(1) All facilities	(2) Public	(3) Private	(4) Rural	(5) Urban	(6) Hospital	(7) Health center	(8) Health post
Caseload: Outpatients per provider per day	Niger	10.9	11.2	5.0	11.2	8.1	1.1	21.6	6.1
		(9.1, 12.8)	(9.1, 13.2)	(2.8, 7.2)	(9.0, 13.4)	(5.2, 10.9)	(0.6, 1.7)	(17.0, 26.3)	(5.0, 7.1)
	Mozambique	23.2	23.4	12.5	23.7	19.6	16.7	24.9	-
		(19.9, 26.6)	(20.0, 26.7)	(0, 36.1)	(20.4, 27.0)	(5.1, 34.2)	(7.7, 25.8)	(21.5, 28.4)	
	Togo	6.3	6.0	6.8	6.1	6.6	6.6	7.6	5.8
		(5.5, 7.2)	(5.0, 7.1)	(5.3, 8.3)	(5.0, 7.3)	(5.4, 7.8)	(3.9, 9.4)	(6.1, 9.0)	(4.7, 6.9)
	Sierra Leone	11.3	11.5	9.2	11.7	10.5	8.0	11.3	11.5
		(10.0, 12.6)	(10.1, 12.9)	(7.1, 11.2)	(10.1, 13.3)	(8.4, 12.6)	(6.3, 9.7)	(8.4, 14.2)	(9.9, 13.1)
	Uganda	17.0	26.1	7.0	20.2	10.1	16.6	17.1	16.9
		(14.7, 19.3)	(22.8, 29.5)	(5.0, 9.1)	(17.4, 22.9)	(6.4, 13.9)	(3.0, 30.1)	(12.4, 21.9)	(14.4, 19.5)
	Madagascar	6.4	5.1	11.8	4.9	10.5	5.5	7.7	4.0
		(5.2, 7.5)	(3.8, 6.4)	(9.7, 13.8)	(3.4, 6.4)	(8.8, 12.3)	(2.5, 8.4)	(6.1, 9.2)	(2.9, 5.1)
	Tanzania	11.7	11.9	11.3	10.1	15.3	33.5	14.2	10.4
		(9.7, 13.7)	(9.4, 14.3)	(7.7, 14.9)	(8.1, 12.0)	(10.9, 19.7)	(16.7, 50.2)	(8.6, 19.9)	(8.5, 12.4)
	Kenya	23.1	30.4	15.0	24.6	20.1	24.6	25.0	22.2
		(22.0, 24.1)	(29.0, 31.9)	(13.8, 16.3)	(23.4, 25.7)	(17.9, 22.2)	(20.7, 28.4)	(22.6, 27.4)	(21.1, 23.4)
	Nigeria	2.8	2.7	3.2	2.6	3.2	4.1	2.7	2.0
		(2.6, 3.1)	(2.5, 3.0)	(2.1, 4.4)	(2.3, 2.9)	(2.7, 3.7)	(3.3, 5.0)	(2.4, 3.0)	(1.7, 2.3)
Percent of facilities with <5 outpatients per provider per day	Niger	42.6	41.5	70.5	42.1	46.8	100.0	6.8	58.3
		(35.8, 49.3)	(34.3, 48.7)	(53.2, 87.7)	(34.2, 50.0)	(33.6, 60.0)	(100.0, 100.0)	(0.3, 13.3)	(49.9, 66.7)
	Mozambique	14.0	13.6	50.0	12.7	23.8	39.5	7.4	-
		(8.9, 19.1)	(8.5, 18.7)	(0, 150.0)	(7.5, 17.9)	(4.8, 42.9)	(23.4, 55.5)	(3.1, 11.8)	
	Togo	59.5	63.9	53.2	61.9	56.4	56.3	38.7	68.3
		(51.9, 67.1)	(55.6, 72.3)	(36.1, 70.3)	(52.9, 70.9)	(42.5, 70.3)	(30.6, 81.9)	(24.2, 53.2)	(59.3, 77.4)
	Sierra Leone	32.4	32.3	32.5	30.2	37.4	26.6	36.6	31.4
		(28.2, 36.5)	(28.0, 36.7)	(17.5, 47.5)	(25.3, 35.1)	(29.5, 45.2)	(9.6, 43.6)	(27.2, 46.1)	(26.6, 36.2)
	Uganda	32.5	3.4	64.1	20.3	58.8	47.8	36.1	29.6
		(27.3, 37.7)	(0.8, 6.0)	(55.7, 72.6)	(15.1, 25.6)	(47.9, 69.7)	(7.0, 88.5)	(26.9, 45.3)	(23.3, 36.0)
	Madagascar	65.3	73.1	31.4	73.0	43.0	68.4	58.0	78.5
		(60.4, 70.1)	(67.5, 78.7)	(23.4, 39.4)	(66.4, 79.7)	(36.1, 49.8)	(51.7, 85.1)	(52.1, 63.9)	(69.0, 88.1)
	Tanzania	37.0	35.6	40.5	37.6	35.5	12.1	46.6	36.1
		(32.0, 42.0)	(29.7, 41.6)	(31.2, 49.8)	(31.1, 44.2)	(27.8, 43.2)	(0.0, 24.4)	(35.8, 57.4)	(30.2, 42.1)
	Kenya	18.1	5.0	32.4	12.6	29.0	18.8	13.8	19.3
		(16.6, 19.7)	(3.8, 6.1)	(29.6, 35.3)	(11.1, 14.2)	(25.5, 32.5)	(13.9, 23.7)	(10.8, 16.8)	(17.4, 21.2)
	Nigeria	86.0	86.6	83.1	87.1	84.1	78.2	87.0	90.3
		(84.5, 87.5)	(85.1, 88.2)	(77.0, 89.1)	(85.2, 89.0)	(81.6, 86.6)	(73.9, 82.5)	(85.1, 88.9)	(87.4, 93.1)

4.4 Provider absence rate

Table 5 shows the results for health care provider unauthorized absence. Unauthorized absence varies across countries, from 0.1% in Tanzania to 8.9% in Uganda. It is higher in public facilities than private facilities in all countries. In the multivariate regression, unauthorized absence is not meaningfully associated with provider age or sex. Other health care providers were slightly more likely to be absent than nurses or doctors. Overall, slightly less than 5 percent of providers are found to be absent from facility without authorization. Uganda has the highest rate of unauthorized absence (27.9% of absences) and Tanzania has the lowest (1.4%). At public facilities, 90.7% of absences are authorized for reasons ranging from participation in training or community outreach or sick leave. No clear relationship exists between absence without authorization and size or level of health facility. Variance decomposition shows that the majority of the variance is attributable to within-country differences (82.0%), compared to between-country differences (18.0%), as shown in **Appendix Table A8**.

Figure 6 shows overall absence rates (for both authorized and unauthorized reasons), which vary between 13.8% in Tanzania and 53.8% in Kenya. In most countries, health care providers are absent more often in public versus private facilities. The reasons for absence in public facilities are shown in **Figure 7**. These included sick/maternity leave (ranging from 5.9% to 19.7% of all reasons for absence), training/meeting (ranging from 5.8% to 43.5%), official mission (ranging from 3.8% to 21.0%), and other authorized absence (ranging from 16.1% to 41.0%).

Figure 6: Percent of health care providers absent by facility ownership, ordered by increasing GDPpc

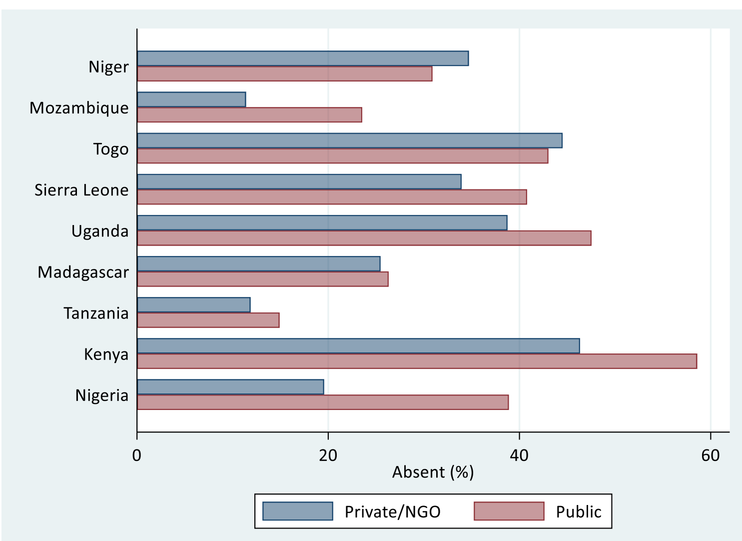


Figure 7: Reasons for health care provider absence among public facility providers, ordered by increasing GDPpc

