

# Indirect effects on maternal and child mortality from the COVID-19 pandemic: evidence from disruptions in healthcare utilization in 18 low- and middle-income countries

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## Abstract

**Background:** The COVID-19 pandemic has had wide-reaching direct and indirect impacts on population health. We describe one of the most critical of these secondary consequences, the decrease in the utilization of health services and the resulting consequences for mortality. In low- and middle-income countries, these disruptions can halt progress towards reducing maternal and child mortality.

**Methods:** Data on service utilization from January 2018 to June 2021 is extracted from health management information systems of 18 low- and lower-middle-income countries. Interrupted time series design is used to estimate percent change in the volumes of essential health services delivered during the pandemic compared to projected volumes based on pre-pandemic trends. The Lives Saved Tool mathematical model is used to estimate the impact of the service utilization disruptions on child and maternal mortality. In addition, the estimated monthly disruptions are also correlated to the COVID-19 burden, time since the start of the pandemic, and relative severity of mobility restrictions.

**Findings:** We estimate that decreases in essential health service utilization between March 2020 and June 2021 led to 113,873 additional deaths in the 18 countries, representing 3.8% and 1.4% increases in child and maternal mortality, respectively. This corresponds to an average of 2.6 indirect deaths per COVID-19 death officially reported in the same period. This excess mortality results from the decline in utilization of the RMNCH services included in the analysis, but the utilization shortfalls vary substantially between countries, health services, and over time. The largest disruptions, resulting in 27.5% of the excess death, occurred during the second quarter of 2020, regardless of whether countries experienced the highest rate of COVID-19-related deaths during the same months. There is a significant relationship between the magnitude of service disruptions and the stringency of mobility restrictions.

**Interpretation:** Large declines in health care utilization during the COVID-19 pandemic amplify the pandemic's harmful impacts on health outcomes. As efforts and resource allocation towards prevention and treatment of COVID-19 continue, essential health services must be maintained, particularly in low and middle-income countries.

**Funding:** The Global Financing Facility for Women, Children, and Adolescents.

## Research in Context

**Evidence before this study:** Disruptions to essential health services during the SARS-CoV-2 (COVID-19) pandemic amplify the pandemic's impact on mortality and pose a profound threat to the ability of low-income and middle-income countries to achieve Universal Health Coverage (UHC) and the Sustainable Development Goals (SDGs). These indirect effects have been documented in past epidemics, such as the 2013-2016 West African Ebola Epidemic. For the COVID-19 pandemic, early policy decisions on the continuity of essential services were based on mathematical modeling based on hypothesized scenarios. Throughout the pandemic, there have been an array of findings on the effects from small sets of facilities and specific services showing decreases in health service volume, with few exceptions. Surveys of households and pregnant women have corroborated these decreases in utilization.

**Added-value of this study:** This study presents projections of indirect child, neonatal, and maternal mortality during the COVID-19 pandemic based on actual service utilization data. Moreover, this study presents the broadest evidence on changes in the utilization of essential health services from low- and middle-income countries to date, drawn from health facilities in 18 countries on eight services between March 2020 and June 2021. The analysis demonstrates variation in the magnitude of service delivery reductions between countries, services, and over time and suggests that the magnitude of service disruptions was largest at the start of the pandemic and during months with strict mobility restrictions, regardless of the COVID-19 burden.

**Implication of all the available evidence:** The estimated disruptions to essential services are likely to cause an increase in child and maternal mortality. While this excess mortality is smaller than initial projections, it comprises a substantial proportion of the overall impact of the pandemic in low- and middle-income countries. There is strong evidence to recommend that the safeguarding essential services be integrated into pandemic preparedness and response activities. The large variation in the estimated indirect impact between countries, and lower than expected service volume in many countries as of June 2021, suggest the need for further context-specific responses and investments to improve health system resiliency.

## Introduction

By June 2021, more than a year after the World Health Organization declared the COVID-19 outbreak a pandemic, nearly 4,000,000 deaths had been reported.<sup>1</sup> In settings where excess mortality has been analyzed, the total mortality is larger than the reported number of COVID-19-related deaths.<sup>2-5</sup> While the gap between excess mortality and officially reported COVID-19-related deaths is partly explained by underreporting, previous outbreaks have demonstrated that indirect health effects caused by reductions in the delivery of routine health services could be as important as the direct consequences.<sup>6</sup> The threat of this double crisis is particularly worrying for low and middle-income countries (LMICs). LMICs, on average, have higher mortality rates, more fragile health systems, and health outcomes that are more sensitive to income shocks, such as those unleashed by the COVID-19 pandemic.<sup>6,7</sup> These factors heighten the risk of short-term downturns in the utilization of preventive, promotive, and curative care to erode the hard-fought progress towards reducing global maternal and child mortality and lead into a prolonged, secondary health crisis.

Global pandemics can affect health service utilization through numerous pathways. On the supply side, health systems may lack the ability to maintain continuity of care and implement rapid adaptations due to limitations in infrastructure, health workforce, supply chains, and financial space. Limited resources to respond to a global pandemic might necessitate reallocation away from routine activities and impact the provision of essential health services through reduced hours, caps on patient intake, and changes in the types of services offered. Demand-side factors that may prevent access to services include mobility restrictions, shutdowns of public transportation, perceived changes in quality of services<sup>8</sup> or fear of contracting COVID-19 at health facilities. The economic contraction caused by the pandemic may constrain the ability to pay for health services.<sup>9</sup>

At the start of the COVID-19 pandemic, statistical modeling was used to project increases in maternal and child mortality through hypothesized disruptions to essential health services.<sup>10-12</sup> Multiple sources have since confirmed increases in adverse maternal outcomes and decreases in reproductive, maternal, and child (RMNCH) services during the pandemic.<sup>13,14</sup> Studies have quantified decreases in total health facility attendance, complementing the qualitative reports by health workers and stakeholders.<sup>13,15,16</sup> In Nepal, a large cohort study of women found decreases of more than half in institutional delivery rates, poorer quality of care, and increases in stillbirth and neonatal mortality rates.<sup>17</sup> While there is clear evidence that service disruptions have occurred, there is substantial variation across countries, levels of care, and service type. For example, studies from Burkina Faso, Kenya, and Mozambique found limited disruptions in contraceptive use and quick recovery to expected levels. In Bangladesh, 40% of mothers reported disruptions to family planning services.<sup>18-20</sup> The findings on disruptions to child vaccination programs are more consistent across countries, as many countries temporarily paused mass vaccination campaigns between March and May 2020.<sup>21-23</sup>

This study estimates the reductions in maternal, reproductive, and child service utilization across LMICs and projects indirect mortality caused by the pandemic. Previous studies have involved either fully hypothetical scenarios or empirical data from only a small set of health facilities or for a short duration of time. We present broader evidence of the impact of the COVID-19 pandemic on essential health service delivery by analyzing comprehensive data from 18 countries on eight essential services between March 2020 and June 2021. Based on the estimated decline in service coverage, the underlying burden of disease, and the effectiveness of different interventions in preventing deaths, we aim to generate more accurate forecasts of indirect mortality.

## Methods

We used an interrupted time-series design to estimate the percent change in the volumes of essential health services delivered during the pandemic. These estimates of lost services were translated into changes in coverage of interventions delivered during those periods to estimate the number of lives lost. The estimated monthly disruptions were also correlated to the COVID-19 burden, time since the start of the pandemic, and relative severity of mobility restrictions to determine which driver is most associated with the measured disruptions.

### Data sources and preparation

Monthly administrative data on the volume of key essential health services between January 2018 and June 2021 are collated from 18 countries participating in a monitoring activity supported by the Global Financing Facility for Women, Children, and Adolescents (GFF). Seven services were selected to represent the continuum of reproductive, maternal, and child health. In addition, outpatient consultations are used as a proxy for the general use of health services. The eight indicators are not available for all countries. When available, we map the closest indicator or proxy to each category (see Appendix Table A1). HMIS data were downloaded on August 22<sup>nd</sup>, 2021 and were prepared for analysis by removing outlier values and restricting data for indicators with low completeness. These preparation steps and the advantages and disadvantages of HMIS data are detailed in the Appendix B and in previous work.<sup>24</sup> Changes in reporting patterns, especially during the pandemic period, may bias our findings. We describe data reporting completeness in Appendix B as well as include a sensitivity check showing that changes in reporting patterns do not drive the results. The final dataset includes 137,192 health facilities over 42 months and eight services, for a total of 21,421,125 non-missing facility-month-service observations in the 18 countries.

Data on COVID-19 deaths are obtained from the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University, which compiles data from official government COVID-19 surveillance reports. Information on the policy measures affecting population mobility is obtained from the Oxford COVID-19 Government Policy Tracker, which systematically tracks implementation dates and scores the stringency of policy interventions. We selected a subset of policies that may affect population access to health facilities: public transport closures, stay-at-home requirements, movement limitations, school closures, and workplace closures. The dataset includes ordinal severity scores for each policy capture the severity, ranging from no restrictions to recommendations to requirements with minimal exceptions. We construct an index representing the daily severity of mobility restrictions using the first component of a principal component analysis of these selected indicators.

### Analysis of service utilization disruptions

We used an interrupted time-series approach to predict the volume of services that would have been delivered had the pandemic not occurred. The interruption period is defined as starting with the WHO pandemic declaration in March 2020, coinciding with the start of community transmission and mobility restrictions in most countries. Service and countries were modeled separately using an ordinary least squares equation with the following form

$$Y_{tf} = \beta_0 + \beta_1 T + \beta_{2..12} Month + \beta_{13..29} PandemicMonth + \alpha_f + \varepsilon_{tf}$$
where the expected volume in the absence of the pandemic (*counterfactual*) is comprised of  $T$ , the time in months since January 2018 to account for secular trend ( $\beta_1$ ),  $Month$  represents calendar months to account for seasonality ( $\beta_{2..12}$ ), and  $\alpha_f$  represents the facility-level fixed effect accounting for time-invariant facility characteristics. Fixed effects were replaced with facility characteristic covariates (province and facility type) in Uganda, where an update to the administrative system did not allow for consistent identification of facilities over time.

$\beta_{13..29}$  contains estimated disruption for each month since the pandemic. Average facility-level disruption is translated into percent change by dividing by the expected volume. The cumulative shortfall was estimated by running the same model with a single pandemic period. A two-year pre-pandemic time horizon was chosen to minimize capturing changes in data collection practices, policy changes, or other health shocks while separating seasonality from secular trends.

#### Correlate drivers of utilization changes

We further examined whether the estimated monthly changes in service volumes showed statistical association with the time elapsed since the start of the pandemic, the monthly number of reported COVID deaths, and the stringency of mobility restrictions. These relationships were assessed by running the following ordinary least squares regression separately for each service:

$D_{tc} = \gamma_0 + \gamma_1 Q + \gamma_2 CovidMortality_{tc} + \gamma_3 RestrictionStringency_{tc} + \alpha_c + \varepsilon_{tc}$  where  $D_{tc}$  is the estimated monthly change in service volume for month  $t$  in country  $c$ .  $CovidMortality_{tc}$  represents the reported monthly number of COVID-19-related deaths per 100,000 people and  $RestrictionStringency_{tc}$  represents the average monthly stringency of the mobility restrictions.  $\alpha_c$  represents a country fixed effect and  $\varepsilon_{tc}$  is a normally distributed error term.

#### Mortality estimates

We estimated the impact of the service utilization disruptions on child, neonatal, and maternal mortality using the Lives Saved Tool (LiST). LiST is a mathematical model that forecasts mortality estimates from the coverage of 70+ RMNCH+N health interventions, considering the specific demographic and epidemiological context of a country.<sup>25</sup> We assume that the relative change in the coverage of the interventions included in the LiST model was the same as the estimated relative changes in service utilization. Each intervention is linked to the service during which the intervention is typically delivered or proxied by the service that is assumed to have a similar utilization pattern. For interventions without a reasonable proxy, such as child nutrition services, the conservative default assumed no change in the intervention coverage. This linking of service indicators to LiST interventions is shown in Appendix Table A2. As multiple RMNCH interventions are linked to a small set of indicators, small variations in the few service indicators have large effects on the overall mortality results. To address this, we ran a sensitivity analysis using different linking combinations to understand how these linking decisions alter the results and to bound their potential effect.

For each LiST intervention and country, we obtained coverage values from the most recent household survey for the country (typically a DHS or MICS), which we took as the coverage value that we would have expected in the absence of the pandemic (i.e., as a "counterfactual"). To estimate the coverage value during the pandemic, we multiplied the counterfactual coverage value by the estimated disruption of the service (proxy) indicator. This approach assumes that, during the pandemic, the change in population-level coverage was proportional to the change in facility-level utilization. In this way, we obtained an estimated coverage value for each intervention, country, and period. We used three-month periods (quarters), aggregating the service disruption for the relevant proxy indicator for each quarter and calculating disrupted coverage values for each quarter of the pandemic for each country and intervention.

We ran two LiST analyses for each country and quarter: first, a "without pandemic" scenario, using only the counterfactual coverage values, to obtain the expected deaths in the absence of the pandemic; and second, a "with pandemic" scenario, to obtain the expected deaths during the pandemic. LiST only takes yearly input values, so we entered quarterly values as yearly values (for 2020 or 2021, as appropriate),

and divided the resulting expected deaths by 4, to obtain the expected deaths for the quarter. We took the difference in expected deaths between the "with pandemic" and "without pandemic" scenarios to represent the additional deaths due to the pandemic.

#### Role of funding source

This work was self-funded, and staff from the Global Financing Facility for Women, Children, and Adolescents were involved in all stages of the project.

## **Results**

### Service disruptions

We focus first on the number of outpatient consultations as a proxy for general service utilization. As shown in Table 1, the cumulative number of reported outpatient consultations between March 2020 and June 2021 is significantly lower than expected, given the pre-pandemic trends in all countries apart from Cameroon, Liberia, and Somalia. These three countries also experienced significant monthly declines in outpatient consultations, but the reductions over the sixteen-month duration are not statistically significant (see Appendix Table A3). On average, the countries in this analysis experienced a cumulative reduction of 13 percent in outpatient consultations. The largest decline of 40 percent is estimated for Bangladesh, followed by 25 percent in Haiti and Kenya. Large declines between 10 and 20 percent are estimated for Ethiopia, Ghana, Guinea, Madagascar, Nigeria, Senegal, Sierra Leone, and Uganda. As seen in Figure 1, the average monthly outpatient service volumes are below expected levels for all months between March 2020 and June 2021.