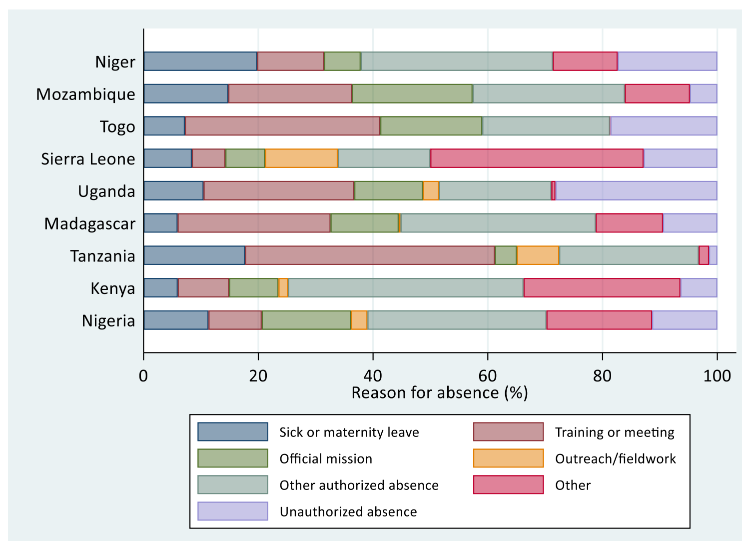


Table 5: Health care provider unauthorized absence

Indicator	Country	(1) All facilities	(2) Public	(3) Private	(4) Rural	(5) Urban	(6) Hospital	(7) Health center	(8) Health post	(9) Doctors	(10) Nurses	(11) Other workers
Percent of providers absent for unauthorized reasons	Niger	5.1	5.4	1.9	8.4	1.8	4.1	3.3	8.8	4.7	3.9	7.0
		(3.5, 6.8)	(3.5, 7.2)	(0.0, 4.7)	(5.3, 11.4)	(0.4, 3.2)	(0.6, 7.6)	(1.2, 5.4)	(5.4, 12.2)	(0.0, 10.5)	(1.8, 5.9)	(3.9, 10.1)
	Mozambique	1.1	1.1	0.0	1.0	1.3	0.7	1.9	-	1.2	0.7	1.2
		(0.4, 1.8)	(0.4, 1.8)	(0.0, 0.0)	(0.3, 1.7)	(0.0, 3.0)	(0.0, 1.6)	(0.8, 2.9)		(0.2, 2.2)	(0.0, 1.7)	(0.0, 2.7)
	Togo	7.9	8.0	7.7	8.5	7.5	12.0	9.0	6.3	3.4	8.1	8.5
		(6.1, 9.6)	(6.0, 10.1)	(4.3, 11.1)	(6.1, 10.9)	(4.8, 10.1)	(6.5, 17.5)	(6.0, 12.0)	(4.0, 8.6)	(0.0, 7.4)	(5.0, 11.1)	(6.1, 10.9)
	Sierra Leone	4.8	5.2	1.9	4.7	4.8	3.2	5.5	5.0	0.0	3.9	5.3
		(3.9, 5.7)	(4.2, 6.3)	(0.2, 3.6)	(3.5, 6.0)	(3.5, 6.2)	(0.9, 5.5)	(3.7, 7.3)	(3.8, 6.2)	(0.0, 0.0)	(2.3, 5.5)	(4.2, 6.4)
	Uganda	8.9	12.5	3.9	11.4	5.6	4.1	10.3	7.6	8.8	9.8	7.1
		(7.3, 10.5)	(10.3, 14.7)	(2.0, 5.8)	(9.4, 13.4)	(2.9, 8.3)	(0.0, 11.5)	(8.0, 12.7)	(5.5, 9.7)	(5.5, 12.0)	(7.5, 12.1)	(4.5, 9.8)
	Madagascar	1.8	2.5	0.5	2.5	1.2	0.8	1.9	3.4	1.1	2.7	0.8
		(1.2, 2.5)	(1.5, 3.5)	(0.0, 1.0)	(1.1, 3.9)	(0.6, 1.9)	(0.0, 2.0)	(1.1, 2.6)	(0.6, 6.2)	(0.2, 2.0)	(1.5, 3.9)	(0.0, 1.7)
	Tanzania	0.1	0.2	0.0	0.2	0.1	0.2	0.1	0.1	0.0	0.2	0.2
		(0.0, 0.3)	(0.0, 0.5)	(0.0, 0.2)	(0.0, 0.5)	(0.0, 0.3)	(0.0, 0.7)	(0.0, 0.4)	(0.0, 0.3)	(0.0, 0.0)	(0.0, 0.5)	(0.0, 0.4)
	Kenya	2.9	3.8	1.6	3.5	2.4	2.3	2.6	3.9	2.8	2.0	4.3
		(2.6, 3.2)	(3.3, 4.2)	(1.3, 2.0)	(3.1, 3.8)	(1.9, 2.8)	(1.6, 3.0)	(2.1, 3.1)	(3.5, 4.4)	(2.1, 3.5)	(1.6, 2.3)	(3.7, 4.9)
	Nigeria	3.8	4.3	2.2	4.6	3.2	2.6	4.7	5.1	0.5	2.0	4.7
		(3.4, 4.2)	(3.9, 4.7)	(1.1, 3.3)	(4.0, 5.1)	(2.7, 3.8)	(2.0, 3.2)	(4.2, 5.2)	(3.8, 6.4)	(0.0, 1.2)	(1.3, 2.7)	(4.2, 5.2)

4.5 Diagnosis and treatment accuracy

Figure 8 shows the confidence interval estimates for diagnostic accuracy by cadre and country. Overall mean diagnostic accuracy (combining the results from all vignettes) varies by country, from a high of 69.2% in Tanzania to a low of 39.9% in Niger. Across the sample, doctors and clinical officers (COs) have the best diagnostic accuracy (66.8%), followed by nurses (55.4%) and other medical staff (35.8%). However, the range between the cadres varies substantially by country, from a 10-percentage point difference between doctors and other medical staff in Mozambique to a 43-percentage point difference in Uganda. Results from the multivariate regression, controlling for both facility and provider level characteristics, indicate that doctors have the highest diagnostic accuracy, males have higher diagnostic accuracy than females, and 40-49 year-olds have slightly higher diagnostic accuracy than younger or older colleagues. Perhaps not unexpectedly, providers with secondary and post-secondary education perform significantly better than those with only primary education. There is not a significant difference between performance of providers in urban and rural facilities or between those in public or private facilities, but providers at health posts score significantly lower than those at hospitals or health clinics.

Treatment and diagnostic accuracy are shown in **Figure 9**. The diagnostic accuracy of health care providers varies based on the topics of the five diseases vignettes: tuberculosis (85.7% correct), diabetes (59.5%), pneumonia (59.4%), diarrhea with dehydration (26.9%), and malaria with anemia (21.8%). Correct treatment is above 50% for all diseases, except malaria with anemia which has a correct treatment rate of 22.7%. Provider-level trends for treatment accuracy show doctors and clinical officers performing better than nurses and other staff, providers with post-secondary education performing better and male providers performing better overall. Provider treatment accuracy is higher at hospitals than other facility types, higher at rural than urban facilities, and higher at public than private facilities. Treatment accuracy is higher than diagnosis accuracy for the two dual diagnosis conditions because providers sometimes failed to diagnose the comorbidity (e.g. diagnosing malaria, but not anemia) but offered treatment that was satisfactory for both conditions (e.g. artemisinin combination therapy and iron supplements).[23] Full details of diagnostic and treatment accuracy are shown in **Appendix Table A9**.

Provider performance on assessments of response to the urgent medical conditions of neonatal asphyxia and post-partum hemorrhage (PPH) is shown in **Figures 10**. Assessing providers on these two measures, nurses score as well as doctors/COs on the asphyxia vignette and almost as well on the PPH vignette. Similar to diagnostic and treatment accuracy, providers at hospitals perform better than those at lower-level facilities, as do those at public and rural facilities (as opposed to their private and urban counterparts).

Results for inappropriate antibiotic usage are shown in **Figure 11** and indicate that nearly half of health care providers prescribed an antibiotic in cases where it is not recommended. The results by cadre show variation in prescription patterns, with doctors more likely to inappropriately prescribe antibiotics in Mozambique, Sierra Leone and Nigeria, while nurses or other medical staff are more likely to inappropriately prescribe antibiotics in other countries. Inappropriate prescription of antibiotics is not

[23] In the diarrhea and dehydration vignette, the child presents as a case of diarrhea but displays multiple warning signs for severe dehydration. According to IMCI guidelines, severe dehydration necessitates rehydration with an IV or NG tube. However, 84.0% of providers simply prescribe ORS and 48.2% prescribe ORS plus zinc. We have included ORS + zinc as appropriate treatment since the child is able to drink in most vignettes. Similarly, for malaria with anemia, most providers identify malaria as the primary condition (diagnosed by 64.7%) but do not identify the warning signs for anemia (diagnosed by 36.8%) and therefore do not prescribe iron supplements.

noticeably different based on ownership or urban/rural location. Inappropriate prescription is slightly higher at hospitals than health centers. Health care providers over the age of 50 are less likely to inappropriately prescribe antibiotics than younger providers and male providers are significantly more likely to inappropriately prescribe antibiotics than female providers.

Figure 8: Diagnostic accuracy by cadre and country, ordered by increasing GDPpc

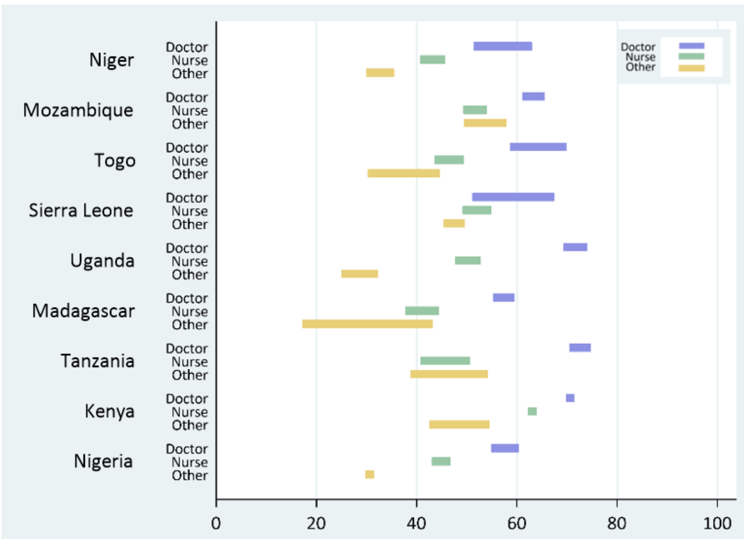


Figure 9: Health care provider accuracy of diagnosis and treatment by disease, in public facilities

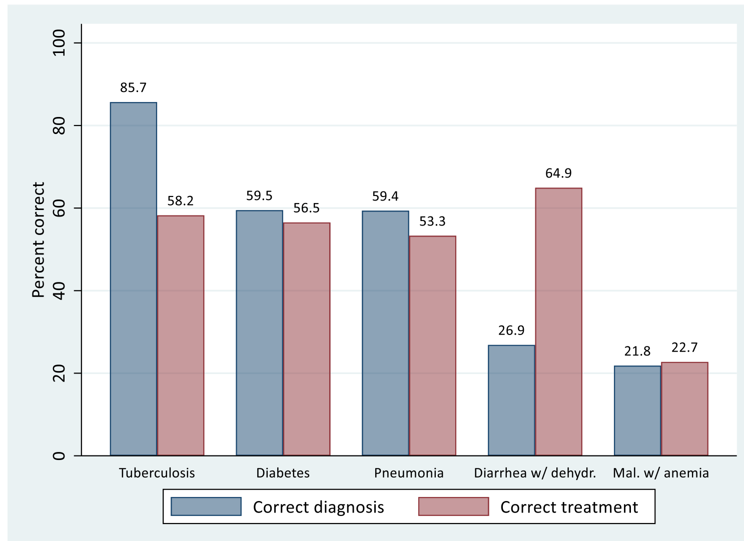


Figure 10: Actions taken for neonatal asphyxia in public facilities by cadre, ordered by increasing GDPpc (Nigeria and Uganda are omitted due to incomparability of the standards used in assessment)

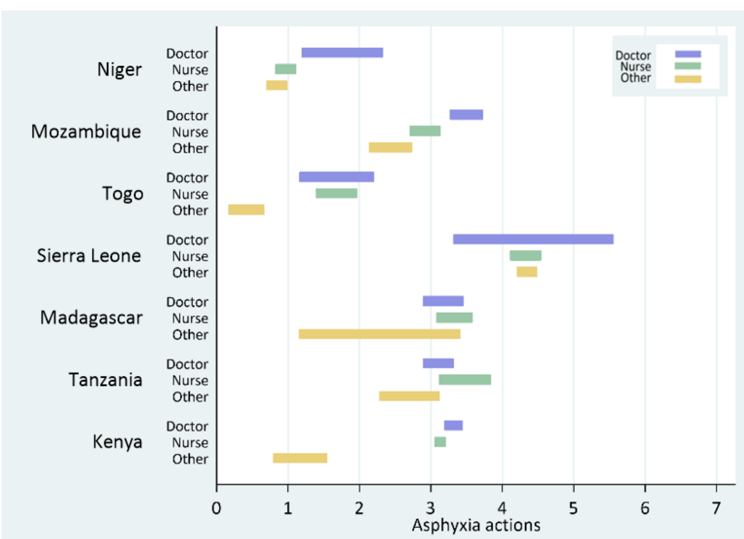
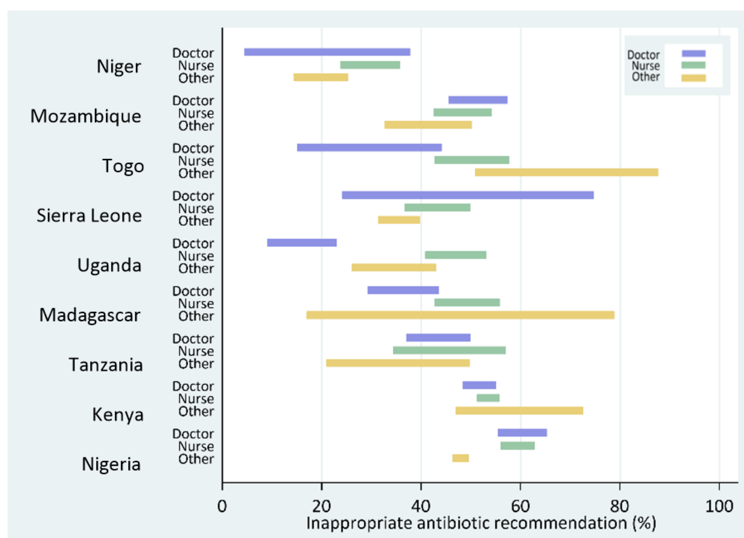