The disruptions to reproductive, maternal, and child services are on smaller on average than those observed in outpatient consultations. For child vaccination, 10 out of 18 countries experienced significant cumulative reductions in the number of children receiving the third dose of the pentavalent vaccine. Out of the 14 countries with HMIS data on administered BCG vaccine doses, eight experienced significant cumulative reductions. In most countries, the monthly reductions in vaccination were largest at the start of the pandemic and returned to the pre-pandemic expectation by July 2020 (see Figure 1). While the return to the expected levels is encouraging, we do not see an increase representing facility-based catch-up for the vaccinations missed early during the pandemic. A different pattern is observed for antenatal care initiation (ANC1), where an initial decrease is followed by an increase above the expected volume, indicating that some women may have delayed their visit without forgoing antenatal care completely. In general, reproductive and maternal health services disruptions were more context-specific than disruptions in outpatient care and child vaccination. Significant declines in institutional delivery, for example, are estimated in 10 out of the 18 countries, while 4 of the countries have reported volumes significantly exceeding those expected based on pre-pandemic trends. Significant cumulative reductions in family planning services are estimated for six out of 12 countries with available data. Large reductions of at least 10% were experienced in Guinea, Mali, and Sierra Leone.

### Correlates

In addition to the cross-country variation, the magnitude of service volume disruption varied during the pandemic. Figure 2 presents the example of outpatient consultations and portrays a country-specific relationship between the magnitude of the estimated disruptions, the time elapsed since the beginning of the pandemic, and the monthly number of reported COVID-related deaths. To assess the correlations of the disruptions with these factors, we present cross-country regression results in Table 2. The largest utilization reductions were experienced in April and May 2020, regardless of the period with the highest reported COVID-19-related mortality. Family planning is the only service with large drops in the second

quarter of 2021. Moreover, there is no significant relationship between the number of monthly reported COVID-19-related deaths and the magnitude of change in any service. There is, however, a significant relationship between imposed restrictions and the magnitude of the estimated disruptions in outpatient consultations, child vaccinations, and the fourth antenatal care visit. For example, a standard deviation in the mobility restrictions stringency is associated with a 3.8 percent reduction in outpatient consultation volume (Column 1 of Table 2).

### Mortality estimates

Table 3 shows estimates of the impact of service disruptions on child, neonatal, and maternal mortality. For each country and age group, we report the number of deaths that we would have expected in the absence of the pandemic for the period March 2020 to June 2021, the estimated number of additional deaths due to the change in service utilization during this same period, and the relative increase in mortality because of service utilization declines during the pandemic. The country with the greatest estimated increase in mortality was Bangladesh, with a 14.9% increase in child mortality, 9.7% increase in neonatal mortality, and 3.9% increase in maternal mortality. Haiti, Kenya, Nigeria, Sierra Leone, and Uganda were also estimated to have child mortality increases of 5% or greater. Cameroon, Liberia, and Somalia were estimated to have small *reductions* in child mortality to the pre-pandemic period, and six countries were estimated to have minor reductions in maternal mortality. We estimate that 27.6% of the additional child deaths and 24.3% of the additional maternal deaths occurred due to utilization declines in Quarter 2 of 2020, reflecting the results shown above (see Appendix Table A4). In sum, the absolute number of additional deaths across the 18 countries from March 2020 to June 2021 is estimated to be 110,608 child deaths (0-59 months), 31,979 neonatal deaths (<1 month) and 3,265 maternal deaths. Many factors, including population size and baseline mortality rate, drive the absolute number of additional deaths. In general, estimated increases in maternal mortality across all countries were smaller than increases in child or neonatal mortality, due to smaller facility delivery reductions than those in outpatient and vaccination services.

We conducted two sensitivity analyses to understand the potential error in the mortality results. First, we used the upper and lower 95% confidence intervals of the service disruption estimates and found that the additional deaths could be 43.8% higher or 42.9% lower than the estimates in Table 3. Given the perfect correlation in the error of the disruption estimates that this approach assumes, these bounds are overly conservative. Second, we varied the linkage of service indicators to LiST interventions by setting all interventions to each single service in turn, and by randomizing the link between interventions and services. We found that the mortality estimates could be up to 31.8% higher or 55.1% lower than in Table 3. However, given the combinations that we tested, these bounds are conservative as well. For more detail on these sensitivity analyses, see Appendix Table 5 and 6.

## **Discussion**

Compared against the expected volumes based on pre-pandemic trends, we estimate statistically significant reductions in service utilization. The magnitudes of the cumulative shortfalls vary substantially by country, type of service, and time. The largest disruptions, on average, are estimated for outpatient consultations – a proxy for general healthcare utilization. Smaller cumulative shortfalls in the number of children receiving the third dose of the pentavalent vaccine are detected for most countries. We forecast the disruptions will result in 113,873 additional deaths among women and children across 18 LMIC countries. These deaths result from an average decrease in utilization of all selected services between March 2020 and June 2021. Compared to COVID-19 mortality officially reported by the 18 countries, this increase represents 2.<sup>6</sup> indirect deaths among women and children for every reported COVID-19 death. It

is important to note that this ratio varies widely between countries. Additionally, the number of reported COVID-19 deaths is likely to be underreported. Regardless of the exact number, this illustrates that indirect deaths due to reductions in service coverage account for a substantial proportion of the overall death toll of the pandemic.

Service disruptions were largest during the first quarter of the pandemic, regardless of the timing of high COVID-19-related mortality or the stringency of policies imposed to contain the virus's spread. This pattern may suggest a process of adaptation and learning. Individuals, health systems, and governments initially responded to the pandemic with uncertainty due to limited knowledge of the virus, transmission dynamics, risk, and safety measures. As more information became available, perceptions and behaviors might have changed. Alternatively, fatigue of mobility restrictions and social distancing could have influenced behavior patterns as the months elapsed. The duration of the pandemic may also have allowed time for health systems to adapt service provision, including combining multiple services in a single visit and transitioning care to the community level.

We also show a relationship between mobility restrictions and the magnitude of disruptions, highlighting the tradeoffs inherent to the difficult policy decisions governments worldwide have had to make since the beginning of the pandemic. Imposing mobility and social gathering restrictions to contain the spread of the virus and protect those at high risk of COVID-19 mortality can come at the cost of reduced utilization of life-saving essential health services. In Nigeria, for example, a third of women surveyed during exit interviews after receiving RMNCH services reported not being able to access such services at some point since the start of the pandemic, with the most cited reasons being an inability to leave their household due to the lockdown, or because of the shutdowns and increased costs of public transportation.<sup>26</sup> These same issues were cited in other settings.<sup>26,27</sup> When mobility restrictions are imposed, the population's ability to access essential health services must be maintained.

We estimate that the service disruptions led to increases in mortality on the order of 2% to 5% for most countries in our analysis. The magnitude of the excess mortality is well below the least severe scenario proposed at the onset of the pandemic, which predicted a relative increase in mortality of 10%.<sup>26</sup> However, the impact is proportional to the extent of the service disruptions experienced by each country, with some countries have experienced indirect mortality in the range of 5-15%. The *type* of services that were disrupted is also important. Countries that saw larger declines in the proportion of women delivering at a facility were more likely to see larger increases in maternal mortality, linked to reductions in the parenteral administration of uterotonics, antibiotics, and anticonvulsants interventions. Countries with larger disruptions to outpatient utilization saw larger increases in child mortality, driven by estimated reductions in curative child health services such as antibiotics for pneumonia and neonatal sepsis, oral rehydration solution for dehydration due to diarrhea, and artemisinin-combination therapy for malaria. Although the primary driver of mortality is the magnitude and duration of service disruptions and the consequent reduction in coverage of interventions, other factors such as a country's baseline coverage levels, baseline mortality rates, and cause-of-death structure were also important for country-specific mortality estimates.

Our study has several important limitations. Data derived from country health management information systems used in this study predominantly reflect the utilization patterns in the public sector, and the type of public facilities reporting data can vary between indicators and countries (detailed in supplemental table S1). Theoretically, there could be a shift between public and private providers, which our analysis would not account for as changes in utilization. Additionally, data gaps can affect the completeness and

quality of the HMIS data. We conduct a robustness check confirming that these changes in reporting patterns do not drive our findings.

The mortality estimates are limited by the accuracy of the coverage inputs, the set of health interventions considered in the analysis, and the assumptions made in linking the disruption in specific services to the overall coverage of interventions. The analysis does not account for changes in health seeking behaviors by the risk group of patients. Reductions in health-care seeking behavior among low-risk patients may cause overestimations in the predicted mortality, whereas reductions in ability to access healthcare by high-risk patients may result in mortality underestimates.

Indirect mortality due to COVID-19 can result from pathways not considered in this analysis. For example, reduced quality of care may impact the quality of care provided during the pandemic, lowering the effectiveness of interventions in saving lives. We also do not consider effects such as malnutrition due to economic setbacks and disruptions to food markets. Other analyses have suggested that food insecurity could alone increase mortality by up to 10% in some countries.<sup>28</sup> Likewise, the ripple effects of disruptions to family planning could affect birth outcomes and mortality rates for several years.<sup>12</sup> These broader effects are likely to have been vast and will result in cascading effects into the future.

Our findings have both short-term and long-term policy implications. Given the delays in COVID-19 vaccination access in low and middle-income countries, the direct and indirect impacts of the COVID-19 crisis are likely to linger. The persistence of service disruptions, although to a lesser extent relative to the beginning of the pandemic, implies that children and mothers remain at higher risk of mortality during the protracted outbreak period. Continuity of essential health services during COVID-19 response must be monitored and maintained to minimize these preventable deaths. This study's findings also highlight the need to invest in health system resiliency. Future studies should explore the reasons why certain countries experienced more (or less) severe service disruptions by studying specific causes of disruptions and adaptations made by health facilities to address them. Together, these studies can inform future efforts to strengthen health systems to better prepare for and minimize loss of life during future health emergencies.

Additionally, this work helps understand how COVID-19 poses a profound threat to countries' ability to progress towards Universal Health Coverage (UHC) and the Sustainable Development Goals (SDG 3.8.1). All four of the UHC service coverage index indicators for reproductive, maternal, newborn, and child health are represented in our analysis (i.e., family planning, ANC4, DTP3, and care-seeking for pneumonia). Given that most countries have experienced significant cumulative decreases in service volume in at least one of these four services since the start of the pandemic, our study provides evidence that COVID-19 is reversing longstanding progress towards achieving UHC by reducing coverage of essential health services.

## **Contributors**

TA, TR, and GS conceived the study. TA, GS, and JF developed the methodology for the analysis of the HMIS data. TA, Monitoring of Essential Health Services Team, and GS conducted the analysis. TR conceptualized and conducted the mortality estimates analysis. Country health officials (JPA, MB, MD, HK, PM, NAM, CM, YN, CN, AAO, TR, HS, FS, HU, NW, CSW, MLY, and SY) contributed to the data collection and validating the country-specific results. TA, TR, and GS wrote the first draft of the paper. PV, Monitoring of Essential Health Services Team, PMH and JF provided comments on the first draft. All authors reviewed and approved the final manuscript.

## **Declaration of Interests**

We declare no competing interests.

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## **Data sharing statement**

The data underlying this article were provided by the ministries of health of the countries participating in the analysis. The data will be shared on reasonable request to the corresponding author with permission of the corresponding ministries.

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## Figures and Tables

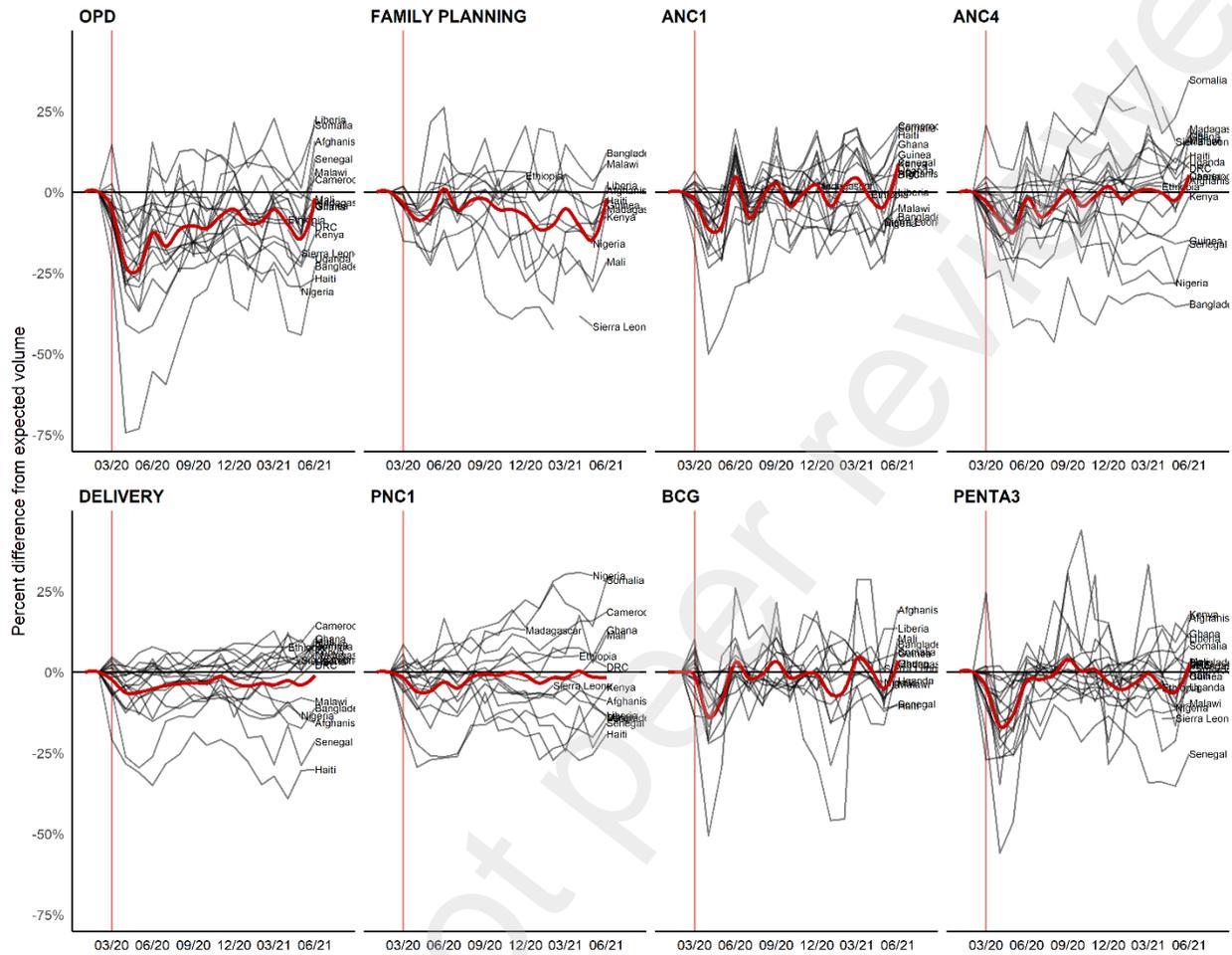
**Table 1.** Cumulative change in service volumes during the pandemic period (March 2020 – June 2021) compared to expected volume based on pre-pandemic trends