Figure 11: Inappropriate antibiotic recommendation in public facilities by country and rural/urban, ordered by increasing GDPpc

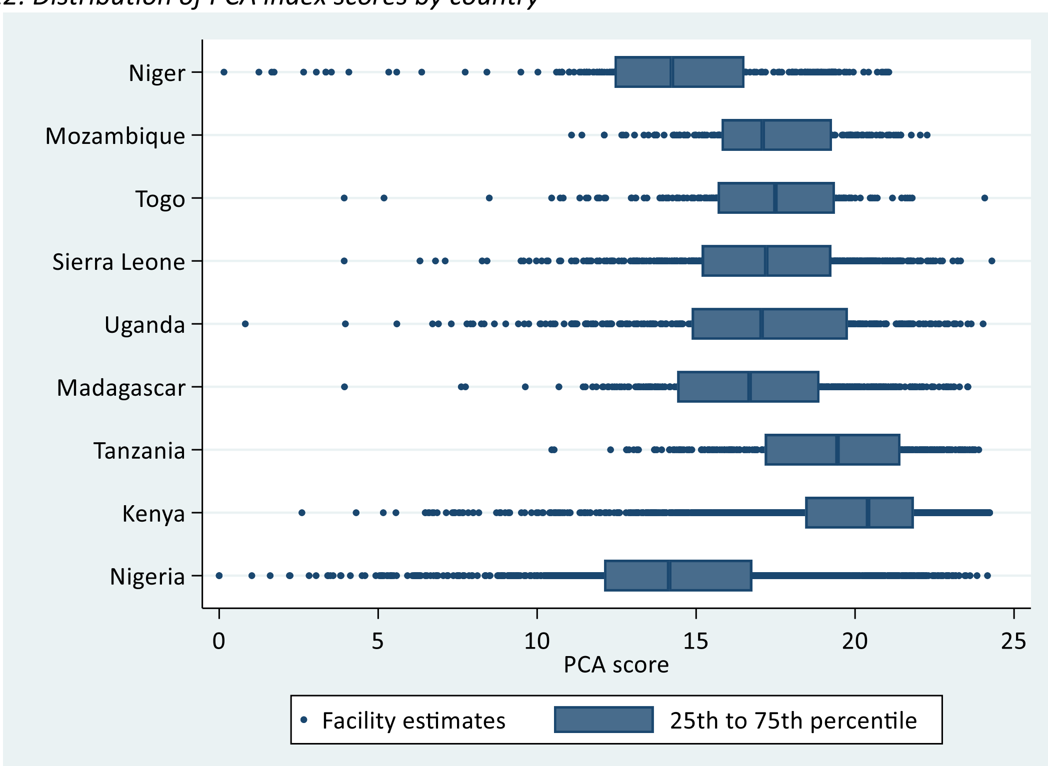


4.6 An aggregate look at quality of facilities

The variables shown in the sections above can be combined using PCA to provide a composite indicator for each facility. The distributions of the raw PCA score can be seen in **Figure 12**. Public facilities score worse than private facilities on average and health clinics and health posts score worse than hospitals. Tanzania and Kenya are at the top end, while Niger and Nigeria show the worst outcomes. The differences between countries are large, with 92.5% of Nigeria's facilities scoring below Kenya's country average. However, variance decomposition also reveals substantial variance in-country, with almost two-thirds of the variance attributable to within-country differences (64.1%), compared to roughly one-third from between-country differences (35.9%), as shown in **Appendix Table A8,** and in line with the analysis of individual components of the PCA.

The characteristics of high and low performers, defined as the top and bottom 10% of this aggregate metric, respectively, are identified and the characteristics of these facilities are shown in **Table 6**. Kenya has the highest prevalence of high performers, with nearly 20% of facilities in Kenya identified as high performers. Public facilities are more likely than private facilities to be identified as low performers in all countries. Rural facilities are also more likely to be low performers, with all countries except Mozambique having a higher share of low performers in rural areas than in urban areas. The percent of facilities identified as high performers is generally higher in richer countries, as measured by GDP per capita.

Figure 12: Distribution of PCA index scores by country[24]



[24] The PCA index here is renormalized to a minimum of zero, for ease of viewing results.

Table 6. Percent of facilities identified as high or low performers by country, location, ownership and facility level

Indicator	Country	(1) All facilities	(2) Public	(3) Private	(4) Rural	(5) Urban	(6) Hospital	(7) Health center	(8) Health post
Percent of facilities scoring as high performers	Niger	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mozambique	0.5	0.5	0.0	0.0	4.3	2.6	0.0	-
	Togo	0.1	0.0	0.2	0.0	0.1	0.0	0.3	0.0
	Sierra Leone	2.1	2.0	3.0	1.8	2.7	4.5	3.0	1.7
	Uganda	5.0	2.7	7.3	3.8	7.2	14.9	11.6	1.0
	Madagascar	2.6	1.8	5.8	1.5	6.0	9.4	3.2	0.0
	Tanzania	15.3	8.8	32.6	8.4	29.7	44.1	22.1	12.8
	Kenya	19.5	19.1	20.0	18.8	21.1	33.4	25.3	16.0
	Nigeria	1.7	0.5	7.0	0.7	3.5	5.6	1.0	0.0
Percent of facilities scoring as low performers	Niger	19.6	20.3	5.3	21.2	2.9	0.0	6.7	25.7
	Mozambique	1.0	1.0	0.0	0.6	4.3	0.0	11.8	-
	Togo	5.4	8.9	0.0	9.9	0.0	0.0	1.9	6.6
	Sierra Leone	6.4	6.7	3.0	6.7	5.8	0.0	3.9	7.4
	Uganda	11.9	15.4	8.2	13.5	8.8	19.4	5.6	14.7
	Madagascar	4.4	5.2	1.2	5.3	1.4	1.7	2.9	7.6
	Tanzania	0.4	0.6	0.0	0.6	0.0	0.0	0.0	0.5
	Kenya	2.1	2.2	1.9	2.6	0.8	1.9	0.5	2.5
	Nigeria	24.8	27.9	11.0	27.5	20.0	10.5	26.4	33.6

5. Discussion and conclusion

In this paper, we provide a comprehensive overview of primary health care delivery across nine Sub-Saharan African countries and across a variety of medical conditions. Overall, the results indicate that despite global efforts to strengthen primary care delivery and the focused investments made towards expanding the reach and quality of primary care since the Alma Ata declaration, the quality of primary care delivery in these nine Sub-Saharan African countries remains suboptimal. These results complement other analysis of the SDI, which looked at the results related to child and maternal health and the constraints in care readiness.[25] Our findings suggest substantial heterogeneity in the quality of primary care service delivery between and, especially, within countries. Our investigation of the distribution of quality service delivery indicates that an average citizen's experience with primary health care, across these nine countries, depends to a large extent on where the individual is accessing care.

Collectively, these findings emphasize the need for evidence-based and context-driven policies to strengthen health systems and to improve health service delivery in the nine Sub-Saharan African countries. Realizing the vision of the Sustainable Development Goals and Universal Health Coverage relies extensively on effective and responsive health systems that are built on the foundation of strong primary care.[26] Our findings indicate that without judicious and targeted investments in improving the quality of primary care delivery, these global goals will fail to have the desired impact of improved health and well-being of all people. The lessons learned from over a decade of data collection efforts to understand health service delivery can provide instructive insight on two fronts: (1) strengthening health system performance and (2) enhancing health system measurement.

5.1 Strengthening health system performance

This analysis documents important disparities between a citizen's experience of care at facilities in rural as opposed to urban areas. Specifically, while availability of basic infrastructure (improved water and sanitation facilities, and electricity) is variable across countries in the sample, the starkest within-country contrasts are between urban facilities and rural facilities. This reflects well-known disparities between infrastructure availability/functionality in urban and rural areas both within and well beyond the health sector.[27] The implications of poor infrastructure at health facilities are dire: without safe water and sanitation, health care facility staff and patients are at increased risk of infection and associated illness (including COVID-19 transmission).[28,29] Facilities without access to electricity cannot operate crucial medical devices for essential services (such as mammograms and electrocardiograms) and cannot reliably maintain a cold chain for storage of vaccines or other medicines.[30] This capacity for cold chain maintenance takes on added importance now, as the global community begins provision of COVID-19 vaccines and navigates the requirements for ultra-cold freezers.[31] Given that rural health facilities may also be more likely to provide care to lower-income members of the population, poorer quality facility infrastructure may also contribute to increased health disparities by income. The findings of this analysis indicate that despite decades of investments in infrastructure, not least from the World Bank, rural health facilities in particular are still lacking.

While global evidence on relative accountability, efficiency, and availability of key inputs in public versus private health facilities remains mixed,[32] this analysis highlights notable differences between facilities under these two different types of ownership. In particular, unauthorized health care provider absences are more prevalent in public

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[25] Di Giorgio et al. (2020).
[26] Pettigrew et al. (2015).
[27] Leslie et al. (2017).
[28] UNICEF (2019).
[29] Sharma et al. (2020).
[30] Adair-Rohani et al. (2013).
[31] Fischetti (2020).
[32] Basu et al. (2012).

compared to private facilities in all nine countries, potentially arising from differences in incentive structures and management practices between these facility types. Health care provider absences have been well documented previously and our results are approximately consistent with the 35% absence rate reported by other researchers in a cross-section of low-income countries, but suggest that the problem has persisted into more recent years.[33] The absence rate overall is also higher in public facilities, suggesting that providers in public facilities may have increased demands that take them outside of the facility, including attending trainings, seminars, outreach, and other authorized activities. While authorized absences might not have an adverse effect on health service delivery, especially if facility management is strong, unauthorized provider absence will disrupt services and might result in increased patient wait times and deter patients from seeking health care in the future. For example, in western Kenya, nurse absence during a patient's first antenatal care (ANC) visit significantly reduces the probability that a woman tests for HIV over her entire pregnancy, whereas nurse attendance during first ANC visit increases the likelihood of delivering in a hospital or health center and receiving appropriate treatment and counseling.[34] Authorized absences, particularly in overburdened facilities, might reflect insufficient staffing or planning, speaking to the importance of better understanding staffing decisions and the role of management quality. Beyond staff management, more research is required to further corroborate existing evidence of the positive impact of strong facility management practices on primary health care processes and outcomes.[35] In sum, the ramifications of differences between provider absence in public as opposed to private facilities are non-negligible and have the potential to further increase health disparities between those able to afford private care versus public care.

Similarly, key medicines and supplies are more commonly available in private as opposed to public facilities. This again begins to suggest that private facilities may have more effective procurement and supply chain systems that prevent stockouts of these key inputs. The gap between public and private persists even in urban areas, suggesting that it is not driven by the inaccessibility or remoteness of facilities. Higher level public facilities have better availability, but the lack of medicines in lower level public facilities is concerning, given that medicines included in the SDI survey are geared towards primary care and would be useful and necessary even at lower levels. Private facilities that profit from medicine sales may also be further incentivized to maintain adequate stock in a way that public facilities are not. Further investigation is required to better understand the potential incentive structures, efficiencies, and management practices that may be driving better performance in private facilities, so that these practices can be emulated in public ones.

The SDI vignettes focus on core conditions that providers at all levels of the health care system should be able to successfully diagnose and treat. Diagnostic and treatment accuracy are higher at hospitals than health centers or health posts. Since the majority of initial patient presentation is likely to be at lower-level facilities, these results suggest that strengthening the capacity of workers at lower-level institutions is needed in order to enable them to act as the frontline of primary care. Results are not significantly different between public and private facilities or urban and rural facilities, suggesting an encouraging equity in the current distribution of skilled health care providers.

Nurses and lower-level medical providers comprise the majority of the health workforce and need to be relied upon for patient care. Yet, they performed significantly worse than doctors on diagnostic and treatment accuracy as measured by the SDI vignettes. With increased task shifting, lower-level staff are asked to play a larger role in patient care. Nurses are also more likely to prescribe antibiotics when they are not required (though this varies by country), which may be due to uncertainty about proper prescription or patient pressure for access to antibiotics. The implications for patient health and for contributing to antimicrobial resistance cannot be overlooked. The evidence

[33] Chaudhury et al. (2006).

[34] Goldstein (2013).

[35] Macarayan et al. (2019).

in this paper suggests that more attention should be placed on the skills and training of the health workforce to ensure that patients receive quality care, regardless of the type of provider they see. While post-secondary education is associated with better diagnostic ability, more investigation and data are needed to understand how medical training and on-the-job training build on basic provider skills and competencies.

The analysis of a caseload indicator arises from a recognition of a global human resources shortage and an uneven distribution of health workers, both at the global and local level. Specifically, the World Health Organization (WHO) estimates that the Africa region bears more than 24% of the global burden of disease but has access to only 3% of the health workers.[36] Contrary to expectations, this analysis indicates relatively low caseload overall in the period before COVID-19, with 43% of health facilities seeing fewer than 5 patients per provider per day. This is in line with recent analyses in Latin America which look at efficient allocation of care and found substantial variation. In Ecuador, a World Bank report estimated that approximately one-third of primary care facilities have low case counts (fewer than 500 outpatient visits per month).[37] Similarly, in Peru, analysis found that around 10% of health facilities have fewer than 30 total patient visits per day.[38] Although it is difficult to determine the optimal theoretical caseload, in both of these cases other similarly equipped facilities are able to see three to four times the volume of patients.

Low caseload might raise some concerns about effective allocation of human resources in health care delivery, but it also points to the success of the global effort to bring health facility and health care providers closer to people, especially in rural and remote areas.[39] While this expanded geographical access to care is important, especially from an equity perspective, low caseload in primary care facilities across countries provides further evidence to consider reorganization of services within the existing health system to enhance efficiency without compromising on equitable access, as proposed by the Lancet Global Health Commission on High Quality Health Systems.[40] Such quality-focused service delivery redesign would entail providing treatment of chronic and stable conditions, preventative care, low acuity and algorithmic services, and palliative care at the primary level while more complex or rare conditions will be managed in tertiary or specialized care centers.

Our findings concerning low caseload also offer insight on the debate regarding overcrowding in facilities and its impact on quality of care. Academic literature on health facility capacity has focused on overcrowding, and its potential impact on wait times and reduced time for clinical consultation.[41,42] For instance, in central Mozambique, evidence indicates that the average outpatient consultation requires over 40 minutes of waiting at most clinics. Longer wait times, of up to one hour, are reported for first antenatal visits.[43] The patient experience of long wait times and short consultation times might not necessarily result from health care providers' failure to cope with high demand. Caseload is only reflective of the clinical aspects of the health care providers' job and their responsibilities may include other administrative tasks. Long wait times might be reflective of poor facility management and health care providers' time being stretched to accommodate other activities. Overcrowding at health facilities may also result from an uneven distribution of patients throughout the day, a lack of scheduled appointments, or a concentration of patients for a specific service (e.g., antenatal care) on pre-specified days. In addition, many countries now face overcrowding due to surges in COVID-19 cases, putting an unprecedented strain on health care systems and personnel.[44]

[36] WHO (2013).
[37] Vermeersch & Giovagnoli (2020).
[38] World Bank (2020c).
[39] WHO & IBRD (2017).
[40] Kruk et al. (2018).
[41] WHO (2006).
[42] Chen et al. (2004).
[43] Wagenaar et al. (2016).
[44] Odula (2020).

Finally, the PCA metric is intended as an overall assessment of facility performance, combining results across the variables and allowing for identification of high and low performing facilities. These differences follow some predictable patterns, such as private facilities scoring better than public facilities on average, but there remains wide variation within each country unexplained by our analysis. There may be facility factors that increase performance which our survey has not measured, such as the adeptness of management or the job satisfaction of health workers, and these results suggest a continued need for research into determinants of facility performance. Continued efforts to identify high-performing facilities, both in terms of outputs and health outcomes, can open opportunities for country governments to identify these positive deviants and to learn lessons on what enables their success.

5.2 Enhancing health system measurement

In 2018, the World Bank, in collaboration with the WHO and the Organisation for Economic Co-operation and Development (OECD), released a joint report, "Delivering quality health services", highlighting the importance of delivering high quality health services as a global imperative within the context of achieving Universal Health Coverage by 2030.[45] This report acknowledges the dearth of actionable evidence on quality of service delivery, despite its critical role in initiating, sustaining and monitoring quality improvement processes. As the Service Delivery Indicators surveys are specifically developed with the aim of improving quality and accountability in public service delivery, these data can provide useful guidance to this end.

These lessons have already informed project design and supported reform in a number of countries. Along with the policy lessons learned, the 10-year experience of data collection efforts across a variety of settings offers valuable lessons on further enhancing the goals and methods employed for health system measurement, including future SDI surveys. Quality of service delivery is a multifaceted, complex process and no single survey can comprehensively measure all relevant aspects. By employing a novel methodology to measure provider ability and effort, SDI surveys go beyond most existing large-scale efforts that focus primarily on measuring inputs to care. However, the SDI survey, in contradiction to the guidance from the recent body of literature on measuring quality of care, lacks a user-centered approach, partly attributable to its emphasis on measuring the supply-side correlates of service delivery.

The analysis presented in this paper is limited by the characteristics of the underlying data and of the survey methodology. For example, our indicator for measuring caseload assumes equal distribution of cases across all types of providers (including nutritionists, surgeons and other health care staff), which may introduce downward bias in measurement of caseload. Other reasons for a downward bias include the fact that our indicator does not account for inpatient care, which may be significant despite the facility designation as a primary care facility. Likewise, the current indicator does not account for the possibility of a single patient seeing multiple providers during a visit. Additionally, as we interpret the findings on caseload, we must consider that caseload does not equate to workload of the provider who may be contributing to other aspects of facility functioning, including, but not limited to, administrative duties and community outreach. To address these limitations, the future iteration of SDI surveys aims to triangulate between facility report and provider self-report to better capture the true volume of patients served, hours spent on different tasks on a typical day, and the differential distribution of caseload across different administrative units (departments) within a facility and across different provider cadres.

The methodological innovations introduced by the SDI survey in measuring provider ability and effort can be further strengthened for generating readily actionable evidence. Apart from the limitations of the vignettes that have been discussed elsewhere, our results have indicated a few opportunities for methodological improvements in the design and implementation of the vignettes.[46] For instance, in our current analysis, while we can assess when a provider

[45] OECD/WHO/World Bank Group (2018).

[46] Peabody et al (2000).

fails to diagnose a disease correctly, the data do not allow further investigation on why providers are unable to correctly diagnose the disease or propose a correct treatment option. To address this, the future SDIs will record the incorrect diagnosis or treatment proposed by the respondent. Furthermore, to better adapt to the evolving burden of disease, future SDI surveys will expand to include vignettes of other non-communicable diseases and chronic conditions including hypertension and depression. At the same time, they will expand beyond clinical interaction to include an evaluation of interpersonal aspects of care delivery, and patient education and counseling. Another key aspect of the SDI survey is the measurement of provider absence. A careful review of the data across nine surveys has revealed a need for redesigning the questions informing this indicator. For example, in our data, a large fraction of absent workers are classified as "other excused" which does not provide adequate information on the nature of the absence. In response, it will be important for future SDI surveys to provide better clarity and granularity for correctly classifying provider absence from the facility during their expected hours of clinical duty.

There are some limitations of the SDI survey's approach to measuring key inputs to care, including infrastructure and availability of medicine and supplies. As the analysis here has indicated, the data do not allow an investigation of the quantity or stock of medicine, equipment or other medical supplies. Likewise, there is limited information on service readiness as it pertains to the growing burden of non-communicable diseases globally and recently on important aspects of pandemic preparedness, such as infection control or surge capacity. The SDI is not intended for rapid measurement of facility readiness for pandemics but it does provide some insight on hospitalization capacity, WaSH measures and effective communication and coordination, summarized in a previous paper.[47] These measures of infrastructure do not adequately capture the basic requirements for access for differently abled individuals, or gender dimensions of accessing basic services and amenities at health facilities.[48] A revised SDI instrument for measuring these foundations for delivering quality care can include more and better questions that allow an investigation of readiness, considering both sustainability and equity goals.

Finally, it is worth noting that facility performance is also influenced to a large extent by factors outside the facility, including the economic, epidemiological and demographic characteristics of the catchment population and community, public sector governance, and other demand-side elements, including patient preferences and utilization patterns. These, along with the expected differences in survey implementation across different settings, can limit spatial and temporal comparability of the survey results. Some of these differences can be mitigated analytically, for example by utilizing survey weights, where available, to correct for differences in samples across countries. However, certain differences, for example the inclusion of more community health workers in Nigeria compared to the rest of the sample, cannot be corrected analytically. Similarly, as mentioned previously, the SDI in Nigeria is not representative (as it includes only 12 of the country's 36 states) and inferences drawn from this limited sample should be interpreted with caution. Overall, the differences between countries should be treated carefully, including as a reflection of differences in survey design and implementation.

Collectively, a careful review of the methodological choices in conducting SDI surveys across the nine countries indicates the strength of this large-scale survey in measuring health system performance and identifying priorities for future investments in building a resilient health system that better responds to the population's needs. The limitations documented here are also helpful in ensuring that the next phase of health measurement is more responsive to global guidance on measuring health system quality and in producing actionable evidence to ensure quality and efficiency in health service delivery. COVID-19 has catalyzed a long overdue health system redesign and strengthening effort. The analysis in this paper documented substantial shortfalls in the primary health care system capacity and performance in the pre-COVID period, which have likely been compounded by the current pandemic. The evidence presented here can help to guide and optimize ongoing and future investments in improving service

[47] Sharma et al. (2020).
[48] WHO & UNICEF (2018).

delivery in the health sector and in improving measurement of health system performance, both in Sub-Saharan African countries and globally, at a time when health workers and health systems are more under pressure and essential than ever.