Country	Outpatient consultation (OPD)	Family Planning (FP)	First Antenatal Care Visit (ANC1)	Fourth Antenatal Care Visit (ANC4)	Delivery	First Postnatal Care Visit (PNC1)	BCG Vaccination	Third Dose of the Pentavalent Vaccination (Penta3)
Afghanistan	-9.0%***	-6.3%*	-8.0%***	-6.1%*	-9.4%**	-8.0%**	3.00%	-3.30%
Bangladesh	-40.0%***	-3.7%**	-26.2%***	-33.1%***	-11.40%	-19.6%***	-3.5%*	-12.9%***
Cameroon	-2.70%	-	1.50%	-2.30%	2.3%**	4.0%**	-	-0.40%
DRC	-4.4%***	-	1.3%**	2.0%**	-1.0%*	-1.2%**	-	-0.10%
Ethiopia	-15.4%***	1.10%	-4.2%***	-3.4%***	2.0%**	1.10%	-	-2.6%***
Ghana	-18.1%***	-	4.7%***	-0.20%	-0.30%	1.40%	-3.7%***	-0.70%
Guinea	-14.5%**	-10.4%**	-0.20%	-6.1%**	0.50%	-	-4.2%**	-5.8%**
Haiti	-25.0%***	0.30%	-7.5%**	-14.4%**	-25.5%***	-19.0%***	-12.0%***	3.80%
Kenya	-24.9%***	0.20%	-3.9%***	-13.5%***	-4.2%**	-4.5%**	-	-0.30%
Liberia	-6.00%	-2.80%	-4.0%*	-7.90%	-3.8%**	-7.5%***	2.60%	-2.60%
Madagascar	-10.0%***	-2.30%	0.40%	3.80%	5.5%**	8.7%***	0.50%	-2.6%*
Malawi	-7.0%**	4.40%	-2.00%	3.1%*	-3.6%**	-2.80%	-1.30%	-3.5%**
Mali	-5.0%**	-9.8%**	-	-3.00%	-3.4%*	-0.50%	-10.0%***	-12.5%***
Nigeria	-14.3%***	-4.6%***	-5.4%***	-14.5%***	-7.9%***	-1.80%	1.00%	-2.3%**
Senegal	-13.3%***	-	-12.3%***	1.00%	4.2%**	3.70%	4.3%**	-8.8%***
Sierra Leone	-13.6%***	-19.2%***	-1.60%	5.3%**	-4.7%**	-4.4%**	-6.8%**	-9.5%**
Somalia	4.00%	-	1.10%	11.4%**	1.10%	8.6%**	-3.70%	-3.60%
Uganda	-17.2%***	-	-2.8%**	-4.2%**	-6.3%***	-	-7.7%***	-6.3%***
<b>Mean</b>	<b>-13.1%</b>	<b>-4.4%</b>	<b>-4.1%</b>	<b>-4.6%</b>	<b>-3.7%</b>	<b>-2.6%</b>	<b>-3.0%</b>	<b>-4.1%</b>

Note: The reported mean is the average value across countries and is not population weighted. Sample sizes by country and indicator are reported in Appendix B.

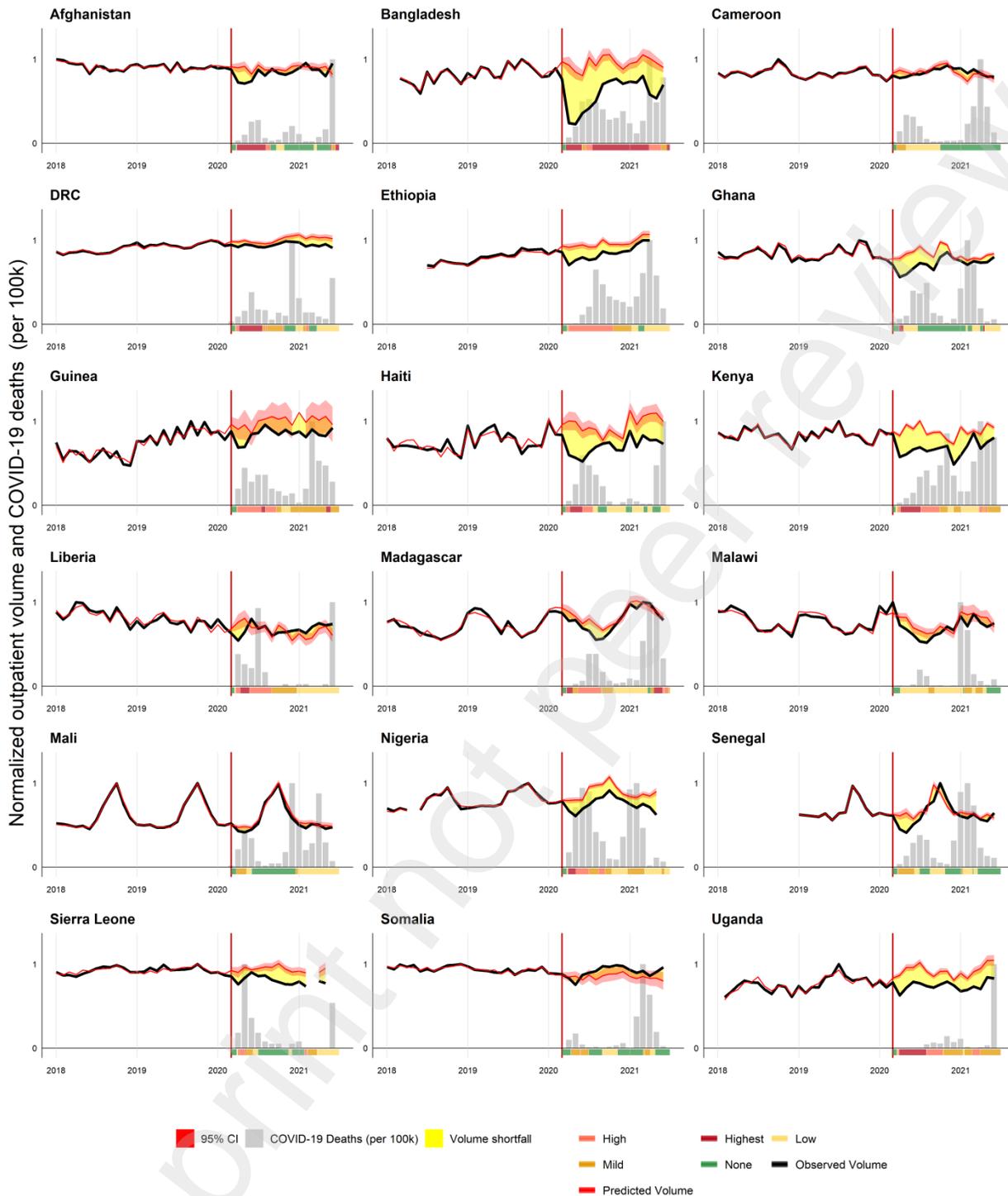
\* p < 0.1; \*\* p < 0.05; \*\*\* p < 0.001

**Figure 1.** Percent change in volume from pre-pandemic baseline by selected health services, March 2020 -February 2021



Note: The horizontal line at 0% represents the expected volume of services based on pre-pandemic trends. The red line plots a LOESS smoothed line to summarize the monthly disruptions across countries.

**Figure 2.** Estimated and observed volume of outpatient consultations with COVID-19 deaths per 100,000 and mobility restrictions by country, January 2018 -June 2021



**Note:** Outpatient consultations are used as a proxy for the utilization of general health services. Data on COVID-19 deaths are compiled from Johns Hopkins University Coronavirus dashboard.<sup>1</sup> Population denominators for all countries are based on 2019 estimates from the World Bank Development Indicators database. Utilization volume and mortality data are normalized by dividing by the highest observed monthly value across all countries. Data on mobility restrictions is summarized by an index of public transport closures, stay-at-home requirements, movement limitations, school closures, and workplace closures stringency scores provided by the Oxford COVID-19 Government Response Tracker. Gaps in the service volume data are due to months removed because of low completeness. Details on data completeness can be found in Appendix B.

**Table 2.** Correlates of monthly disruption magnitude in outpatient consultation volume

Dependent variable: percentage monthly decline in outpatient consultations volume								
	OPD	FP	ANC1	ANC4	Delivery	PNC1	BCG	Penta3
March-May 2020	-6.097*** (1.863)	2.349 (2.336)	-9.265*** (1.829)	-7.526*** (1.603)	-1.858* (1.039)	-4.247*** (1.558)	-6.906*** (2.261)	-6.716*** (1.899)
June-Aug 2020	-2.577 (1.794)	6.366*** (2.278)	-2.553 (1.774)	-3.970** (1.544)	-1.098 (1.000)	-2.727* (1.475)	1.046 (2.156)	2.708 (1.829)
Sep-Nov 2020	-0.914 (1.698)	3.376 (2.165)	-2.224 (1.656)	-2.435* (1.461)	0.180 (0.947)	-0.552 (1.400)	-0.165 (2.086)	4.822*** (1.731)
Dec 2020- Feb 2021	0.208 (1.646)	-0.764 (2.160)	-1.509 (1.612)	-1.629 (1.417)	-0.855 (0.918)	-1.304 (1.362)	-5.128** (2.032)	-1.626 (1.678)
Deaths per 100k people <sup>a</sup>	0.060 (0.109)	0.020 (0.127)	-0.030 (0.102)	-0.108 (0.094)	-0.041 (0.061)	-0.077 (0.085)	0.018 (0.125)	0.100 (0.112)
Index of mobility restrictions stringency <sup>b</sup>	-3.865*** (0.914)	-1.507 (1.094)	-0.730 (0.880)	-2.004** (0.787)	-0.494 (0.510)	-0.562 (0.751)	-2.274** (1.122)	-2.667*** (0.932)
Number of observations	279	179	257	279	279	241	217	279

Note: All regressions include country fixed effects. The dependent variable is the estimated percentage monthly change in volume of outpatient consultations, presented in Figure 1 and in the supplemental appendix table.

<sup>a</sup> Reported COVID-19 deaths were obtained from the Center for Systems Science and Engineering at Johns Hopkins University. The monthly number of COVID-19 attributable deaths is population standardized per 100,000 people using the 2019 World Development Report estimated population.

<sup>b</sup> An index of mobility restrictions stringency is constructed with principal component analysis using data from the Oxford COVID-19 Government Policy Tracker on daily restriction. An average over the daily stringency is taken to compute the monthly index.

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

**Table 3.** Expected and additional child, neonatal, and maternal deaths, March 2020 to June 2021

Country	Child deaths (0-59 months)			Neonatal deaths (< 1 month)			Maternal deaths		
	Expected deaths	Additional deaths	Relative increase in mortality	Expected deaths	Additional deaths	Relative increase in mortality	Expected deaths	Additional deaths	Relative increase in mortality
Afghanistan	100,472	3,091	3.1%	67,835	2,238	3.3%	11,667	435	3.7%
Bangladesh	118,156	17,578	14.9%	75,257	7,317	9.7%	7,605	300	3.9%
Cameroon	89,319	-609	-0.7%	36,249	-602	-1.7%	7,219	-122	-1.7%
DRC	414,800	4,928	1.2%	153,158	2,352	1.5%	25,615	0	0.0%
Ethiopia	264,992	3,267	1.2%	153,851	664	0.4%	21,858	-76	-0.3%
Ghana	56,105	1,607	2.9%	31,996	695	2.2%	4,111	-51	-1.2%
Guinea	61,910	1,728	2.8%	22,115	332	1.5%	4,085	2	0.1%
Haiti	23,296	1,396	6.0%	10,636	703	6.6%	1,962	139	7.1%
Kenya	79,842	4,328	5.4%	44,367	1,578	3.6%	7,758	57	0.7%
Liberia	15,145	-120	-0.8%	5,970	36	0.6%	1,610	20	1.2%
Madagascar	62,158	601	1.0%	27,100	-75	-0.3%	4,399	-41	-0.9%
Malawi	40,202	1,747	4.3%	21,394	1,119	5.2%	3,335	136	4.1%
Mali	103,991	1,115	1.1%	40,264	315	0.8%	6,914	-9	-0.1%
Nigeria	1,194,118	60,307	5.1%	409,318	11,827	2.9%	103,980	2,261	2.2%
Senegal	31,762	1,285	4.0%	17,097	1,051	6.1%	2,606	168	6.5%
Sierra Leone	36,034	2,296	6.4%	12,886	561	4.4%	4,385	32	0.7%
Somalia	106,149	-613	-0.6%	37,779	-289	-0.8%	8,328	-13	-0.2%
Uganda	101,096	6,675	6.6%	49,924	2,158	4.3%	9,411	29	0.3%
Total	2,899,546	110,608	3.8%	1,217,196	31,979	2.6%	236,851	3,265	1.4%

## Appendix A: Supplementary Tables

**Table A1. HMIS indicator definition and mapping**

	OPD	FP	ANC1	ANC4	DELIVERY	PNC1	BCG	PENTA3
Afghanistan	Outpatient clients	Family planning clients counseled	First antenatal care visits	Fourth antenatal care visits	Institutional deliveries	First postnatal visit	BCG doses administered	Penta3 doses administered
Bangladesh	Headcount <i>or</i> Outpatient consultations	Cycles of oral pills distributed	Mothers received ANC1	Mothers received ANC4	Institutional deliveries <i>or</i> Normal deliveries	Number of mothers received PNC1 at facility	BCG doses given to children (0-11 months)	Penta 3 doses given to children (0-11m)
Cameroon	Outpatient consultations	Family planning clients counseled	Mothers registered for ANC	Mothers received ANC4+	Institutional deliveries	Couples receiving PNC1 within 48 hours	BCG doses given to children (0-11 months)	Penta 3 doses given to children (0-11m)
DRC	New outpatient cases		First antenatal care visits	Fourth antenatal care visits	Skilled deliveries	PNC visit within 6 hours	BCG de 0 à 11 mois Total	Penta3 total
Ethiopia	Outpatient consultations	New and repeat family planning users	Pregnant women that received Antenatal Care (ANC) at least once by maternal age	Mothers received ANC4+	Skilled deliveries	PNC visit within 7 days		Children given Penta 3
Ghana	Total OPD attendance	Family planning clients counseled	ANC registrants	Mothers making 4th ANC visit	Normal deliveries	PNC visit within 48 hours	BCG doses given	Children vaccinated with Penta 3
Guinea	Total consultations	Family planning clients counseled	First antenatal care visits	Four or more antenatal care visits	Institutional deliveries by skilled birth attendants	Total PNC visits	BCG doses administered	Penta3 doses administered
Haiti	New visits	Number of utilizers of modern methods	Pregnant women that received antenatal care during the first trimester	Pregnant women that received 4th antenatal visit	Institutional deliveries	First postnatal visit	BCG doses given	Penta3 doses given
Kenya	Total attendance	Family planning clients counseled	First antenatal care visits	Mothers making 4th ANC visit	Institutional deliveries	First postnatal visit		Penta3 doses administered

Liberia	New outpatient cases	Family planning clients counseled	First antenatal care visits	Fourth antenatal care visits	Institutional deliveries by skilled birth attendants	First postnatal visit	BCG doses given	Penta3 doses given
Madagascar	New outpatient cases	New family planning clients	Mothers received ANC1	Fourth antenatal care visits	Total deliveries	PNC visit within 6 hours	BCG doses given to children (0-11 months)	Penta 3 doses given to children (0-11m)
Malawi	Total OPD attendance	Family planning clients counseled	Mothers received ANC1	Fourth antenatal care visits	Institutional deliveries	<b><u>Baby checked within 2 days</u></b>	BCG doses given to children (0-11 months)	Penta 3 doses given to children (0-11m)
Mali	Total curative consultations	Family planning clients counseled		<b><u>Total ANC visits</u></b>	Institutional deliveries by skilled birth attendants	First postnatal visit	BCG doses given to children (0-11 months)	Penta3 doses administered
Nigeria	Total OPD attendance	Family planning clients counseled	First antenatal care visits	Fourth antenatal care visits	<b><u>Total deliveries</u></b>	Total PNC visits	BCG doses given	Penta3 doses given
Senegal	Total consultations		First antenatal care visits	Fourth antenatal care visits	Facility deliveries	<b><u>Mothers received PNC1</u></b>	BCG doses given to children (0-11 months)	Penta 3 doses given to children (0-11m)
Sierra Leone	Headcount		Antenatal client 1st visit	Antenatal client 4th visit	Normal deliveries	Postnatal visit 1st contact	BCG doses given	Penta3 doses given
Somalia	New outpatient cases	Family planning methods disbursed	First antenatal care visits	Fourth antenatal care visits	Normal deliveries	PNC visit within 48 hours	BCG doses given	Penta3 doses given
Uganda	New outpatient cases	Cycles of oral pills distributed	Mothers received ANC1	ANC 4th Visit for women	Institutional deliveries		BCG doses given	Penta3 doses given

**Table A2. Linkage between service indicators to LiST interventions**

Service indicator	LiST intervention
ANC 4	Intermittent preventive treatment of malaria during pregnancy Calcium supplementation Micronutrient supplementation (iron and multiple micronutrients) Iron supplementation in pregnancy Multiple micronutrient supplementation in pregnancy Balanced energy supplementation Hypertensive disorder case management Diabetes case management Malaria case management
ANC 1 (or ANC 4 when ANC 1 not available)	Folic acid supplementation/fortification Blanket iron supplementation/fortification Tetanus toxoid vaccination Syphilis detection and treatment
Facility delivery	Post abortion case management Ectopic pregnancy case management Thermal protection Clean cord care Clean birth environment Immediate drying and additional stimulation Neonatal resuscitation Antenatal corticosteroids for preterm labor Antibiotics for preterm or prolonged PROM Parenteral administration of anti-convulsants Parenteral administration of uterotonics Parenteral administration of antibiotics Assisted vaginal delivery Manual removal of placenta Removal of retained products of conception Surgery Blood transfusion Induction of labor for pregnancies lasting 41+ weeks Prevalence of early initiation of breastfeeding Safe abortion services
PNC 1 (or Facility delivery when PNC 1 not available)	Complementary feeding - education only Complementary feeding - supplementary feeding and education
PNC 1 (or OPD when PNC 1 not available)	Maternal sepsis case management Kangaroo mother care Full supportive care for prematurity Full supportive care for neonatal sepsis/pneumonia
OPD	Case management of neonatal sepsis/pneumonia Oral antibiotics for neonatal sepsis Injectable antibiotics for neonatal sepsis

	<p>Oral rehydration solution</p> <p>Antibiotics for treatment of dysentery</p> <p>Zinc for treatment of diarrhea</p> <p>Oral antibiotics for pneumonia</p> <p>Vitamin A for treatment of measles</p> <p>Artemisinin compounds for treatment of malaria</p> <p>SAM - treatment for severe acute malnutrition</p> <p>MAM - treatment for moderate acute malnutrition</p>
Penta 3	<p>Polio vaccine</p> <p>Pentavalent vaccine</p> <p>DPT vaccine</p> <p>H. influenzae b vaccine</p> <p>HepB vaccine</p> <p>Pneumococcal vaccine</p> <p>Rotavirus vaccine</p> <p>Meningococcal A</p> <p>Malaria vaccine</p> <p>Measles vaccine</p> <p>Vitamin A supplementation</p> <p>Zinc supplementation</p>
BCG (or Penta 3 when BCG not available)	BCG vaccine

**Table A3. Difference between expected and observed service coverage by month and country**

Country	Mar 2020	Apr 2020	May 2020	Jun 2020	Jul 2020	Aug 2020	Sep 2020	Oct 2020	Nov 2020	Dec 2020	Jan 2021	Feb 2021	Mar 2021	Apr 2021	May 2021	Jun 2021	
OPD	Afghanistan	-3.5%	-19.7%	-22.4%	-10.4%	-6.2%	-7.5%	1.0%	-5.1%	-5.4%	-7.7%	-3.3%	5.2%	-3.5%	-1.9%	-12.5%	15.7%
	Bangladesh	-21.4%	-74.3%	-73.1%	-55.5%	-59.4%	-45.7%	-32.9%	-30.0%	-19.2%	-19.5%	-22.7%	-25.2%	-23.8%	-42.8%	-44.1%	-22.8%
	Cameroon	-3.5%	-10.8%	-6.6%	0.4%	-5.0%	0.1%	-1.9%	-5.9%	-3.0%	4.8%	10.2%	13.1%	6.4%	0.0%	-1.8%	4.0%
	DRC	-4.2%	-6.4%	-4.7%	-3.2%	-4.6%	-4.4%	-3.3%	-5.0%	-5.0%	-6.4%	-8.4%	-9.0%	-9.5%	-9.6%	-7.9%	-10.7%
	Ethiopia	-9.4%	-24.3%	-19.0%	-16.7%	-18.0%	-16.6%	-15.2%	-12.8%	-12.9%	-10.2%	-10.0%	-7.5%	-8.4%	-8.5%		
	Ghana	-9.4%	-28.3%	-29.3%	-23.0%	-21.5%	-16.7%	-19.0%	-18.5%	-9.3%	1.8%	-6.7%	-6.7%	-4.7%	-5.4%	-10.4%	-4.4%
	Guinea	-8.5%	-23.9%	-27.6%	-0.8%	-14.4%	-6.8%	-15.4%	-18.2%	-14.6%	-11.1%	-20.5%	-17.9%	-15.3%	-17.5%	-22.0%	-4.0%
	Haiti	-12.8%	-40.7%	-43.5%	-41.2%	-32.3%	-23.2%	-5.1%	-16.9%	-22.0%	-17.7%	-21.9%	-27.9%	-21.7%	-29.0%	-29.2%	-26.6%
	Kenya	-3.5%	-30.7%	-36.9%	-26.8%	-31.3%	-23.4%	-23.6%	-21.5%	-8.7%	-33.3%	-36.5%	-16.0%	-3.3%	-19.9%	-23.0%	-13.0%
	Liberia	-7.5%	-29.0%	-20.3%	15.4%	-1.4%	1.0%	3.5%	-11.9%	-3.4%	21.6%	7.5%	14.1%	22.8%	9.8%	1.2%	22.4%
	Madagascar	-6.1%	-12.4%	-5.0%	-7.3%	-17.8%	-24.6%	-15.1%	-11.1%	-1.1%	1.5%	-2.2%	-9.2%	0.8%	4.3%	-0.7%	-3.2%
	Malawi	14.6%	-11.6%	-17.4%	-12.0%	-19.3%	-17.1%	-5.4%	-11.6%	5.6%	6.5%	-6.1%	-16.0%	-1.2%	-8.4%	-13.4%	6.2%
	Mali	2.6%	-9.2%	-14.0%	-5.2%	-6.3%	4.5%	-1.6%	-1.5%	-9.2%	-5.7%	-5.1%	-10.8%	-2.3%	0.8%	-7.7%	-2.2%
	Nigeria	-1.1%	-15.6%	-23.9%	-13.3%	-22.3%	-16.6%	-15.7%	-15.1%	-12.8%	-7.9%	-10.9%	-14.8%	-13.6%	-15.8%	-30.7%	
	Senegal	-2.4%	-26.0%	-36.4%	-11.4%	-12.8%	8.5%	-19.9%	13.1%	11.0%	6.2%	-6.9%	-7.8%	-0.3%	-2.2%	-12.8%	10.3%
	Sierra Leone	-7.5%	-15.7%	-13.2%	-3.4%	-9.4%	-10.6%	-15.7%	-21.9%	-19.2%	-16.5%	-13.7%	-18.0%		-11.5%	-18.8%	
	Somalia	0.9%	-2.0%	-12.0%	7.6%	3.0%	12.6%	13.2%	9.5%	11.6%	7.5%	9.2%	8.1%	7.7%	3.5%	9.0%	20.8%
Uganda	-6.4%	-27.6%	-25.2%	-17.9%	-24.1%	-19.2%	-15.4%	-17.3%	-13.7%	-7.5%	-24.0%	-16.4%	-19.4%	-25.8%	-19.1%	-20.5%	
Total	-4.9%	-22.7%	-23.9%	-12.5%	-16.8%	-11.4%	-10.4%	-11.2%	-7.3%	-5.2%	-9.6%	-9.0%	-5.3%	-10.0%	-14.3%	-1.9%	
FAMILY PLANNING	Afghanistan	-0.8%	-16.7%	-18.5%	-14.1%	-12.9%	-10.6%	-6.6%	0.4%	-1.4%	-1.7%	19.7%	18.5%	0.5%	-0.7%	-11.8%	0.6%
	Bangladesh	-4.8%	-8.1%	-10.1%	7.6%	-6.0%	-0.1%	0.6%	-2.3%	1.2%	3.6%	-2.5%	2.7%	5.6%	2.2%	0.9%	12.1%
	Ethiopia	-3.2%	-4.3%	2.9%	2.5%	0.9%	5.6%	3.2%	-0.1%	2.9%	5.1%						
	Guinea	-4.8%	-13.3%	-8.7%	-1.9%	-6.5%	-7.4%	-11.8%	-20.3%	-13.4%	-12.8%	-10.0%	-9.9%	-12.3%	-9.5%	-9.7%	-3.9%
	Haiti	-4.1%	-7.1%	-7.2%	-2.4%	-1.4%	2.2%	5.9%	6.7%	6.4%	6.2%	-2.7%	0.7%	0.3%	-2.7%	-4.8%	-2.5%
	Kenya	1.7%	-5.4%	-1.9%	12.0%	6.4%	4.6%	8.3%	-0.3%	1.3%	-23.9%	-20.2%	-3.0%	5.4%	-6.6%	-10.0%	-7.6%
	Liberia	-3.7%	-3.6%	21.5%	26.2%	-7.3%	0.6%	-4.0%	-11.1%	-14.8%	-12.0%	-30.4%	-34.5%	-12.3%	-12.0%	-14.0%	2.1%
	Madagascar	-4.5%	-6.3%	-5.3%	-3.0%	-5.9%	-4.0%	0.9%	-4.0%	2.3%	-5.6%	-15.4%	-20.4%	-17.2%	-22.6%	-27.5%	-5.2%

Malawi	2.0%	-5.2%	0.6%	2.2%	5.5%	5.9%	16.5%	1.8%	11.3%	20.4%	2.7%	-0.3%	14.7%	8.4%	3.4%	8.8%
Mali	-15.0%	-15.6%	-22.6%	-11.7%	-24.2%	-19.3%	-9.6%	4.2%	-17.8%	-27.7%	-23.5%	-16.1%	-25.4%	-21.2%	-30.7%	-21.5%
Nigeria	-0.6%	-12.1%	-21.3%	0.1%	-9.4%	1.7%	3.6%	-1.6%	-3.3%	-2.9%	-9.3%	-6.8%	-9.8%	-11.7%	-15.8%	
Sierra Leone	-3.9%	-5.5%	-8.9%	-4.3%	-6.0%	-9.0%	-32.3%	-37.3%	-39.1%	-35.9%	-35.4%	-42.5%		-38.2%	-41.5%	
Total	-3.5%	-8.6%	-6.6%	1.1%	-5.6%	-2.5%	-2.1%	-5.3%	-5.4%	-7.2%	-11.5%	-10.1%	-5.0%	-10.4%	-14.7%	-1.9%