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Appendix

Appendix Table A1: Definition of all indicators

Indicators	
1. Infrastructure availability	
Availability of an improved water source, an improved toilet and electricity.	Infrastructure availability is calculated as the availability of three components: improved water source, improved toilet and electricity. Credit is given if all three components are available. Improved toilet: Credit is given if facility reports and enumerator confirms facility has one or more functioning flush toilets or ventilated improved pit (VIP) latrines, or covered pit latrine (with slab). Improved water source: Credit is given if facility reports their main source of water is piped into the facility, piped onto facility grounds or comes from a public tap/standpipe, tubewell/borehole, a protected dug well, a protected spring, bottled water or a tanker truck. This definition is based on the WHO/UNICEF Joint Monitoring Program for Water Supply, Sanitation and Hygiene.[49] Electricity: Credit is given if facility reports using electric power grid, fuel-operated generator, battery-operated generator, or a solar powered system as their main source of electricity.
2. Medicine availability	
Percent of 14 basic medicines which were available and in-stock at the time of the survey.	Medicine availability is calculated as the percent of 14 medicines available and in-stock at the time of the survey. The list of medicines included for the SDI is based on a subset of the WHO Essential Medicines list.[50] The medicines included are: 1) Amitriptyline (anti-depressant) 2) Amoxicillin (antibiotic) 3) Atenolol (beta blocker) 4) Captopril (ACE inhibitor) 5) Ceftriaxone (antibiotic) 6) Ciprofloxacin (antibiotic) 7) Cotrimoxazole (antibiotic) 8) Diazepam (anti-seizure) 9) Diclofenac (nonsteroidal anti-inflammatory) 10) Glibenclamide (anti-diabetic) 11) Omeprazole (proton pump inhibitor) 12) Paracetamol (analgesic) 13) Salbutamol (bronchodilator) 14) Simvastatin (statin) The list of medicines in the SDI is adapted based on country standards and some of these medicines were not included in the surveys in Kenya, Nigeria and Uganda, so these countries have been omitted from this indicator.
3. Equipment availability	
Availability and functioning thermometer, stethoscope, sphygmomanometer and weighing scale.	Equipment availability is calculated as the availability and functioning of a thermometer, a stethoscopes, a sphygmomanometer and a weighing scale (adult, child or infant). Credit is given if all four components are available. Thermometer: Credit is given if a facility reports and the enumerator observes that the facility has one or more functioning thermometers (used for measuring patient body temperature). Stethoscope: Credit is given if a facility reports and the enumerator observes that the facility has one or more functioning stethoscopes. Sphygmomanometer: Credit is given if a facility reports and the enumerator observes that the facility has one or more functioning sphygmomanometers.

[49] UNICEF (2019).
[50] WHO (2017).

	Weighing Scale: Credit is given if a facility reports and the enumerator observes that the facility has one or more functioning adult, child or infant weighing scale.
4. Caseload per health provider	
Number of outpatient visits per clinician per day.	Caseload is calculated as the number of outpatient visits recorded in outpatient records in the three months prior to the survey, divided by the number of days the facility was open during the three-month period and the number of health professionals who conduct patient consultations. This indicator is adjusted for the average absence rate at the facility-level. For example, if a facility reports having 10 health care providers who conduct outpatient consultations, but that facility's absence rate on an unannounced visit is found to be 40%, then the number of health care providers will be adjusted down by 40% and only 6 health care providers will be counted as available for patient care.
5. Provider absence rate	
Share of a maximum of 10 randomly-selected providers absent from the facility during an unannounced visit.	Number of health professionals who are absent from the facility on an unannounced visit as a share of ten randomly sampled workers who should be on-duty. Health professionals doing outreach are counted as present.
6. Diagnostic accuracy	
Percent of correct diagnoses provided in the five clinical vignettes.	The SDI includes five core vignettes: (i) acute diarrhea w/ dehydration; (ii) pneumonia; (iii) diabetes mellitus; (iv) pulmonary tuberculosis; (v) malaria w/ anemia. Health care providers are scored on their ability to provide correct diagnosis on each of those vignettes and their overall score is calculated as the percent of vignettes answered correctly. Further details on diagnostic accuracy for each disease are provided in **Appendix Table A4**.
7. Treatment accuracy	
Percent of correct treatments provided in the five clinical vignettes.	The SDI includes five core vignettes: (i) acute diarrhea w/ dehydration; (ii) pneumonia; (iii) diabetes mellitus; (iv) pulmonary tuberculosis; (v) malaria w/ anemia. Health care providers are scored on their ability to provide correct treatment on each of those vignettes and their overall score is calculated as the percent of vignettes answered correctly. Further details on treatment accuracy for each disease are provided in **Appendix Table A5**.
8. Management of maternal and neonatal complications	
Number of relevant treatment actions proposed by the clinician.	The SDI includes two vignettes to assess maternal and neonatal complications. Providers are scored on the number of relevant treatment actions that they propose out of five specific actions for post-partum hemorrhage and seven specific actions for neonatal asphyxia.
9. Inappropriate antibiotic usage	
Percent of providers inappropriately prescribing antibiotics	The SDI surveys also collect information on inappropriate antibiotic use, defined as providers that prescribed an antibiotic during the tuberculosis vignettes (aside from the antibiotics recommended as part of the tuberculosis regimen) or any antibiotics for the diarrhea vignettes (for which antibiotics are not indicated given the patient examination). Inappropriate antibiotic usage is calculated as the percentage of health care providers that inappropriately prescribe antibiotics among all health care providers given the clinical vignettes.

Appendix Table A2: Rules for correct diagnosis

Disease	Notes
Diarrhea with dehydration	The Integrated Management of Childhood Illnesses (IMCI) guidelines[51] suggest that this case should be classified as diarrhea with severe dehydration due to the presence of three warning signs: lethargy, sunken eyes and skin pinch going back **very** slowly. We require clinicians to arrive at the dual diagnosis of diarrhea and dehydration but allow for a broader range of classifications than would be suggested by IMCI guidelines. This includes any mention of diarrhea ("diarrhea" or "acute diarrhea") and any mention of dehydration ("dehydration", "moderate dehydration" or "severe dehydration"). In Mozambique and Niger, the child was listed as unable to drink or drinking poorly, another risk sign for severe dehydration. Countries varied in how they asked about diagnosis and some countries listed diagnoses jointly. Nigeria and Uganda listed "acute diarrhea with severe dehydration" as the only diagnosis possible. Madagascar listed "diarrhea with moderate dehydration" and "diarrhea with severe dehydration". Togo listed "diarrhea with severe dehydration". All of these answers were counted as correct. Note that for these countries we are not able to provide an accurate estimate of how many doctors diagnosed diarrhea alone, we can only calculate the joint diagnosis rate.
Pneumonia	We have counted a diagnosis of pneumonia as the correct response.
Diabetes	Based on the characteristics presented in this vignette, clinicians should arrive at a diagnosis of diabetes type II as the correct response. However, the option of diabetes (type not specified) was available in Kenya, Madagascar, Mozambique, Niger, Sierra Leone and Tanzania. Clinicians were not prompted to select a specific type if they answered diabetes. Although treatment varies for different types of diabetes, we have chosen to classify the general diabetes response as correct. This results in higher correct diagnosis rates, an improvement by 14 – 50 percentage points depending on the country.
Tuberculosis	We have counted a diagnosis of tuberculosis as the correct response.
Malaria with anemia	This case should be classified as malaria with anemia and we require clinicians to arrive at this dual diagnosis. All countries except Togo included "malaria" as an option and all countries except Nigeria and Uganda included "simple malaria" as an option. Both of these were counted as correct. All countries also included "severe malaria" as an option and this is not counted as correct since the case does not meet the definition of severe and severe malaria would require different treatment. Anemia is listed simply as "anemia" without a severity specified. Providers therefore received credit for specifying malaria or simple malaria AND anemia. Kenya excluded this module entirely so is omitted and their diagnostic accuracy is counted as the average of the four other vignettes.
Post-partum hemorrhage	We have counted a diagnosis of post-partum hemorrhage as the correct response.
Neonatal asphyxia	We have counted a diagnosis of neonatal asphyxia or respiratory distress as the correct response.

[51] "IMCI Chart Booklet." *World Health Organization*, Integrated Management of Childhood Illnesses, 17 Sept. 2017, www.who.int/maternal_child_adolescent/documents/IMCI_chartbooklet/en/.

Appendix Table A3: Rules for correct treatment

Disease	Notes
Diarrhea with dehydration	The Integrated Management of Childhood Illnesses (IMCI) guidelines note that correct treatment of diarrhea with severe dehydration would be to give intravenous fluid immediately, to give an NG tube if that is not possible and to refer to a higher-level facility if both treatments are unavailable. If the child has only some dehydration, then ORS is the recommended treatment. Given the symptoms here the correct treatment should be rehydration with an IV or NG tube. However, we also counted as correct the use of ORS plus zinc. Since the child was able to drink in most cases, the providers may have incorrectly believed that this was a less severe case of dehydration. Correct treatment rates would be much lower if we counted only IV fluids/NG tube as correct (13% correct). Uganda did not include an option for ORS so only treatment with IV fluids/NG tube is taken as a correct response. Kenya did not include an option for IV fluids/NG tube so only ORS with zinc is taken as a correct response.
Pneumonia	The IMCI guidelines suggest oral amoxicillin for five days as treatment for pneumonia. Severe pneumonia can be treated with "the first dose of an appropriate antibiotic" and urgent referral to a hospital. In addition, the simulated child has a fever of 38.5 and IMCI guidelines recommend an anti-pyretic in this case. Correct treatment is counted as treatment with amoxicillin, a first-line antibiotic, and any anti-pyretic.
Diabetes	The World Health Organization's (WHO) Package of Essential Noncommunicable Disease Interventions (PEN) protocols[52] state that "individuals with persistent fasting blood glucose >6 mmol/l despite diet control should be given metformin and/or insulin as appropriate." For our purposes, correct treatment is counted as any hypoglycemic (including insulin) or referral to specialist. Referral to a higher level is the recommended protocol for diabetes at the primary level in multiple countries so we include that option as correct. Although PEN protocol would suggest diet control before prescribing hypoglycemics, we allowed prescriptions upon first presentation to count as correct.
Tuberculosis	The WHO Guidelines for Treatment of Tuberculosis[53] recommend combination therapy, ideally with fixed dose combination (FDC). We required simply that providers mention combination therapy. Knowledge of correct duration and dosage was not necessary and providers would do worse if these were required. For example, 23% of providers prescribe combination therapy but only 8% accurately recalled the correct dosage and timing (this comparison is possible in Madagascar, Mozambique, Niger, Sierra Leone and Tanzania). However, Nigeria and Uganda recorded "correct duration and dose" as one option, so we are forced to assess providers on having gotten the correct dosage/timing. We therefore likely have a downward bias for provider treatment abilities in these two countries. Kenya did not record any information on whether providers gave the correct duration and dosage.
Malaria with anemia	IMCI guidelines recommended that children with a positive malaria test should be given "recommended first line antimalarial" and "one dose of paracetamol in clinic" for fever reduction. In addition, iron should be given for treatment of anemia.

[52] "WHO PEN - Package of Essential Noncommunicable Disease Interventions." Noncommunicable Diseases and Their Risk Factors, *World Health Organization*, 22 July 2019, www.who.int/ncds/management/pen_tools/en/.
[53] "Guidelines for Treatment of Drug-Susceptible Tuberculosis and Patient Care (2017 Update)." *World Health Organization*, 18 May 2018, www.who.int/tb/publications/2017/dstb_guidance_2017/en/.