ANCI	Afghanistan	-7.6%	-23.5%	-19.9%	-4.4%	-6.1%	-6.1%	3.0%	-4.4%	-7.3%	-8.9%	-7.1%	-2.5%	-13.0%	-11.0%	-22.0%	5.8%
	Bangladesh	-16.3%	-49.9%	-41.7%	-29.4%	-27.5%	-24.8%	-8.5%	-8.4%	-11.2%	-10.8%	-11.5%	-12.3%	-11.1%	-23.8%	-19.3%	-7.5%
	Cameroon	3.3%	0.2%	-3.9%	0.1%	-4.5%	7.2%	3.1%	1.4%	8.5%	17.4%	5.1%	14.0%	17.2%	10.3%	14.9%	20.5%
	DRC	0.2%	1.4%	0.7%	3.9%	1.9%	0.7%	3.8%	1.1%	0.4%	3.1%	1.1%	2.1%	2.7%	2.5%	4.6%	5.6%
	Ethiopia	-10.2%	-16.3%	2.3%	-1.2%	-8.3%	1.1%	0.7%	-0.1%	-0.7%	4.2%	-1.2%	-4.3%	-4.1%	-0.6%		
	Ghana	2.6%	-1.8%	-4.0%	19.4%	1.0%	3.4%	5.3%	4.3%	9.0%	19.0%	-3.3%	7.8%	13.7%	5.1%	-0.4%	14.9%
	Guinea	1.2%	-9.3%	-6.7%	11.8%	-2.9%	4.7%	1.2%	-4.1%	6.1%	1.9%	7.0%	6.0%	9.1%	5.4%	4.9%	11.7%
	Haiti	-2.4%	-19.9%	-17.2%	-8.1%	-10.2%	-5.3%	16.2%	0.7%	-1.1%	0.3%	2.5%	18.1%	19.3%	2.7%	7.9%	17.7%
	Kenya	-2.7%	-5.1%	-2.6%	12.1%	-3.5%	-0.4%	3.8%	-3.8%	3.9%	-20.4%	-11.8%	18.0%	19.9%	6.3%	-4.1%	8.8%
	Liberia	-7.2%	-17.6%	-6.5%	10.3%	-6.9%	-2.9%	-3.5%	-13.7%	-3.2%	12.9%	-5.3%	-3.8%	-2.9%	-10.5%	-12.4%	0.1%
	Madagascar	-4.0%	-9.3%	-1.0%	14.1%	-3.7%	-1.8%	11.3%	-4.9%	6.3%	1.9%						
	Malawi	6.5%	-0.5%	-6.8%	3.3%	-10.1%	-4.0%	20.0%	-17.1%	-10.3%	1.1%	-13.5%	-8.0%	-6.1%	-15.7%	-9.0%	-4.9%
	Nigeria	-1.1%	-14.9%	-21.2%	14.7%	-16.1%	2.1%	-1.7%	-4.0%	-0.1%	-3.4%	-13.5%	-10.7%	-3.8%	-16.8%	-9.5%	
	Senegal	3.3%	-2.5%	-20.7%	11.0%	-28.1%	0.7%	-16.1%	-18.7%	-10.5%	-10.7%	-19.3%	-13.2%	0.7%	0.3%	-13.3%	9.2%
	Sierra Leone	-1.4%	-6.8%	-12.7%	8.2%	-4.5%	-4.7%	3.5%	-3.2%	-2.7%	9.8%	1.2%	0.9%		5.2%	-9.1%	
	Somalia	-2.9%	-7.2%	-12.2%	4.9%	-1.5%	9.4%	7.8%	6.7%	6.3%	8.6%	10.5%	14.8%	11.2%	3.7%	8.0%	19.9%
	Uganda	0.1%	-10.1%	-6.4%	12.6%	-6.2%	-0.8%	-2.7%	-5.9%	2.2%	12.2%	-12.0%	5.4%	13.3%	0.5%	-6.6%	6.7%
	Total	-2.3%	-11.4%	-10.6%	4.9%	-8.1%	-1.3%	2.8%	-4.4%	-0.2%	2.2%	-4.4%	2.0%	4.4%	-2.3%	-4.4%	8.3%
	ANCI4	Afghanistan	3.0%	-8.2%	-12.7%	-9.0%	-11.5%	-5.5%	-2.6%	3.4%	2.7%	1.6%	3.5%	-2.4%	-3.2%	0.0%	-5.1%
Bangladesh		-26.5%	-24.2%	-41.8%	-39.1%	-40.1%	-46.4%	-26.4%	-38.0%	-41.0%	-32.0%	-34.6%	-32.0%	-31.2%	-32.5%	-35.5%	-34.6%
Cameroon		-0.7%	-0.7%	-8.2%	-1.1%	-4.1%	-4.4%	-0.1%	-1.7%	1.9%	6.7%	-3.7%	1.5%	2.6%	3.1%	1.5%	5.0%
DRC		1.3%	1.6%	1.4%	3.0%	3.5%	3.2%	4.2%	3.5%	2.9%	3.7%	3.8%	4.3%	4.8%	6.2%	10.6%	7.4%
Ethiopia		-4.8%	-9.3%	-2.4%	-4.5%	-6.1%	-2.4%	-0.6%	1.4%	0.4%	4.9%	3.1%	0.7%	2.2%	1.7%		
Ghana		1.2%	-7.6%	-10.1%	2.3%	2.0%	2.3%	3.4%	4.9%	8.3%	15.3%	2.4%	9.3%	16.3%	12.8%	9.0%	17.2%

	Guinea	-4.4%	-13.6%	-11.5%	-6.3%	-10.7%	-8.2%	-9.0%	-9.7%	-5.7%	-7.0%	-6.8%	-8.9%	-12.7%	-14.2%	-15.9%	-14.9%
	Haiti	-5.7%	-21.1%	-20.1%	-20.8%	-23.4%	-19.2%	-3.7%	-12.5%	-2.6%	3.1%	4.9%	11.1%	9.1%	8.1%	6.9%	11.3%
	Kenya	-6.4%	-13.9%	-21.7%	-14.1%	-14.2%	-13.3%	-5.5%	-10.6%	-7.0%	-25.9%	-9.5%	-14.3%	-12.7%	-13.7%	-10.3%	-1.2%
	Liberia	-5.4%	-16.9%	-11.7%	6.9%	4.6%	-4.8%	-6.8%	-21.8%	-8.4%	2.2%	-15.9%	-10.9%	-2.9%	-7.6%	-3.0%	4.9%
	Madagascar	0.4%	-2.8%	-1.5%	10.8%	4.2%	2.7%	12.8%	5.4%	11.0%	13.4%	6.5%	8.5%	18.0%	11.6%	5.5%	19.7%
	Malawi	20.6%	7.9%	6.8%	21.7%	-4.8%	-4.2%	14.1%	-13.8%	-6.6%	9.1%	-4.0%	5.1%	20.6%	4.1%	14.1%	16.0%
	Mali	-2.1%	-6.6%	-12.9%	8.8%	-11.0%	8.3%	1.3%	-3.4%	0.3%	-1.5%	-1.5%	2.2%	3.5%	4.9%	-6.2%	17.6%
	Nigeria	-10.4%	-15.2%	-27.4%	-5.0%	-17.4%	-7.9%	-9.4%	-17.0%	-16.1%	-15.6%	-28.6%	-26.9%	-24.2%	-28.3%	-28.0%	
	Senegal	-6.5%	-2.5%	-19.3%	-3.9%	-11.0%	2.0%	0.3%	-9.6%	-2.2%	-13.3%	-22.1%	-22.4%	-19.4%	-16.8%	-28.7%	-16.0%
	Sierra Leone	-2.7%	-3.3%	-8.6%	-0.9%	-3.2%	-5.3%	14.0%	19.9%	17.6%	29.7%	25.0%	26.2%		26.5%	15.6%	
	Somalia	4.8%	0.5%	-6.6%	20.2%	5.8%	24.7%	19.5%	15.3%	19.0%	29.3%	33.8%	39.1%	30.6%	18.2%	23.1%	34.8%
	Uganda	-9.2%	-13.8%	-16.4%	-2.3%	-0.8%	-1.5%	5.8%	4.8%	3.2%	9.1%	2.5%	11.6%	13.8%	10.7%	4.0%	9.4%
	Total	-3.0%	-8.3%	-12.5%	-1.8%	-7.7%	-4.4%	0.6%	-4.4%	-1.2%	1.8%	-2.3%	0.1%	0.9%	-0.3%	-2.5%	5.3%
	Afghanistan	-6.5%	-11.2%	-12.4%	-15.2%	-12.8%	-10.3%	-6.8%	-8.5%	-7.9%	-7.7%	-11.3%	-13.3%	-13.4%	-9.2%	-14.0%	-15.6%
	Bangladesh	-5.8%	-26.1%	-29.5%	-26.1%	-15.2%	-13.5%	-14.0%	-9.6%	-0.8%	2.0%	-1.2%	-2.1%	-10.4%	-15.8%	-17.3%	-11.1%
	Cameroon	2.4%	1.9%	0.8%	2.0%	5.6%	6.0%	2.8%	4.3%	7.5%	5.8%	2.2%	5.0%	6.4%	11.4%	9.2%	14.5%
	DRC	-1.6%	-0.8%	0.5%	0.8%	1.2%	-0.4%	-0.6%	-1.1%	-1.3%	-2.4%	-1.3%	-1.9%	-1.7%	-0.4%	4.5%	2.2%
	Ethiopia	1.4%	-1.2%	2.9%	2.7%	-1.1%	0.9%	1.2%	4.8%	6.6%	8.9%	9.0%	7.8%	7.9%	7.8%		
	Ghana	2.3%	-0.7%	0.3%	-0.6%	4.8%	-0.7%	-3.7%	-1.7%	5.7%	-1.7%	2.2%	6.0%	4.1%	4.8%	3.0%	10.4%
	Guinea	3.4%	-3.1%	-0.5%	2.9%	0.8%	2.9%	1.1%	1.9%	4.4%	0.1%	-0.8%	-0.2%	1.6%	3.0%	5.8%	8.5%
	Haiti	-20.8%	-28.3%	-31.0%	-35.0%	-28.4%	-25.3%	-18.5%	-22.6%	-20.8%	-23.2%	-27.7%	-34.8%	-32.2%	-39.1%	-30.4%	-30.1%
	Kenya	-0.6%	-4.0%	-3.9%	-0.5%	-1.5%	-1.3%	-1.2%	-4.0%	-2.5%	-13.9%	-5.5%	0.4%	3.0%	3.7%	0.6%	6.2%
	Liberia	1.4%	-5.6%	-2.3%	4.1%	-3.8%	-2.7%	-4.7%	-8.2%	-5.8%	-9.0%	-7.9%	-3.2%	-5.0%	-4.5%	-0.8%	3.4%
	Madagascar	4.7%	1.6%	6.0%	7.9%	6.5%	2.4%	6.7%	6.8%	6.7%	7.1%	4.6%	0.9%	6.4%	3.1%	2.5%	5.4%
	Malawi	-0.7%	0.4%	-1.0%	-4.7%	-4.3%	-3.9%	-9.1%	-9.0%	-4.0%	-5.3%	-3.9%	-7.2%	-8.5%	-9.7%	-8.0%	-9.1%
	Mali	-7.2%	-4.0%	-7.9%	-5.6%	-5.5%	-2.1%	2.1%	1.9%	1.6%	3.8%	1.5%	4.7%	0.1%	12.2%	0.6%	9.6%
	Nigeria	-0.3%	-5.4%	-13.1%	-6.3%	-10.6%	-11.2%	-8.9%	-7.9%	-6.9%	-10.3%	-13.3%	-14.5%	-13.8%	-10.2%	-13.4%	
	Senegal	-6.7%	-4.0%	-6.0%	-14.5%	-6.6%	-2.8%	-3.2%	-2.4%	-8.1%	-9.6%	-20.3%	-19.7%	-28.5%	-16.4%	-28.8%	-21.5%
	Sierra Leone	-5.0%	-11.6%	-5.3%	-0.8%	0.0%	0.2%	-3.4%	-2.7%	-1.8%	-8.1%	-8.3%	-3.6%		0.4%	3.8%	
	Somalia	4.1%	0.9%	-1.4%	1.8%	-0.2%	0.3%	2.8%	1.7%	2.3%	3.1%	5.9%	10.0%	12.8%	3.9%	4.9%	8.0%
	Uganda	-5.7%	-12.6%	-8.1%	-6.1%	-3.2%	-2.7%	-2.3%	-2.9%	1.9%	-1.2%	-2.4%	3.3%	4.8%	8.0%	10.1%	3.9%

DELIVERY

	Total	-2.3%	-6.3%	-6.2%	-5.2%	-4.1%	-3.6%	-3.3%	-3.3%	-1.3%	-3.4%	-4.4%	-3.5%	-3.9%	-2.6%	-4.0%	-1.0%
PNC1	Afghanistan	-4.4%	-11.5%	-10.2%	-12.6%	-13.6%	-8.3%	-3.6%	-6.4%	-6.4%	-7.1%	-6.3%	-7.4%	-10.0%	-5.7%	-7.6%	-8.9%
	Bangladesh	-16.1%	-29.4%	-27.1%	-26.5%	-26.0%	-16.4%	-16.3%	-13.8%	-15.6%	-11.8%	-14.3%	-12.8%	-16.7%	-17.8%	-20.0%	-14.0%
	Cameroon	3.6%	0.9%	2.5%	4.8%	8.2%	10.8%	5.9%	6.9%	11.8%	10.6%	6.7%	10.1%	12.7%	15.7%	15.9%	18.6%
	DRC	-1.9%	-1.4%	0.1%	0.5%	0.4%	-0.8%	-1.1%	-0.5%	-1.7%	-2.7%	-1.3%	-1.9%	-2.4%	-1.0%	3.8%	1.6%
	Ethiopia	0.5%	-1.9%	3.5%	3.4%	-1.6%	0.4%	-0.1%	1.8%	3.5%	6.3%	5.7%	4.6%	4.7%	5.1%		
	Ghana	2.9%	-0.7%	1.0%	4.4%	5.5%	-0.5%	-1.0%	2.7%	7.7%	2.6%	3.8%	6.1%	7.5%	7.4%	4.9%	13.1%
	Haiti	-13.3%	-22.3%	-25.8%	-26.2%	-25.2%	-18.1%	-6.3%	-18.1%	-17.2%	-19.8%	-18.8%	-27.2%	-23.6%	-27.2%	-25.4%	-19.2%
	Kenya	1.9%	-5.1%	-5.6%	1.4%	-3.9%	-3.9%	-0.7%	-10.4%	-9.4%	-9.4%	-7.2%	-8.2%	-1.8%	-3.9%	-10.6%	-4.6%
	Liberia	5.7%	-8.4%	-1.5%	-2.4%	-9.1%	-4.4%	-15.2%	-12.7%	-11.5%	-16.1%	-27.1%	-23.6%	-22.4%	-16.8%	-10.8%	-13.4%
	Madagascar	8.5%	2.4%	4.9%	8.6%	9.0%	5.9%	10.2%	12.3%	13.6%	13.0%						
	Malawi	-0.1%	4.0%	-4.3%	-2.9%	-5.4%	-2.4%	-9.7%	-3.5%	-6.8%	-6.5%	-6.7%	-7.0%	-5.2%	-8.9%	-9.7%	-13.9%
	Mali	-1.8%	-0.9%	-3.5%	1.0%	-3.2%	2.1%	3.5%	3.7%	5.7%	2.5%	-0.9%	7.5%	5.7%	17.5%	2.9%	11.5%
	Nigeria	-2.7%	-10.1%	-17.3%	-8.3%	-12.6%	-3.0%	12.8%	11.4%	18.3%	22.3%	19.7%	28.1%	30.3%	30.8%	29.9%	
	Senegal	-6.2%	-3.7%	-4.7%	-9.2%	-7.4%	0.1%	1.4%	-2.5%	-6.1%	-5.9%	-16.5%	-16.6%	-24.4%	-10.3%	-23.4%	-15.7%
	Sierra Leone	-5.5%	-11.6%	-6.1%	0.0%	-0.8%	0.2%	-2.6%	-1.9%	-5.2%	-7.9%	-8.0%	-4.1%				
Somalia	1.9%	3.3%	-0.2%	16.6%	5.5%	12.9%	14.1%	15.3%	19.2%	13.9%	19.7%	27.0%	21.2%	19.1%	14.2%	28.5%	
Total	-1.7%	-6.0%	-5.9%	-3.0%	-5.0%	-1.6%	-0.5%	-1.0%	0.0%	-1.0%	-3.4%	-1.7%	-1.7%	0.3%	-2.8%	-1.4%	
BCG	Afghanistan	7.2%	-5.4%	0.1%	5.1%	2.1%	5.7%	10.4%	4.0%	-0.1%	5.7%	8.1%	10.0%	4.6%	8.0%	0.5%	19.3%
	Bangladesh	-13.7%	-50.5%	-29.2%	25.9%	10.2%	14.6%	6.4%	4.0%	-0.4%	-5.6%	12.7%	10.0%	4.8%	-2.0%	-8.7%	8.7%
	Ghana	-2.5%	-3.5%	-8.0%	-6.3%	-2.2%	-2.1%	-5.2%	-3.7%	-1.7%	1.2%	-2.9%	-0.5%	0.0%	-1.8%	-5.5%	2.8%
	Guinea	-0.1%	-11.1%	-6.8%	3.3%	-0.5%	-1.6%	-4.9%	-7.7%	0.6%	-5.6%	2.2%	2.4%	6.2%	2.8%	4.5%	5.9%
	Haiti	10.1%	-22.0%	-19.6%	-10.8%	-2.3%	-10.5%	13.9%	1.3%	-20.7%	-28.0%	-45.8%	-45.4%	28.7%	28.6%	-11.2%	-10.3%
	Liberia	6.2%	-20.3%	5.0%	10.6%	-1.1%	5.3%	10.8%	-0.5%	17.8%	15.5%	6.3%	2.4%	22.6%	0.3%	13.4%	13.6%
	Madagascar	3.8%	-16.9%	-7.0%	8.8%	-0.7%	-3.8%	21.5%	-9.2%	3.0%	8.3%	-4.1%	-14.9%	-4.2%	-15.9%	-16.3%	2.6%
	Malawi	2.8%	-5.1%	0.7%	1.7%	1.6%	-0.2%	-3.9%	-5.6%	-1.4%	-1.4%	-7.5%	-7.1%	-4.3%	-1.4%	-7.7%	-3.7%
	Mali	-4.8%	-21.3%	-14.3%	-0.8%	-14.9%	-3.8%	-4.2%	1.7%	2.2%	-8.8%	-28.9%	-15.3%	4.1%	3.0%	-10.1%	10.5%
	Nigeria	1.5%	-6.8%	-12.9%	4.0%	-5.9%	1.0%	6.1%	5.3%	9.3%	18.9%	-2.4%	3.2%	4.2%	-1.5%	-3.1%	
	Senegal	-1.8%	0.2%	0.3%	0.1%	-5.0%	9.0%	4.7%	-5.8%	-1.0%	-1.8%	-15.6%	-13.2%	-9.2%	-6.7%	-12.1%	-9.8%
Sierra Leone	-7.6%	-14.4%	-9.5%	0.3%	-3.5%	-2.2%	-3.4%	-4.5%	-5.0%	-8.6%	-9.9%	-5.5%		-0.4%	1.1%		
Somalia	-2.1%	-4.8%	-13.5%	3.2%	-0.7%	-8.2%	-3.7%	-0.3%	-6.9%	-0.8%	8.3%	-0.6%	-0.9%	1.2%	-6.3%	6.3%	

	Uganda	-13.6%	-14.0%	-6.6%	-1.1%	-4.4%	-10.1%	-1.7%	-4.4%	-4.3%	1.5%	-15.9%	-4.4%	-0.3%	-2.2%	-8.3%	-2.5%	
	Total	-1.0%	-14.0%	-8.7%	3.1%	-1.9%	-0.5%	3.3%	-1.8%	-0.6%	-0.7%	-6.8%	-5.6%	4.3%	0.9%	-5.0%	3.6%	
PENTAS3	Afghanistan	-3.7%	-15.5%	-13.7%	-0.1%	-2.5%	0.9%	5.2%	1.9%	-2.4%	-0.9%	3.1%	2.0%	-6.0%	-2.6%	-10.6%	16.9%	
	Bangladesh	-18.9%	-55.9%	-46.3%	-8.6%	1.6%	22.0%	14.3%	8.1%	1.3%	-21.7%	-1.4%	2.6%	5.6%	-0.7%	-8.2%	3.2%	
	Cameroon	-0.3%	-1.5%	-5.2%	0.6%	2.3%	-1.2%	1.0%	-1.2%	-1.6%	2.7%	-5.8%	-3.5%	-5.1%	-5.0%	-5.6%	0.9%	
	DRC	-0.5%	-2.5%	-0.4%	-0.2%	1.4%	-0.7%	0.6%	0.5%	-0.5%	2.1%	2.6%	4.0%	2.7%	-0.6%	4.5%	2.4%	
	Ethiopia	-6.0%	-7.6%	-0.7%	-0.9%	-0.9%	0.7%	-1.7%	-3.3%	-3.8%	-0.7%	-1.8%	-3.9%	-5.8%	-4.8%			
	Ghana	-4.4%	-6.3%	-3.4%	5.0%	2.7%	1.8%	-0.1%	0.0%	3.7%	4.7%	1.9%	4.3%	6.1%	6.7%	6.1%	12.0%	
	Guinea	0.5%	-12.9%	-9.4%	-3.3%	-1.7%	-5.4%	-4.9%	-7.1%	-2.8%	-7.6%	-2.4%	-1.6%	0.5%	-1.5%	-2.3%	-1.3%	
	Haiti	24.5%	-20.6%	-25.8%	-17.8%	8.1%	0.0%	31.4%	43.9%	16.3%	15.2%	-1.8%	-5.1%	4.4%	13.3%	4.6%	-1.0%	
	Kenya	1.7%	1.9%	-3.6%	9.1%	1.9%	0.5%	4.6%	0.1%	3.9%	-5.3%	1.2%	4.5%	13.4%	14.4%	9.3%	17.9%	
	Liberia	-0.6%	-34.6%	-2.2%	-3.2%	0.5%	4.2%	30.4%	6.6%	29.9%	-28.5%	-21.4%	10.0%	33.2%	-1.8%	15.2%	10.5%	
	Madagascar	-8.8%	-23.4%	-17.6%	4.2%	-1.0%	-1.3%	14.9%	-9.6%	10.2%	6.3%	-6.2%	-12.0%	-6.0%	-24.5%	-21.2%	2.1%	
	Malawi	2.0%	-9.4%	-2.9%	-2.0%	-2.3%	-1.7%	-4.2%	-5.4%	-4.6%	-5.4%	-10.7%	-14.0%	-11.6%	-12.7%	-11.6%	-9.6%	
	Mali	-9.0%	-26.6%	-23.5%	-7.1%	-16.6%	-5.8%	-8.8%	-8.0%	-5.4%	-10.2%	-10.5%	-7.3%	-8.3%	-3.1%	-16.7%	3.3%	
	Nigeria	-4.1%	-12.9%	-18.4%	-1.5%	-7.6%	-3.9%	3.1%	5.9%	6.5%	14.6%	-4.4%	-0.6%	-1.8%	-8.4%	-10.9%		
	Senegal	-27.1%	-26.2%	-25.5%	-13.0%	-20.9%	-10.1%	-13.7%	-21.5%	-16.6%	-13.6%	-18.1%	-22.6%	-34.1%	-34.0%	-35.2%	-25.2%	
	Sierra Leone	-8.9%	-20.6%	-16.9%	-9.8%	-8.6%	-8.1%	-3.6%	-6.3%	-8.5%	-7.2%	-8.7%	-7.9%		-14.4%	-14.2%		
	Somalia	-4.5%	-8.7%	-12.4%	-0.5%	0.6%	2.2%	5.7%	0.4%	-1.1%	-4.0%	-2.1%	-0.8%	3.6%	0.0%	3.2%	8.2%	
	Uganda	-11.1%	-18.6%	-10.4%	3.0%	1.0%	-6.2%	-2.8%	0.9%	-9.1%	2.1%	-11.2%	-5.1%	0.2%	-2.7%	-11.1%	-4.6%	
		Total	-0.044	-0.168	-0.132	-0.026	-0.023	-0.007	0.04	0.003	0.009	-0.032	-0.054	-0.032	-0.005	-0.046	-0.062	0.024

**Table A4. Projections of mortality from LiST Model by Quarter**

	Quarter	Child deaths (0-59 months)		Neonatal deaths (< 1 month)		Maternal deaths	
		Expected deaths	Additional deaths	Expected deaths	Additional deaths	Expected deaths	Additional deaths
Afghanistan	Q2 2020	18,724	1,204	11,235	673	1,933	97
	Q3 2020	18,724	456	11,235	339	1,933	74
	Q4 2020	18,724	507	11,235	334	1,933	58
	Q1 2021	19,029	415	11,448	400	1,968	94
	Q2 2021	19,029	384	11,448	404	1,968	96
Bangladesh	Q2 2020	22,213	6,435	12,578	2,747	1,271	119
	Q3 2020	22,213	3,768	12,578	1,602	1,271	63
	Q4 2020	22,213	1,748	12,578	621	1,271	19
	Q1 2021	22,056	1,840	12,473	709	1,261	25
	Q2 2021	22,056	3,162	12,473	1,391	1,261	62
Cameroon	Q2 2020	16,690	75	6,013	29	1,198	-4
	Q3 2020	16,690	-53	6,013	-69	1,198	-17
	Q4 2020	16,690	-100	6,013	-110	1,198	-26
	Q1 2021	16,843	-281	6,099	-201	1,214	-20
	Q2 2021	16,843	-253	6,099	-246	1,214	-51
DRC	Q2 2020	76,990	660	25,284	296	4,229	-3
	Q3 2020	76,990	568	25,284	255	4,229	-3
	Q4 2020	76,990	888	25,284	476	4,229	14
	Q1 2021	79,083	1,406	26,012	736	4,349	14
	Q2 2021	79,083	1,168	26,012	455	4,349	-27
Ethiopia	Q2 2020	49,493	1,202	25,560	387	3,637	-1
	Q3 2020	49,493	953	25,560	294	3,637	1
	Q4 2020	49,493	423	25,560	-70	3,637	-31
	Q1 2021	50,008	332	25,805	-41	3,656	-35
	Q2 2021	50,008	91	25,805	-34	3,656	-11
Ghana	Q2 2020	10,511	750	5,317	396	683	3
	Q3 2020	10,511	518	5,317	270	683	-2
	Q4 2020	10,511	194	5,317	83	683	-8
	Q1 2021	10,535	54	5,364	-21	689	-17
	Q2 2021	10,535	23	5,364	-58	689	-25
Guinea	Q2 2020	11,519	414	3,651	101	675	5
	Q3 2020	11,519	267	3,651	52	675	1
	Q4 2020	11,519	318	3,651	59	675	-1
	Q1 2021	11,757	402	3,755	94	693	4
	Q2 2021	11,757	274	3,755	21	693	-5
Haiti	Q2 2020	4,374	391	1,775	177	328	33
	Q3 2020	4,374	212	1,775	110	328	25
	Q4 2020	4,374	197	1,775	102	328	21
	Q1 2021	4,358	254	1,768	135	326	26
	Q2 2021	4,358	291	1,768	150	326	27
Kenya	Q2 2020	14,917	1,177	7,357	437	1,287	18
	Q3 2020	14,917	954	7,357	340	1,287	9
	Q4 2020	14,917	938	7,357	436	1,287	37
	Q1 2021	15,059	653	7,470	216	1,306	6
	Q2 2021	15,059	560	7,470	128	1,306	-14
Liberia	Q2 2020	2,824	142	990	24	267	2
	Q3 2020	2,824	-5	990	11	267	3
	Q4 2020	2,824	-2	990	20	267	8

	Q1 2021	2,867	-156	1,006	-7	271	6
	Q2 2021	2,867	-127	1,006	-14	271	1
Madagascar	Q2 2020	11,601	157	4,498	-11	731	-7
	Q3 2020	11,601	324	4,498	27	731	-8
	Q4 2020	11,601	9	4,498	-41	731	-11
	Q1 2021	11,744	63	4,554	-18	738	-7
	Q2 2021	11,744	11	4,554	-29	738	-7
	Malawi	Q2 2020	7,492	446	3,543	217	552
Q3 2020		7,492	538	3,543	307	552	27
Q4 2020		7,492	137	3,543	133	552	31
Q1 2021		7,614	397	3,612	254	563	31
Q2 2021		7,614	370	3,612	271	563	42
Mali	Q2 2020	19,321	611	6,647	303	1,142	28
	Q3 2020	19,321	104	6,647	65	1,142	8
	Q4 2020	19,321	204	6,647	25	1,142	-10
	Q1 2021	19,793	233	6,837	34	1,173	-10
	Q2 2021	19,793	-58	6,837	-161	1,173	-36
Nigeria	Q2 2020	222,905	14,126	67,788	2,281	17,230	381
	Q3 2020	222,905	14,128	67,788	2,524	17,230	415
	Q4 2020	222,905	8,691	67,788	1,873	17,230	385
	Q1 2021	225,551	10,922	69,084	2,911	17,530	657
	Q2 2021	225,551	12,066	69,084	2,187	17,530	395
Senegal	Q2 2020	5,924	429	2,835	278	432	20
	Q3 2020	5,924	173	2,835	119	432	11
	Q4 2020	5,924	-31	2,835	16	432	17
	Q1 2021	6,007	367	2,879	327	438	59
	Q2 2021	6,007	306	2,879	281	438	56
Sierra Leone	Q2 2020	6,721	435	2,136	131	727	29
	Q3 2020	6,721	401	2,136	86	727	3
	Q4 2020	6,721	661	2,136	157	727	2
	Q1 2021	6,815	376	2,171	104	738	5
	Q2 2021	6,815	321	2,171	49	738	-15
Somalia	Q2 2020	19,709	52	6,236	34	1,375	0
	Q3 2020	19,709	-131	6,236	-47	1,375	-1
	Q4 2020	19,709	-146	6,236	-64	1,375	-2
	Q1 2021	20,226	-191	6,418	-117	1,413	-6
	Q2 2021	20,226	-197	6,418	-98	1,413	-4
Uganda	Q2 2020	18,888	1,826	8,280	759	1,562	67
	Q3 2020	18,888	1,361	8,280	481	1,562	18
	Q4 2020	18,888	848	8,280	271	1,562	1
	Q1 2021	19,067	1,244	8,402	338	1,583	-19
	Q2 2021	19,067	1,199	8,402	209	1,583	-53

#### A5. Bounding the mortality estimates using service disruption confidence intervals

	Additional deaths for March 2020 to June 2021 (child and maternal combined)			Relative difference from point estimate	
	Point estimate	Using disruption estimate CI upper bound	Using disruption estimate CI lower bound	Lower bound mortality estimate	Upper bound mortality estimate
Afghanistan	3,526	628	6,496	-82.2%	84.2%
Bangladesh	17,878	10,687	25,460	-40.2%	42.4%
Cameroon	-731	-1,677	231	--	--
DRC	4,928	1,850	8,028	-62.5%	62.9%
Ethiopia	3,191	1,376	5,018	-56.9%	57.2%
Ghana	1,556	725	2,401	-53.4%	54.3%
Guinea	1,730	-746	4,276	-143.1%	147.1%
Haiti	1,534	965	2,114	-37.1%	37.8%
Kenya	4,385	3,180	5,607	-27.5%	27.9%
Liberia	-100	-887	701	--	--
Madagascar	560	-437	1,569	-178.0%	180.3%
Malawi	1,883	-328	4,184	-117.4%	122.2%
Mali	1,106	-1,441	3,722	-230.3%	236.5%
Nigeria	62,568	44,789	80,484	-28.4%	28.6%
Senegal	1,453	743	2,180	-48.8%	50.1%
Sierra Leone	2,328	1,184	3,502	-49.1%	50.4%
Somalia	-626	-1,515	267	--	--
Uganda	6,703	4,317	9,129	-35.6%	36.2%
Total	113,873	63,413	165,371	-44.3%	45.2%

To calculate an upper bound of mortality, the input into the LiST model is the the upper limit of the 95% CI from the cumulative disruption estimate is used for all the services. To calculate a lower bound, the lower limit of the 95% CI is used for all services.