	The questions on malaria treatment vary a bit between countries and credit was given for treatment with any artemisinin combination therapy (ACTs) or artemether-lumefantrin (coartem). In addition to anti-malarials, the provider must prescribe paracetamol and iron for the anemia. Kenya did not include the malaria vignette and was excluded. Nigeria and Uganda did not include questions about iron and were excluded for the sake of comparability.
Post-partum hemorrhage (PPH)	The WHO Recommendations for the Prevention and Treatment of Postpartum Hemorrhage[54] state that "The use of uterotonics (oxytocin alone as the first choice) plays a central role in the treatment of PPH. Uterine massage is recommended for the treatment of PPH as soon as it is diagnosed, and initial fluid resuscitation with isotonic crystalloids is recommended." We defined five specific actions that a provider should take. These were: 1) Proposed to determine cause 2) Proposed any uterotonics 3) Proposed an IV line 4) Proposed a foley catheter 5) Proposed bimanual uterine massage. Uterotonics included oxytocin or another uterotonic drug, such as misoprostol, ergometrine or a prostaglandin. Togo and Uganda only gave credit to health providers if they were able to determine the correct dosage of oxytocin.
Neonatal asphyxia	The WHO Guidelines on Basic Newborn Resuscitation[55] provide detailed recommendations on newborn care and actions which should be taken if the child is exhibiting danger signs. Assessments for neonatal asphyxia varied between countries. There were eight actions which were assessed in all countries and we used these eight as our standard of assessment: 1) Call for help 2) Dry baby 3) Keep baby warm 4) Check to see if baby is breathing 5) Place baby in a natural position 6) Initiate resuscitation with bag/mask 7) Check heartrate This set of actions does not represent the full standard of treatment for neonatal asphyxia but does allow for a common set of actions upon which health providers can be compared across our sample of countries. We count correct treatment as providing at least half of these actions.

[54] "Recommendations for the Prevention and Treatment of Postpartum Haemorrhage," Sexual and Reproductive Health, *World Health Organization*, 6 Feb. 2019, www.who.int/reproductivehealth/publications/maternal_perinatal_health/9789241548502/en/.

[55] "Guidelines on Basic Newborn Resuscitation." Maternal, Newborn, Child and Adolescent Health, *World Health Organization*, 8 Feb. 2019, www.who.int/maternal_child_adolescent/documents/basic_newborn_resuscitation/en/.

Appendix Table A4: Sampling and sample weights

Facility-level weights	All surveys were designed to be nationally representative, except for Nigeria, where data was collected in 12 of 36 states due to logistical constraints and Kenya, where data was representative at the county-level. To construct a sample for the SDI, a full listing of facilities is collected from the Ministry of Health or other associated governmental partners. To be eligible for inclusion, facilities must be currently in operation and providing outpatient primary care. Some facilities may be excluded if they are too specialized (e.g. disease specific facilities, such as HIV clinics or cancer centers) or if they are not actively involved in patient diagnosis and treatment (e.g. pharmacies). This listing is then usually stratified by facility-type and location (either urban/rural or specific administrative designations) and a sample is drawn. The sample size depends on budgetary and operational considerations but is aimed to be representative of the variety of health care organizations in the country. Facility weights were provided by the respective survey teams for each country and are used throughout the paper to adjust the estimates. The facility-level weights were normalized to a mean of 1.0 at the country-level.
Absence weights	At each facility, a full roster of health care providers is collected from the facility-in-charge and a random sample of up to 10 health care providers are drawn in order to assess the rate of absence. Absence weights were calculated for each facility based on the number of health care providers assessed for absence and the total number of health care providers listed on the roster. In some cases, the total number of health care providers collected in the roster was capped at a maximum amount, such as 50 health care providers, due to logistical concerns. In these cases, the absence weights were calculated on the basis of the total number of health care providers reported at the facility, rather than the number listed on the roster which is known to be an undercount. The weight represents the inverse of the probability of selection. The weight is normalized to 1.0 for each country and combined with the facility-level weight to create an overall absence weight. Absence weights were calculated by the SDI team and are used in presenting all absence-related figures.
Vignette weights	Similar to the process for absence weights, a full roster of health care providers is collected from the facility-in-charge and a random sample of up to 10 health care providers who regularly provide outpatient care are selected to take the clinical vignettes. Health care providers may opt out or refuse to take the clinical vignettes and we assume that any refusals were random. Vignette weights were calculated for each facility based on the number of health care providers given the vignettes and the total number of health care providers listed on the roster who provide outpatient care. In some cases, the total number of health care providers collected in the roster was capped at a maximum amount, such as 50 health care providers, due to logistical concerns. In these cases, the vignette weights were calculated on the basis of the total number of health care providers reported at the facility, with an adjustment to estimate the number that provide outpatient services based on the fraction observed on the roster. The weight represents the inverse of the probability of selection. The weight is normalized to 1.0 for each country and combined with the facility-level weight to create an overall vignette weight. Vignette weights were calculated by the SDI team and are used in presenting all vignette-related figures, including diagnosis and treatment accuracy.

Appendix Table A5: Health care provider-level multivariate regression results

Independent variables	(1) Diagnostic accuracy	(2) Treatment accuracy	(3) PPH actions	(4) Asphyxia actions	(5) Inappropriate antibiotic prescription	(6) Unauthorized absenteeism
Doctor	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)
	-	-	-	-	-	-
Nurse	-6.68**	-5.56**	-0.10*	0.02	9.84**	-0.30
	(-8.74 - -4.62)	(-7.73 - -3.39)	(-0.20 - -0.01)	(-0.12 - 0.17)	(5.78 - 13.91)	(-1.28 - 0.67)
Other	-15.89**	-17.60**	-0.63**	-0.25**	0.61	1.54*
	(-19.63 - -12.14)	(-20.95 - -14.26)	(-0.77 - -0.50)	(-0.44 - -0.06)	(-5.57 - 6.80)	(0.28 - 2.81)
Primary education	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)
	-	-	-	-	-	-
Secondary education	6.84**	0.41	0.05	0.18	-0.49	-0.73
	(1.78 - 11.89)	(-3.98 - 4.80)	(-0.10 - 0.20)	(-0.07 - 0.42)	(-9.71 - 8.73)	(-2.43 - 0.98)
Post-secondary education	12.24**	6.68**	0.39**	0.59**	-0.87	-0.73
	(7.10 - 17.38)	(2.13 - 11.24)	(0.23 - 0.56)	(0.33 - 0.85)	(-10.37 - 8.62)	(-2.39 - 0.92)
20-30 y/o	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)
	-	-	-	-	-	-
30-40 y/o	2.59	2.88*	-0.08	-0.02	-2.86	0.28
	(-0.31 - 5.49)	(0.35 - 5.42)	(-0.18 - 0.03)	(-0.17 - 0.13)	(-7.71 - 1.98)	(-0.46 - 1.03)
40-50 y/o	3.90**	1.89	-0.11	-0.05	-0.89	0.29
	(1.18 - 6.62)	(-0.69 - 4.47)	(-0.22 - 0.01)	(-0.20 - 0.10)	(-5.71 - 3.94)	(-0.75 - 1.34)
50+ y/o	2.27	-0.51	-0.18**	-0.21**	-6.15*	-0.05
	(-0.66 - 5.20)	(-3.32 - 2.29)	(-0.29 - -0.06)	(-0.37 - -0.06)	(-11.19 - -1.10)	(-0.86 - 0.76)
Male	2.79**	2.50**	-0.05	-0.14*	8.19**	0.50
	(0.78 - 4.80)	(0.66 - 4.33)	(-0.14 - 0.03)	(-0.26 - -0.03)	(4.34 - 12.04)	(-0.21 - 1.22)
Hospital	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)
	-	-	-	-	-	-
Health Center	-3.83**	-6.13**	-0.34**	-0.49**	-5.04*	0.40
	(-6.19 - -1.46)	(-8.57 - -3.70)	(-0.45 - -0.23)	(-0.65 - -0.32)	(-10.06 - -0.01)	(-0.43 - 1.23)
Health Post	-5.42**	-6.56**	-0.37**	-0.62**	-4.27	1.27**
	(-8.00 - -2.85)	(-9.16 - -3.97)	(-0.50 - -0.25)	(-0.81 - -0.44)	(-9.86 - 1.32)	(0.38 - 2.15)
Public	-0.99	4.23**	0.19**	0.37**	2.12	1.84**

	(-3.74 - 1.77)	(1.64 - 6.81)	(0.07 - 0.31)	(0.20 - 0.54)	(-3.14 - 7.38)	(1.06 - 2.62)
Rural	0.57	2.17*	0.11*	0.18*	-4.19	0.08
	(-1.39 - 2.53)	(0.27 - 4.07)	(0.02 - 0.21)	(0.04 - 0.31)	(-8.42 - 0.03)	(-0.68 - 0.84)
Kenya	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)	1.0 (ref)
	-	-	-	-	-	-
Madagascar	-18.49**	-17.61**	-1.11**	0.14	-10.29*	-0.90
	(-23.06 - -13.92)	(-22.03 - -13.19)	(-1.26 - -0.95)	(-0.17 - 0.45)	(-18.41 - -2.17)	(-2.29 - 0.48)
Mozambique	-6.81**	-28.52**	-0.62**	0.09	-2.16	-2.01**
	(-10.59 - -3.03)	(-32.70 - -24.34)	(-0.81 - -0.42)	(-0.22 - 0.40)	(-10.91 - 6.59)	(-3.28 - -0.74)
Niger	-14.92**	-22.08**	-0.92**	-1.63**	-28.54**	1.40
	(-18.91 - -10.93)	(-26.00 - -18.16)	(-1.09 - -0.76)	(-1.85 - -1.41)	(-36.69 - -20.39)	(-1.34 - 4.15)
Nigeria	-18.26**	-30.31**	-0.45**	-1.64**	2.81	0.04
	(-23.20 - -13.32)	(-34.54 - -26.08)	(-0.64 - -0.25)	(-1.90 - -1.38)	(-6.04 - 11.66)	(-1.08 - 1.16)
Sierra Leone	-6.09**	-4.05*	0.65**	1.64**	-10.29**	0.59
	(-9.42 - -2.77)	(-7.22 - -0.89)	(0.49 - 0.81)	(1.42 - 1.87)	(-17.14 - -3.43)	(-1.11 - 2.29)
Tanzania	1.73	-3.20	1.14**	0.75**	-12.15	-2.96**
	(-4.10 - 7.56)	(-7.58 - 1.17)	(0.82 - 1.46)	(0.37 - 1.14)	(-25.45 - 1.15)	(-3.71 - -2.20)
Togo	-11.76**	-12.57**	-1.06**	-0.92**	-0.11	4.31**
	(-16.97 - -6.56)	(-18.57 - -6.58)	(-1.25 - -0.87)	(-1.32 - -0.53)	(-13.20 - 12.97)	(1.21 - 7.41)
Constant	58.91**	69.06**	1.75**	2.56**	50.89**	1.25
	(52.32 - 65.50)	(63.10 - 75.02)	(1.51 - 1.98)	(2.19 - 2.92)	(38.64 - 63.14)	(-0.82 - 3.31)
Observations	12,775	12,775	12,775	12,775	12,774	29,405
R-squared	0.28	0.38	0.25	0.32	0.03	0.01

Robust ci in parentheses
** p<0.01, * p<0.05

Appendix Table A6: Facility-level multivariate regression results

Independent variables	(1) Equipment availability	(2) Medicine availability	(3) Infrastructure availability
Hospital	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)
	-	-	-
Health Center	-8.46**	-23.01**	-14.32**
	(-12.28 - -4.64)	(-27.39 - -18.62)	(-18.46 - -10.18)
Health Post	-26.97**	-33.95**	-27.45**
	(-30.71 - -23.22)	(-39.76 - -28.15)	(-31.28 - -23.62)
Public	-11.17**	-16.85**	-19.86**
	(-14.06 - -8.28)	(-20.75 - -12.94)	(-22.98 - -16.73)
Rural	-3.63**	1.85	-13.97**
	(-6.35 - -0.92)	(-1.74 - 5.45)	(-16.63 - -11.31)
Kenya	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)
	-	-	-
Madagascar	-21.29**		-48.05**
	(-29.65 - -12.92)		(-53.63 - -42.47)
Mozambique	-10.88**	5.22	-23.80**
	(-16.89 - -4.87)	(-0.13 - 10.57)	(-30.90 - -16.71)
Niger	-28.07**	-1.12	-44.02**
	(-37.06 - -19.08)	(-6.13 - 3.89)	(-49.60 - -38.44)
Nigeria	-39.26**		-51.66**
	(-42.26 - -36.26)		(-54.55 - -48.77)
Sierra Leone	-15.50**	1.38	-16.80**
	(-20.36 - -10.65)	(-3.34 - 6.09)	(-21.64 - -11.95)
Tanzania	9.81**	13.42**	-10.70**
	(5.38 - 14.24)	(8.23 - 18.62)	(-18.21 - -3.19)
Togo	5.89	5.70	-12.59*
	(-7.17 - 18.95)	(-0.82 - 12.22)	(-23.31 - -1.87)
Uganda	-19.60**		-5.79*
	(-24.94 - -14.27)		(-10.88 - -0.69)
Constant	112.98**	75.27**	119.62**
	(109.45 - 116.51)	(69.81 - 80.73)	(115.92 - 123.31)
Observations	7,810	1,993	7,810
R-squared	0.16	0.34	0.31

Robust ci in parentheses
** $p<0.01$, * $p<0.05$

Appendix Table A7: Components of infrastructure availability

Indicator	Country	(1) All facilities	(2) Public	(3) Private	(4) Rural	(5) Urban	(6) Hospital	(7) Health center	(8) Health post
Improved water source available	Niger	54.4	52.6	87.3	50.2	96.0	100.0	83.4	40.4
		(48.1, 60.6)	(45.9, 59.4)	(75.9, 98.7)	(43.0, 57.4)	(91.0, 100.0)	(100.0, 100.0)	(74.3, 92.6)	(32.9, 47.9)
	Mozambique	86.7	86.5	100.0	84.9	100.0	97.4	84.1	-
		(81.8, 91.5)	(81.6, 91.5)	(100.0, 100.0)	(79.4, 90.4)	(100.0, 100.0)	(92.1, 100.0)	(78.2, 89.9)	
	Togo	85.1	75.6	100.0	74.2	98.5	93.8	97.8	81.0
		(79.8, 90.4)	(68.3, 82.8)	(100.0, 100.0)	(66.3, 82.0)	(95.1, 100.0)	(81.3, 100.0)	(93.5, 100.0)	(73.8, 88.3)
	Sierra Leone	84.0	83.5	89.9	81.6	89.7	100.0	90.9	81.3
		(80.9, 87.2)	(80.2, 86.9)	(80.7, 99.2)	(77.6, 85.6)	(84.9, 94.6)	(100.0, 100.0)	(85.4, 96.5)	(77.4, 85.2)
	Uganda	94.2	91.5	97.0	91.3	99.5	100.0	93.9	94.0
		(91.9, 96.6)	(87.8, 95.1)	(94.2, 99.7)	(88.0, 94.7)	(98.1, 100.0)	(100.0, 100.0)	(89.7, 98.1)	(91.0, 97.0)
	Madagascar	71.5	66.1	93.1	63.8	96.4	96.3	76.9	56.5
		(67.2, 75.8)	(60.5, 71.7)	(89.0, 97.2)	(57.3, 70.3)	(93.9, 98.9)	(90.0, 100.0)	(72.2, 81.7)	(46.1, 67.0)
	Tanzania	74.0	68.7	88.1	66.0	90.8	100.0	90.8	69.8
		(69.5, 78.5)	(63.0, 74.4)	(82.1, 94.1)	(59.7, 72.4)	(86.2, 95.4)	(100.0, 100.0)	(84.7, 96.9)	(64.1, 75.5)
	Kenya	95.1	94.7	95.6	94.8	95.9	97.8	96.7	94.3
		(94.4, 95.9)	(93.6, 95.8)	(94.5, 96.8)	(93.9, 95.7)	(94.4, 97.3)	(96.1, 99.5)	(95.3, 98.2)	(93.3, 95.3)
	Nigeria	64.3	59.5	85.8	58.6	74.6	85.8	64.2	44.2
		(62.3, 66.3)	(57.4, 61.6)	(80.6, 91.0)	(56.0, 61.2)	(71.8, 77.4)	(82.4, 89.3)	(61.7, 66.7)	(39.8, 48.5)
Improved toilet available	Niger	43.1	40.7	88.4	37.6	97.9	98.4	96.3	18.0
		(36.9, 49.3)	(34.0, 47.3)	(77.4, 99.4)	(30.6, 44.6)	(94.2, 100.0)	(91.8, 100.0)	(91.6, 100.0)	(12.1, 23.8)
	Mozambique	72.8	72.5	100.0	70.3	91.3	89.5	68.8	-
		(66.4, 79.2)	(66.1, 79.0)	(100.0, 100.0)	(63.4, 77.3)	(79.3, 100.0)	(79.4, 99.6)	(61.4, 76.2)	
	Togo	84.0	74.8	98.3	72.5	98.0	87.5	96.7	80.0
		(78.5, 89.5)	(67.6, 82.1)	(93.9, 100.0)	(64.5, 80.5)	(94.1, 100.0)	(70.4, 100.0)	(91.3, 100.0)	(72.6, 87.4)
	Sierra Leone	81.1	80.6	87.1	78.1	88.1	84.7	92.5	77.7
		(77.7, 84.5)	(77.0, 84.2)	(76.8, 97.5)	(73.8, 82.4)	(83.0, 93.3)	(71.3, 98.1)	(87.5, 97.6)	(73.5, 81.9)
	Uganda	95.7	94.1	97.4	94.8	97.4	100.0	96.2	95.2
		(93.7, 97.8)	(91.0, 97.2)	(94.8, 99.9)	(92.2, 97.4)	(94.3, 100.0)	(100.0, 100.0)	(92.8, 99.5)	(92.5, 97.9)
	Madagascar	54.8	48.8	79.0	49.5	72.1	78.7	57.7	44.8

		(50.1, 59.6)	(42.9, 54.7)	(72.4, 85.5)	(42.7, 56.3)	(66.1, 78.1)	(65.0, 92.3)	(52.1, 63.3)	(34.4, 55.3)
	Tanzania	88.7	87.0	93.2	87.9	90.4	100.0	86.8	88.6
		(85.5, 91.9)	(82.9, 91.1)	(88.5, 97.9)	(83.5, 92.3)	(85.7, 95.0)	(100.0, 100.0)	(79.7, 94.0)	(84.6, 92.5)
	Kenya	90.1	87.9	92.6	87.9	94.6	95.8	90.6	89.1
		(89.0, 91.1)	(86.3, 89.4)	(91.2, 94.1)	(86.6, 89.3)	(93.0, 96.2)	(93.4, 98.2)	(88.2, 93.0)	(87.8, 90.5)
	Nigeria	45.3	38.6	75.4	36.0	62.1	74.9	45.7	16.1
		(43.3, 47.4)	(36.5, 40.6)	(69.0, 81.8)	(33.5, 38.6)	(58.9, 65.2)	(70.7, 79.2)	(43.1, 48.3)	(12.8, 19.3)
Electricity available	Niger	34.0	30.6	98.1	28.3	91.3	100.0	59.0	21.5
		(28.1, 39.9)	(24.4, 36.8)	(93.4, 100.0)	(21.8, 34.8)	(84.1, 98.4)	(100.0, 100.0)	(46.9, 71.1)	(15.2, 27.7)
	Mozambique	82.1	81.9	100.0	80.2	95.7	94.7	79.0	-
		(76.5, 87.6)	(76.3, 87.4)	(100.0, 100.0)	(74.1, 86.3)	(87.0, 100.0)	(87.4, 100.0)	(72.5, 85.5)	
	Togo	68.4	48.7	99.3	44.7	97.5	100.0	95.7	59.4
		(61.5, 75.4)	(40.3, 57.1)	(96.5, 100.0)	(35.8, 53.5)	(93.1, 100.0)	(100.0, 100.0)	(89.6, 100.0)	(50.4, 68.5)
	Sierra Leone	70.2	67.9	97.0	62.6	87.8	97.7	84.4	64.9
		(66.3, 74.2)	(63.7, 72.1)	(91.7, 100.0)	(57.6, 67.6)	(82.6, 93.0)	(92.2, 100.0)	(77.4, 91.4)	(60.1, 69.7)
	Uganda	79.2	67.5	91.1	73.3	89.9	100.0	89.6	72.6
		(75.1, 83.3)	(61.4, 73.6)	(86.6, 95.7)	(68.1, 78.6)	(84.1, 95.7)	(100.0, 100.0)	(84.3, 94.9)	(66.9, 78.2)
	Madagascar	49.3	37.4	96.7	36.0	92.1	100.0	57.3	24.4
		(44.5, 54.0)	(31.7, 43.1)	(93.8, 99.6)	(29.5, 42.5)	(88.5, 95.7)	(100.0, 100.0)	(51.7, 62.9)	(15.4, 33.5)
	Tanzania	81.2	78.6	88.2	76.9	90.3	98.8	93.6	78.2
		(77.2, 85.2)	(73.6, 83.7)	(82.2, 94.2)	(71.3, 82.6)	(85.6, 95.0)	(94.9, 100.0)	(88.5, 98.8)	(73.1, 83.3)
	Kenya	89.0	81.3	98.0	84.9	97.9	97.1	92.3	87.0
		(87.9, 90.2)	(79.4, 83.2)	(97.2, 98.8)	(83.4, 86.5)	(96.8, 98.9)	(95.1, 99.1)	(90.1, 94.5)	(85.6, 88.5)
	Nigeria	53.9	45.9	89.1	43.5	72.5	87.4	54.0	21.7
		(51.8, 55.9)	(43.8, 48.1)	(84.4, 93.7)	(40.9, 46.2)	(69.6, 75.4)	(84.1, 90.7)	(51.3, 56.6)	(18.1, 25.3)

Appendix Table A8: Variance decomposition

Within country and between country variances are calculated for each indicator and the percent contribution of each is reported below. The variances are computed using the xtsum command in Stata.