## A6. Sensitivity analysis of linking decisions

	Additional child deaths for Quarter 2, 2020									Relative difference from the linking combination used for final analysis							
	Linking combination used for final analysis	All LiST interventions linked to ANC 4	All LiST interventions linked to Facility delivery	All LiST interventions linked to OPD	All LiST interventions linked to Penta 3	Random linking (run 1)	Random linking (run 2)	Random linking (run 3)	Random linking (run 4)	All LiST interventions linked to ANC 4	All LiST interventions linked to Facility delivery	All LiST interventions linked to OPD	All LiST interventions linked to Penta 3	Random linking (run 1)	Random linking (run 2)	Random linking (run 3)	Random linking (run 4)
Afghanistan	1,204	773	1,008	1,373	756	1,038	798	957	872	-35.8%	-16.3%	14.0%	-37.2%	-13.8%	-33.8%	-20.5%	-27.6%
Bangladesh	6,435	4,249	3,245	8,816	4,492	4,661	4,068	4,577	4,805	-34.0%	-49.6%	37.0%	-30.2%	-27.6%	-36.8%	-28.9%	-25.3%
Cameroon	75	131	-59	220	78	89	111	82	96	75.2%	-179.8%	194.7%	5.0%	18.9%	48.9%	10.3%	28.4%
DRC	660	-450	-36	1,095	231	148	-192	142	53	168.2%	105.5%	65.9%	-65.1%	-77.6%	-129.1%	-78.5%	-91.9%
Ethiopia	1,202	665	-178	2,493	376	800	494	696	662	-44.7%	114.8%	107.4%	-68.7%	-33.4%	-58.9%	-42.1%	-44.9%
Ghana	750	279	17	1,568	85	463	298	433	351	-62.8%	-97.7%	109.1%	-88.7%	-38.3%	-60.3%	-42.3%	-53.2%
Guinea	414	372	8	628	302	240	265	251	325	-10.3%	-98.0%	51.5%	-27.2%	-42.2%	-36.0%	-39.5%	-21.5%
Haiti	391	214	329	442	222	344	242	296	242	-45.2%	-15.9%	13.0%	-43.2%	-11.9%	-38.0%	-24.4%	-38.1%
Kenya	1,177	1,065	175	2,084	-152	1,053	574	817	519	-9.5%	-85.1%	77.1%	-112.9%	-10.5%	-51.2%	-30.6%	-55.9%
Liberia	142	111	19	173	206	73	150	101	160	-22.0%	-86.6%	22.0%	44.7%	-48.6%	5.7%	-29.1%	12.5%
Madagascar	157	-68	-160	259	390	73	110	-12	131	143.4%	201.8%	64.9%	147.9%	-53.6%	-30.1%	-107.4%	-16.9%
Malawi	446	-605	93	743	252	134	-250	84	49	235.5%	-79.1%	66.5%	-43.5%	-70.0%	-155.9%	-81.3%	-89.1%
Mali	611	270	444	724	1,490	587	791	569	740	-55.8%	-27.3%	18.5%	144.0%	-3.8%	29.6%	-6.8%	21.1%
Nigeria	14,126	14,445	7,474	16,060	9,924	12,750	10,772	12,726	12,579	2.3%	-47.1%	13.7%	-29.7%	-9.7%	-23.7%	-9.9%	-10.9%
Senegal	429	222	212	671	583	385	316	393	449	-48.2%	-50.6%	56.4%	35.9%	-10.4%	-26.4%	-8.5%	4.6%
Sierra Leone	435	188	261	484	718	361	369	307	490	-56.9%	-40.1%	11.1%	64.9%	-17.0%	-15.2%	-29.5%	12.7%
Somalia	52	-89	-9	41	137	-24	4	-50	-14	272.8%	116.6%	-21.1%	165.8%	-146.3%	-93.0%	-196.2%	-127.1%
Uganda	1,826	1,063	876	2,380	848	1,346	1,201	1,195	1,261	-41.8%	-52.0%	30.3%	-53.6%	-26.3%	-34.2%	-34.6%	-30.9%
Total	30,533	22,834	13,718	40,253	20,939	24,521	20,121	23,564	23,770	-25.2%	-55.1%	31.8%	-31.4%	-19.7%	-34.1%	-22.8%	-22.2%

Note: The sensitivity analysis only focuses on the second quarter of 2020, given the disproportional contribution of service declines in the quarter to the total estimated mortality.

## Appendix B: Data notes

### Service volume data

The volume of services provided by health facilities is extracted directly from country Health Management Information Systems (HMIS). Service volume is self-reported by health facilities and is reviewed and validated at varying levels of rigor between countries and between specific indicators. Data are extracted at the facility-level for the eight indicators across all countries on August 22<sup>nd</sup>, 2021. When used for national level inference, these data have three common sources of bias: data availability which affects the representativeness of the larger health sector, errors introduced through data recording, and shifts in reporting patterns which alter representativeness of data over time. These shortcomings can cause difficulties in interpretation of data, without the detailed information on the patterns and contexts of the data collection systems. summarized below.

Despite these challenges, the HMIS data are among the best sources to track changes in service coverage as they 1) contain data both before and after the COVID-19 pandemic, 2) contain data from a large number of facilities, and in many countries a near census of public facilities, and 3) are frequently updated.

### Data Completeness

Reporting patterns from health facilities may be affected by rollout or changes in data systems, or local conditions which prevent facilities from reporting. Bias is introduced when the trends in completeness are correlated with the change in service coverage. For instance, the level of completeness may depend on the amount of time given to enter reports into the system. In many countries, completeness looks better over time as late reports are submitted. Figure B1 illustrates the completeness of data for each indicator and country. With consultation with and validation by with each ministry, periods of acute drops or trends in completeness, or indicators which were lower than 40% completeness, were identified and omitted from the dataset. After these drops, the final sample size for the analysis is presented in Table B1.

Overall, the completeness during the year of the pandemic for outpatient consultations is 2 percentage points greater than the pre-pandemic period and is unlikely to affect the results. As a robustness check, we present results restricted to facilities with complete reporting and show that changes in completeness during the pandemic do not drive the findings.

### Representativeness

In addition to reporting patterns from facilities within HMIS, there are segments of the health sector not captured in the HMIS. In most countries, the HMIS predominantly covers the public facilities. There are differences in the data availability by the level of the health system (hospitals, health centers, and lower-level facilities). This can be expected, as some health services are not provided at all levels of the health system, due to differences in the types indicators reported by the different levels, or because the HMIS system does not yet cover a specific facility type. In some countries, data are not available from specific regions of the country. These omissions and changes to address completeness issues are summarized in Table B4.

### Identifying outliers

We identify and remove errors that result in outlier values, defined as observations within a facility-service group more than 10 deviations above the positive median absolute deviation (MAD), or,

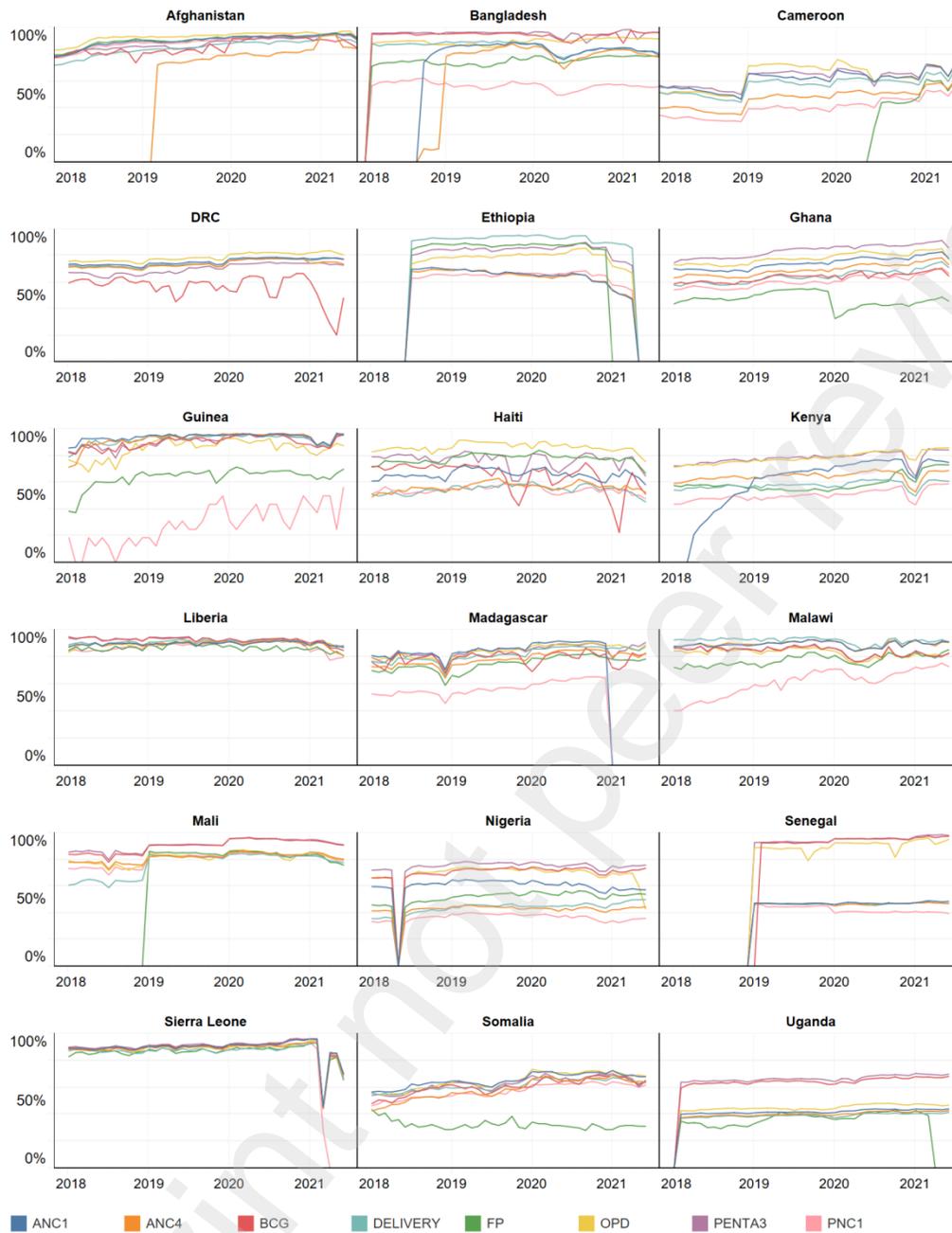
$$Outlier > 10 * \frac{|X_i - \bar{X}|}{\text{Median}(|X_p - \bar{X}|)}$$

Where  $X_p$  are the observations above the median,  $\bar{X}$  is the average value, and  $X_i$  is each observation.

The threshold of 10 was set with the goal of developing a conservative rule which would identify egregious data errors without danger of overcorrecting for events such as mass immunization campaigns.

The proportion of total values identified as outliers during the pre-pandemic and post-pandemic periods is given in Table B5.

**Figure B1.** Level of completeness by country and indicator



**Note:** Monthly completeness is defined as the proportion of facilities which have submitted a non-missing report, divided by the number of facilities that reported at least once during the calendar year. Annual shifts in completeness of multiple indicators may indicate a change in the denominator due to rollout to additional facilities or closure of defunct facilities during the year.