Variable	Within country	Between country
Diagnostic accuracy	66.8%	33.2%
Treatment accuracy	61.5%	38.5%
Unauthorized absence	82.1%	18.0%
Equipment availability	74.4%	25.6%
Medicine availability	75.9%	24.1%
Infrastructure availability	74.0%	26.1%
Caseload	72.0%	28.0%
PCA Index	64.1%	35.9%

Appendix Table A9: Diagnosis and treatment accuracy

Indic-ator	Country	(1) All facilities	(2) Public	(3) Private	(4) Rural	(5) Urban	(6) Hospital	(7) Health center	(8) Health post	(9) Doctors	(10) Nurses	(11) Other workers
Diagnostic accuracy	Niger	39.9	39.5	46.2	34.1	46.5	44.7	44.3	30.3	57.2	43.2	32.7
		(38.1, 41.8)	(37.5, 41.5)	(41.6, 50.9)	(31.5, 36.6)	(44.1, 49.0)	(40.6, 48.9)	(41.4, 47.1)	(27.6, 33.1)	(51.4, 62.9)	(40.7, 45.6)	(29.9, 35.5)
	Mozambique	58.4	58.3	59.7	54.4	67.4	62.4	49.6	-	63.3	51.7	53.7
		(56.8, 59.9)	(56.8, 59.9)	(46.4, 73.0)	(52.7, 56.1)	(64.1, 70.6)	(60.2, 64.7)	(47.6, 51.6)		(61.1, 65.5)	(49.4, 54.0)	(49.5, 57.9)
	Togo	50.3	46.9	54.5	45.7	53.2	50.1	56.3	45.3	64.3	46.5	37.4
		(47.8, 52.9)	(43.8, 50.0)	(49.6, 59.5)	(42.2, 49.3)	(49.4, 57.1)	(42.7, 57.4)	(52.0, 60.6)	(41.9, 48.8)	(58.7, 69.8)	(43.6, 49.4)	(30.2, 44.6)
	Sierra Leone	49.1	48.1	56.8	45.1	54.3	60.5	54.1	45.4	59.3	52.0	47.5
		(47.4, 50.8)	(46.3, 49.9)	(52.2, 61.4)	(42.8, 47.3)	(51.8, 56.8)	(55.9, 65.1)	(50.9, 57.3)	(43.3, 47.5)	(51.1, 67.4)	(49.2, 54.9)	(45.3, 49.6)
	Uganda	56.3	56.4	56.2	49.9	64.6	71.3	64.2	40.8	71.7	50.2	28.7
		(54.4, 58.2)	(54.0, 58.8)	(52.8, 59.5)	(47.5, 52.3)	(61.5, 67.8)	(62.9, 79.7)	(61.8, 66.6)	(38.1, 43.5)	(69.2, 74.1)	(47.6, 52.7)	(25.0, 32.3)
	Madagascar	48.1	46.9	51.7	45.9	52.1	54.5	49.9	38.5	57.4	41.1	30.2
		(46.1, 50.1)	(44.4, 49.5)	(48.5, 54.8)	(42.8, 49.0)	(49.6, 54.6)	(50.4, 58.6)	(47.5, 52.4)	(33.7, 43.3)	(55.2, 59.5)	(37.7, 44.4)	(17.2, 43.2)
	Tanzania	69.2	66.8	74.6	56.0	74.2	71.5	75.1	56.8	72.6	45.7	46.5
		(67.2, 71.2)	(64.3, 69.3)	(71.3, 78.0)	(52.9, 59.1)	(71.7, 76.8)	(66.4, 76.6)	(71.8, 78.3)	(53.8, 59.8)	(70.5, 74.8)	(40.8, 50.7)	(38.7, 54.2)
	Kenya	66.8	67.6	65.4	66.6	67.1	70.6	67.1	64.5	70.6	63.0	48.5
		(66.2, 67.4)	(66.8, 68.3)	(64.4, 66.4)	(65.8, 67.3)	(66.0, 68.2)	(69.1, 72.1)	(65.8, 68.3)	(63.7, 65.3)	(69.7, 71.4)	(62.2, 63.9)	(42.6, 54.5)
	Nigeria	40.9	38.4	52.6	36.5	44.4	52.0	31.7	29.3	57.6	44.9	30.6
		(40.1, 41.8)	(37.5, 39.2)	(49.2, 56.0)	(35.4, 37.6)	(43.1, 45.6)	(50.2, 53.8)	(30.7, 32.6)	(27.4, 31.2)	(54.9, 60.3)	(43.0, 46.7)	(29.7, 31.5)
Treatment accuracy	Niger	41.0	40.8	44.4	42.0	40.0	43.8	41.1	39.6	46.3	41.0	40.2
		(39.2, 42.9)	(38.8, 42.8)	(38.7, 50.1)	(39.6, 44.4)	(37.1, 42.9)	(38.9, 48.6)	(38.0, 44.2)	(37.0, 42.2)	(36.7, 55.9)	(38.5, 43.6)	(37.4, 43.0)
	Mozambique	46.3	46.2	50.8	43.5	52.7	49.5	39.5	-	51.9	38.6	41.2
		(44.5, 48.1)	(44.4, 48.1)	(41.0, 60.6)	(41.6, 45.4)	(48.2, 57.2)	(46.6, 52.4)	(37.4, 41.6)		(49.2, 54.7)	(35.8, 41.3)	(36.9, 45.4)
	Togo	55.9	54.3	57.8	51.3	58.8	56.5	65.1	48.0	66.3	54.2	30.5
		(53.0, 58.8)	(51.0, 57.7)	(51.9, 63.7)	(47.1, 55.4)	(54.7, 62.9)	(49.2, 63.8)	(60.6, 69.6)	(44.0, 51.9)	(61.0, 71.7)	(50.8, 57.7)	(24.3, 36.6)
	Sierra Leone	57.4	56.7	62.3	54.8	60.6	66.4	59.6	55.2	67.5	59.6	56.0
		(55.8, 58.9)	(55.1, 58.3)	(57.7, 67.0)	(52.8, 56.8)	(58.3, 63.0)	(61.5, 71.3)	(56.7, 62.6)	(53.3, 57.1)	(58.4, 76.6)	(56.8, 62.3)	(54.1, 58.0)
	Uganda	48.1	48.3	47.6	39.9	58.7	71.4	57.2	28.2	64.6	39.5	23.5
		(45.9, 50.2)	(45.7, 51.0)	(44.0, 51.3)	(37.3, 42.4)	(55.1, 62.3)	(66.0, 76.8)	(54.4, 60.0)	(25.6, 30.8)	(61.7, 67.6)	(36.4, 42.5)	(20.2, 26.8)
	Madagascar	55.9	58.0	49.4	58.6	51.0	61.6	56.8	49.6	60.0	53.0	40.9
		(53.7, 58.0)	(55.5, 60.5)	(45.3, 53.5)	(55.4, 61.7)	(48.1, 53.9)	(54.6, 68.7)	(54.2, 59.4)	(45.2, 54.0)	(57.1, 62.8)	(49.7, 56.3)	(27.2, 54.6)

	Tanzania	70.1	70.3	69.8	56.3	75.3	75.8	74.6	52.1	73.9	46.8	39.5
		(68.4, 71.9)	(68.0, 72.5)	(67.1, 72.4)	(53.4, 59.3)	(73.4, 77.3)	(72.5, 79.0)	(71.9, 77.2)	(49.3, 55.0)	(72.3, 75.6)	(41.8, 51.9)	(32.2, 46.8)
	Kenya	74.4	77.6	68.7	74.8	73.6	78.9	74.4	71.8	77.2	71.9	50.8
		(73.6, 75.1)	(76.8, 78.4)	(67.4, 69.9)	(74.0, 75.7)	(72.2, 75.0)	(77.0, 80.7)	(73.0, 75.9)	(70.9, 72.7)	(76.1, 78.3)	(71.0, 72.8)	(44.9, 56.7)
	Nigeria	35.0	32.5	46.0	30.1	38.7	47.7	24.4	21.4	54.2	40.3	22.8
		(34.1, 35.8)	(31.7, 33.4)	(42.6, 49.4)	(28.9, 31.2)	(37.5, 40.0)	(45.9, 49.4)	(23.4, 25.4)	(19.5, 23.3)	(51.8, 56.7)	(38.1, 42.4)	(21.9, 23.7)
Inappropriate antibiotic prescription	Niger	25.3	25.3	24.7	25.7	24.8	28.3	23.8	26.3	20.7	29.5	20.3
		(21.5, 29.1)	(21.3, 29.3)	(13.5, 35.9)	(20.5, 31.0)	(19.4, 30.2)	(20.2, 36.3)	(17.5, 30.1)	(20.4, 32.2)	(7.1, 34.3)	(24.0, 35.0)	(14.9, 25.7)
	Mozambique	48.9	49.0	41.9	47.3	52.5	49.2	48.3	-	51.4	48.0	41.4
		(45.2, 52.6)	(45.3, 52.8)	(11.3, 72.5)	(43.2, 51.4)	(43.9, 61.1)	(43.3, 55.1)	(43.5, 53.1)		(45.5, 57.2)	(42.2, 53.7)	(32.7, 50.2)
	Togo	56.5	47.9	66.9	51.0	60.0	43.5	57.8	57.8	33.4	64.9	52.7
		(51.0, 62.1)	(41.5, 54.3)	(55.6, 78.3)	(43.7, 58.2)	(51.2, 68.8)	(29.0, 58.0)	(48.5, 67.1)	(49.8, 65.8)	(21.7, 45.0)	(58.4, 71.5)	(35.1, 70.2)
	Sierra Leone	37.9	37.8	39.1	37.0	39.1	44.1	36.6	37.8	38.4	44.6	34.9
		(34.6, 41.2)	(34.2, 41.3)	(29.2, 49.0)	(32.7, 41.3)	(33.9, 44.3)	(33.4, 54.8)	(30.2, 43.0)	(33.6, 41.9)	(20.7, 56.1)	(38.6, 50.6)	(30.8, 38.9)
	Uganda	37.0	32.0	45.3	40.9	32.0	19.4	35.5	44.3	26.8	47.6	37.6
		(33.5, 40.5)	(27.9, 36.2)	(39.0, 51.6)	(36.8, 44.9)	(24.8, 39.2)	(0.0, 39.4)	(30.2, 40.8)	(39.4, 49.2)	(20.4, 33.2)	(42.5, 52.7)	(30.4, 44.9)
	Madagascar	40.7	45.0	27.9	45.1	32.9	35.1	39.3	48.5	32.6	47.3	44.9
		(36.9, 44.6)	(40.1, 49.8)	(21.8, 33.9)	(39.2, 50.9)	(28.0, 37.9)	(23.8, 46.4)	(34.8, 43.8)	(38.4, 58.6)	(27.7, 37.6)	(41.2, 53.4)	(16.8, 73.1)
	Tanzania	40.6	43.2	34.8	31.1	44.2	32.8	54.3	40.2	40.6	42.3	37.3
		(36.3, 44.9)	(38.0, 48.4)	(27.2, 42.4)	(25.4, 36.7)	(37.9, 50.5)	(21.7, 43.9)	(45.8, 62.8)	(34.6, 45.8)	(35.6, 45.6)	(31.8, 52.8)	(23.2, 51.4)
	Kenya	52.0	52.7	50.8	49.6	55.7	54.5	50.3	51.4	49.2	55.0	60.9
		(50.6, 53.5)	(50.9, 54.6)	(48.4, 53.2)	(47.9, 51.3)	(52.9, 58.6)	(50.5, 58.6)	(47.3, 53.4)	(49.6, 53.3)	(46.8, 51.5)	(53.1, 56.9)	(51.1, 70.6)
	Nigeria	54.0	53.0	58.1	53.5	54.3	59.2	49.5	48.8	60.5	57.9	49.2
		(52.6, 55.3)	(51.6, 54.5)	(52.7, 63.5)	(51.6, 55.4)	(52.3, 56.3)	(56.3, 62.1)	(47.8, 51.3)	(45.0, 52.5)	(56.0, 64.9)	(54.5, 61.2)	(47.6, 50.8)