**Table B1. Sample size used in primary analysis**

	Facility Level	Afghanistan	Bangladesh	Cameroon	DRC	Ethiopia	Ghana	Guinea	Haiti	Kenya	Liberia	Madagascar	Malawi	Mali	Nigeria	Senegal	Sierra Leone	Somalia	Uganda*	Grand Total	
ANC1	Hospital	125	109	317	371	435	494	17	62	649	31	3	79		2,916	17	18	51	176	5,870	
	Health Center	1,505	649	5,164	11,429	4,285	1,858	315	310	1,369	55	2,747	513		13,974	124	258	531	1,815	46,901	
	Lower level	863		131	5,200	12,526	2,887	103	356	4,829	510		83		12,585	1,546	1,097	61	1,711	44,488	
	Other/Unknown		55	325	1,088		73	2	69	237	7	484	8		107			17	198	2,670	
ANC4	Hospital	119	104	314	364	435	491	16	62	771	30	3	79	2	2,673	17	14	50	169	5,713	
	Health Center	1,489	632	4,933	11,255	4,294	1,834	316	285	1,662	54	2,769	513	1,529	13,163	124	258	523	1,648	47,281	
	Lower level	846		124	4,887	13,028	2,770	103	290	5,957	494		81	247	11,256	1,546	1,096	58	1,673	44,456	
	Other/Unknown		48	315	1,046		71	2	60	453	6	484	8	9	106			16	151	2,775	
BCG	Hospital	132			91		329	15	59		31	3	74		2,216		2	18	56	174	3,200
	Health Center	1,152	601		10,642		1,323	315	286		54	2,756	532	1,504	13,859	113	257	486	2,031	35,911	
	Lower level	851	56		2,503		5,286	102	335		487		92	6	13,619	1,472	1,091	56	1,644	27,600	
	Other/Unknown				213		80	1	61		7	221	3		48			17	89	740	
DELIVERY	Hospital	128	104	313	444	406	491	14	59	754	31	1	77	2	2,750	5	25	52	171	5,827	
	Health Center	1,488	656	5,045	11,437	3,709	1,765	305	181	1,462	53	2,692	470	1,507	12,278	114	249	495	1,043	44,949	
	Lower level	828	18	131	5,764	3	1,973	99	164	4,094	495		36	228	9,092	1,487	1,087	35	1,632	27,166	
	Other/Unknown		58	311	1,211		64	2	39	251	7	353	6	8		61		14	146	2,531	
FP	Hospital	128	2	280		427	293	41	58	752	29	2	64	1	2,226			34	83	4,420	
	Health Center	1,501	69	4,472		4,344	1,439	304	295	1,763	48	2,767	517	1,492	13,050			121	1,357	33,539	
	Lower level	862	12,250	92		15,287	5,012	99	336	6,742	484		118	193	11,706			6	1,010	54,197	
	Other/Unknown			245		75		1	66	575	8	496	17	8				2	146	1,639	
OPD	Hospital	145	125	322	471	439	516	37	70	822	34	4	75	1	3,159	18	44	52	189	6,523	
	Health Center	1,509	499	5,317	11,707	4,393	2,163	17	323	1,891	58	2,807	537	1,537	14,671	128	253	534	2,946	51,290	
	Lower level	872	13,699	133	6,626	15,591	3,027		385	7,299	556		100	269	15,993	1,577	1,096	64	1,795	69,082	
	Other/Unknown			361	1,317		96	2	76	725	10	876	4	11		152		17	480	4,127	
PENTAS	Hospital	126		281	101	362	336	15	59	730	32	3	74		2,201	3	18	56	177	4,574	
	Health Center	1,176	598	4,399	10,818	4,138	1,413	315	290	1,528	54	2,759	532	1,501	13,884	114	257	490	2,162	46,428	
	Lower level	857	56	88	2,714	15,619	6,311	102	338	5,535	489		93	6	13,674	1,484	1,092	59	1,669	50,186	
	Other/Unknown			255	240		86	1	61	317	7	256	4		54			18	104	1,403	
PNC1	Hospital	125	105	311	436	435	492	3	55	742	30	1	58	2	2,356	7	21	48		5,227	
	Health Center	1,505	630	4,809	11,396	4,334	1,780	13	246	1,645	52	2,581	346	1,518	11,943	121	253	523		43,695	
	Lower level	863	12,728	120	5,653	14,467	2,408		284	5,932	469		27	220	9,548	1,521	1,082	57		55,379	
	Other/Unknown		58	293	1,185		66		49	439	5	228	1	8		71		17		2,420	
	Total	2,528	14,847	6,214	20,150	20,739	9,323	478	861	10,899	659	3,705	783	1,847	34,701	1,920	1,406	680	5,452	137,192	

Note: Uganda sample size is given for January 2021, as the full timespan includes duplicate facilities (see Appendix Table B4)

**Table B2.** Cumulative change in service volume during the pandemic period (March 2020-June 2021) in a balanced panel of facilities

Country	OPD	Family Planning	ANC1	ANC4	Delivery	PNC1	BCG	Penta3
Afghanistan	-9.2%***	-2.70%	-7.9%**	-2.30%	-5.1%**	-9.8%**	6.8%**	-0.30%
Bangladesh	-40.2%***	-6.1%***	-32.2%***	4.80%	-21.4%***	-20.0%***	-3.6%*	-12.4%***
Cameroon	-1.20%	-	2.50%	-6.00%	-0.40%	-2.30%	-	-2.00%
DRC	-6.5%***	-	0.80%	0.90%	-2.5%***	-1.8%**	-	-0.40%
Ethiopia	-17.1%***	1.00%	-3.7%***	-2.7%**	2.3%**	0.80%	-	-2.6%***
Ghana	-18.5%***	-	3.2%***	-0.40%	-1.8%**	1.30%	-6.0%***	0.20%
Guinea	-14.70%	4.10%	-0.40%	-6.7%*	-3.00%	-	-0.30%	-1.40%
Haiti	-22.8%***	10.1%*	-6.7%*	-10.1%**	-25.7%***	-15.9%***	-27.50%	-2.30%
Kenya	-27.6%***	-0.10%	-5.2%***	-11.1%***	-8.7%**	-7.50%	-	-2.3%***
Liberia	3.80%	6.90%	-2.70%	-6.20%	-1.70%	-6.6%**	4.7%**	-3.00%
Madagascar	-8.6%***	-1.50%	-1.00%	-1.60%	2.10%	-3.50%	3.40%	-0.10%
Malawi	-10.1%**	6.80%	5.60%	2.10%	-3.80%	2.90%	3.70%	-6.30%
Mali	-6.5%**	-10.4%*	-	-0.80%	-4.4%*	-1.40%	-9.9%***	-13.2%***
Nigeria	-13.3%***	-4.70%	-6.6%***	-20.2%***	-14.6%**	-1.20%	0.90%	-1.40%
Senegal	-11.2%***	-	-5.40%	-7.60%	3.80%	-1.30%	4.8%**	-8.6%***
Sierra Leone	-13.5%***	-21.9%**	-1.20%	6.7%**	-3.9%**	-4.3%**	-4.7%**	-7.4%**
Somalia	5.10%	-	-1.20%	6.20%	-1.20%	3.50%	3.80%	0.70%
Balanced panel average	-12.48%	-1.54%	-3.88%	-3.24%	-5.29%	-4.19%	-1.84%	-3.69%
Unbalanced panel average	-13.1%	-4.4%	-4.1%	-4.6%	-3.7%	-2.6%	-3.0%	-4.1%

Note: The balanced panel is comprised of the subset of facilities which had no non-missing reports for the months included in the analysis for each indicator between January 2018 to June 2021. Uganda is omitted from this test as there is no consistent identifier across the entire time period.

**Table B3. Sample size for balanced panel analysis**

	ANC1	ANC4	BCG	DELIVERY	FP	OPD	PENTA3	PNC1	Grand Total
Afghanistan	1,088	801	584	883	1,135	1,544	983	1,011	1,869
Bangladesh	309	26	367	461	2,150	5,377	414	1,021	6,814
Cameroon	560	226		364	1	250	382	62	916
DRC	4,915	4,149	81	4,306		4,957	1,595	3,759	7,034
Ethiopia	3,289	2,664		2,125	8,040	3,415	6,299	2,245	10,419
Ghana	1,634	1,000	643	783	61	1,426	2,793	709	3,979
Guinea	220	215	101	147	11	14	89	2	312
Haiti	88	55	5	59	101	179	41	44	278
Kenya	946	740		832	359	2,139	1,798	181	3,583
Liberia	345	309	297	357	179	260	310	268	419
Madagascar	1,158	532	318	831	384	1,033	620	167	1,454
Malawi	199	202	79	174	31	68	73	10	342
Mali		774	758	486	672	724	909	585	1,176
Nigeria	2,615	647	4,048	788	1,066	4,074	5,650	358	7,964
Senegal	1,137	1,092	1,270	914		1,026	1,330	322	1,563
Sierra Leone	628	496	514	360		432	612	688	918
Somalia	124	55	60	97	4	109	90	52	174
Grand Total	20,757	15,228	10,124	15,105	14,213	28,789	25,237	11,484	51,516

**Table B4. Data considerations**

Afghanistan	ANC4 data unavailable before March 2019.
Bangladesh	Lower-level and upper-level facilities are in different systems. There is no information on ANC care in lower-level facilities, ANC data in upper-level facilities is available starting October 2018. January and February 2018 dropped due to poor completeness tied to elections.
Cameroon	Family planning and BCG data were dropped due to low completeness.
DRC	Family planning data was dropped due to low completeness.
Ethiopia	BCG data was dropped due to low completeness. Data before July 2018 (start of Ethiopian liturgical year) is poor completeness, as the HMIS system was rolling out. Data were unavailable past April 2021 at the time of analysis, and in 2021 for family planning. Data from Tigray is unavailable due to security conditions.
Ghana	No omissions
Guinea	Guinea HMIS has data only from hospitals and health centers, lower-level facilities are not reported. Data are only available start March 2018 for ANC4, and May 2018 for family planning. PNC data are omitted for poor completeness.
Haiti	No data on BCG. Data past May 2021 were poor completeness at the time of analysis
Kenya	No data for BCG available. ANC1 data is available starting July 2018
Liberia	No omissions
Madagascar	There is no updated data for ANC1 and PNC1 in 2021 at the time of analysis. No data from lower-level facilities was reported.
Malawi	No omissions
Mali	Antenatal care is measured in aggregate, no close ANC1 proxy was identified. Family planning indicators were dropped for poor quality in 2018. There is limited reporting from hospitals.
Nigeria	Data from June 2021 were dropped for low completeness at the time of analysis. A change in indicator definitions occurred in October 2020
Senegal	Data from 2018 were not available at the time of analysis. Family planning indicators were dropped for poor completeness.
Sierra Leone	System issues resulted impacted reporting in March 2021 and June 2021. PNC data are not available after February 2021 at time of analysis.
Somalia	The state of Somaliland is not included. Family planning data are not available.
Uganda	System change in 2020 resulted in indicator definition changes and inability to track individual health facilities. High completeness family planning and PNC1 indicators were not identified.

**Table B5.** Percentage of outliers by country in the pre-pandemic (January 2018 – February 2020) and the pandemic (March 2020 – June 2021) periods

Country	Time period	ANC1	ANC4	BCG	DELIVERY	FP	OPD	PENTA3	PNC1	
Afghanistan	Pre-pandemic	0.30%	0.00%	0.30%	0.00%		0.70%	0.40%	0.50%	0.10%
Afghanistan	Pandemic	0.50%	0.50%	0.40%	0.60%		0.80%	0.60%	0.70%	0.40%
Bangladesh	Pre-pandemic	1.90%	0.60%	0.40%	0.20%		0.10%	0.20%	0.10%	0.00%
Bangladesh	Pandemic	0.80%	0.20%	2.10%	0.30%		0.10%	0.10%	2.00%	0.00%
Cameroon	Pre-pandemic	0.10%	0.00%		0.00%		0.00%	0.30%	0.10%	0.00%
Cameroon	Pandemic	0.10%	0.10%		0.00%		0.10%	0.40%	0.10%	0.00%
DRC	Pre-pandemic	1.10%	1.20%	0.20%	0.80%			1.10%	0.50%	0.90%
DRC	Pandemic	1.00%	1.10%	0.50%	0.90%			1.60%	1.40%	0.70%
Ethiopia	Pre-pandemic	0.10%	0.10%		0.10%		0.70%	1.10%	0.00%	0.10%
Ethiopia	Pandemic	0.10%	0.10%		0.20%		0.90%	1.80%	0.00%	0.10%
Ghana	Pre-pandemic	0.00%	0.10%	0.00%	0.00%		0.20%	0.40%	0.00%	0.00%
Ghana	Pandemic	0.00%	0.10%	0.00%	0.00%		0.20%	0.40%	0.00%	0.00%
Guinea	Pre-pandemic	0.70%	0.40%	1.20%	0.20%		2.00%	1.00%	1.20%	1.90%
Guinea	Pandemic	0.80%	0.40%	1.00%	0.10%		1.00%	0.60%	0.50%	1.20%
Haiti	Pre-pandemic	0.00%	0.00%	0.30%	0.10%		1.50%	1.50%	0.30%	0.10%
Haiti	Pandemic	0.00%	0.10%	0.20%	0.00%		1.50%	1.00%	0.30%	0.00%
Kenya	Pre-pandemic	0.00%	0.00%		0.00%		0.70%	0.90%	0.00%	0.10%
Kenya	Pandemic	0.10%	0.00%		0.10%		0.80%	0.70%	0.10%	0.10%
Liberia	Pre-pandemic	1.00%	2.00%	1.20%	1.00%		2.80%	0.90%	0.70%	3.00%
Liberia	Pandemic	0.70%	1.20%	0.30%	0.60%		2.80%	0.60%	0.10%	1.60%
Madagascar	Pre-pandemic	0.10%	0.00%	0.30%	0.00%		0.30%	0.60%	0.30%	0.00%
Madagascar	Pandemic	0.10%	0.00%	0.20%	0.00%		0.40%	1.00%	0.10%	0.00%
Malawi	Pre-pandemic	1.10%	1.00%	1.30%	0.60%		1.30%	1.00%	1.20%	0.10%
Malawi	Pandemic	1.30%	1.30%	1.00%	0.70%		1.40%	1.00%	1.00%	0.10%
Mali	Pre-pandemic		0.40%	0.60%	1.80%		1.90%	0.60%	0.60%	1.20%
Mali	Pandemic		0.30%	1.30%	3.10%		1.80%	0.80%	1.00%	1.70%
Nigeria	Pre-pandemic	0.20%	0.20%	0.10%	0.00%		0.40%	0.70%	0.10%	0.10%
Nigeria	Pandemic	0.20%	0.10%	0.10%	0.00%		0.50%	0.50%	0.10%	0.20%
Senegal	Pre-pandemic	0.10%	0.20%	1.00%	0.40%			1.20%	0.40%	0.30%
Senegal	Pandemic	0.00%	0.00%	0.50%	0.00%			1.30%	0.40%	0.10%
Sierra Leone	Pre-pandemic	0.10%	0.00%	0.00%	0.00%		0.80%	0.70%	0.00%	0.00%
Sierra Leone	Pandemic	0.00%	0.20%	0.00%	0.00%		1.10%	0.70%	0.00%	0.10%
Somalia	Pre-pandemic	0.60%	0.40%	0.60%	0.10%		0.30%	1.00%	0.70%	0.50%
Somalia	Pandemic	0.30%	0.20%	0.40%	0.10%		0.00%	0.60%	0.30%	0.20%
Uganda	Pre-pandemic	0.10%	0.10%	0.50%	0.40%		2.00%	0.50%	0.30%	
Uganda	Pandemic	0.30%	0.30%	0.40%	0.40%		0.90%	0.60%	0.30%	

Preprint not peer reviewed