BMJ Open

Continuity of community-based healthcare provision during COVID-19: a multicountry interrupted time series analysis

Madeleine Ballard, Helen E Olsen, Anoushka Millear, Jane Yang, Caroline Whidden, Amanda Yembrick, Dianna Thakura, Afra Nuwasiima, Molly Christiansen, Daniele J Ressler, Wycliffe Okoth Omwanda, Diego Lassala, Daniel Palazuelos, Carey Westgate, Fabien Munyaneza

To cite: Ballard M, Olsen HE, Millear A, et al. Continuity of community-based healthcare provision during COVID-19: a multicountry interrupted time series analysis. BMJ Open 2022;12:e052407. doi:10.1136/bmjopen-2021-052407

ABSTRACT

Background Pandemics often precipitate declines in essential health service utilisation, which can ultimately kill more people than the disease outbreak itself. There is some evidence, however, that the presence of adequately supported community health workers (CHWs), that is, financially remunerated, trained, supplied and supervised in line with WHO guidelines, may blunt the impact of health system shocks. Yet, adequate support for CHWs is often missing or uneven across countries. This study assesses whether adequately supported CHWs can maintain the continuity of essential community-based health service provision during the COVID-19 pandemic.

Methods Interrupted time series analysis. Monthly routine data from 27 districts across four countries in sub-Saharan Africa were extracted from CHW and facility reports for the period January 2018–June 2021. Descriptive analysis, null hypothesis testing, and segmented regression analysis were used to assess the presence and magnitude of a possible disruption in care utilisation after the earliest reported cases of COVID-19.

Results CHWs across all sites were supported in line with the WHO Guideline and received COVID-19 adapted protocols, training and personal protective equipment within 45 days after the first case in each country. We found no disruptions to the coverage of proactive household visits or integrated community case management (iCCM) assessments provided by these prepared and protected CHWs, as well as no disruptions to the speed with which iCCM was received, pregnancies were registered or postnatal care received.

Conclusion CHWs who were equipped and prepared for the pandemic were able to maintain speed and coverage of community-delivered care during the pandemic period. Given that the majority of CHWs globally remain unpaid and largely unsupported, this paper suggests that the opportunity cost of not professionalising CHWs may be larger than previously estimated, particularly in light of the inevitability of future pandemics.

BACKGROUND

Pandemics often precipitate declines in essential health service utilisation, which can ultimately kill more people than the disease outbreak itself. Meta-analysis indicates that during the 2013–2016 West African Ebola outbreak, healthcare utilisation declined 18%. Similar results were observed during the 2003 severe acute respiratory syndrome epidemic: ambulatory care in Taiwan decreased by 23.9%. Disruptions in health utilisation and child well-being have already been captured during COVID-19. Declines in the delivery of essential health services threaten global progress.
towards Sustainable Development Goals to reduce morbidity and mortality. In the context of a pandemic, changes in access to essential health services may be driven by several forces. On the supply side: a depleted health workforce, resource reallocation to the pandemic response or strained supply chains; on the demand side: lockdowns or other mobility restrictions, financial pressure/loss of insurance and fear. Community health workers (CHWs) have long been heralded as an integral part of primary healthcare (PHC) strategies and of the health system. There is some evidence that the presence of adequately supported CHWs—lay workers trained to provide promotive, preventive and curative medical care to their neighbours—may blunt the impact of health system shocks. Yet, adequate support for their work (eg, as outlined in the WHO CHW Guideline: financial remuneration commensurate with job demands, ongoing training, regular performance evaluation, adequate supplies, etc) is often missing or uneven across countries. This study assesses whether adequately supported CHWs can support the continuity of essential health services during the COVID-19 pandemic.

### METHODS

Intermittent community surveys continue to be the ‘gold standard’ for assessing health service utilisation despite their high cost and low frequency. Routine data collected as part of programmatic care delivery are often overlooked for evaluating causal effects of health programmes due to concerns regarding ‘completeness, timeliness, representativeness and accuracy’ particularly when collected by CHWs.

In cases where data are available and quality is assured via strong data management (eg, use of electronic data systems and quality control measures), however, the intrinsic features of routine data (high coverage, frequent observations over extended periods) allow for robust evaluations of health service delivery.

We used quality-assured routine data to analyse community healthcare utilisation in 27 districts across four countries in sub-Saharan Africa 26 months prior to and 15 months during the COVID-19 pandemic. Data were reported following the Framework for Enhanced Reporting of Interrupted Time Series (FERITS) reporting guideline for interrupted time series studies.

### Table 1: Data collection and quality assurance at each site

| Site (country) | Collection instrument | Frequency of data collection | Data quality assurance |
|---------------|------------------------|-----------------------------|------------------------|
| Region 1 Data from 19 districts in Western and Central Kenya | Mobile | Daily at point of care Data aggregated in real-time dashboards | Quarterly data quality assurance phone surveys to patients on sampling basis on submitted data to ascertain authenticity. Calls made within 2 weeks of service delivered. Daily data trend analysis to flag arising issues. Monthly data reviews data cleaning for duplicates and outliers. Monthly outlier reports completed and given to programme teams for follow-up. Missing data: available case analysis is applied. No imputations have been attempted. |
| Region 2 Data from 1 district in Southern Kenya | Mobile | Daily at point of care Data aggregated in real-time dashboards | Data quality assurance visits to patients to ascertain data authenticity Monthly data review with CHWs Mobile application designed with embedded data validation (eg, skip logic) to ensure data completeness and quality. Error log recording reviewed regularly |
| Region 3 Data from 19 districts in Central-Eastern Uganda | Mobile | Daily at point of care Data aggregated in real-time dashboards | Quarterly data quality assurance phone surveys to patients on sampling basis on submitted data to ascertain authenticity. Calls made within 2 weeks of service delivered. Daily data trend analysis to flag abnormalities. Monthly data reviews. Data cleaning for duplicates and outliers. Monthly outlier reports completed and given to programme teams for follow-up. Missing data: available case analysis is applied. No imputations have been attempted. |
| Region 4 Data from 1 district in Southern Mali | Mobile | Daily at point of care Data aggregated in real-time dashboards | Data quality assurance visits performed monthly by CHW supervisors (without CHWs present) to patients to verify home visit data authenticity Mobile application designed with embedded data validation (eg, skip logic) to ensure data completeness and quality |
| Region 5 Data from 1 district in Southern Malawi | Mobile (2 catchment areas) CHW paper-based registers (12 catchment areas) Facility paper-based registers (12 catchment areas) | Mobile: daily at point of care CHW and facility paper registers: monthly aggregation | Trend analysis to flag abnormalities or incompleteness Data review with CHW paper-based registers Data review with Health Management Information System department on facility paper-based registers |

CHW, community health worker.
Routine CHW programme data were regularly pooled as part of a quality improvement project undertaken by members of the Community Health Impact Coalition, a multicountry network of health practitioners that exists to accelerate the uptake of high-impact community health systems design.20 We pooled aggregate monthly data extracted from CHW and facility reports from January 2018 to June 2021 (ie, the full time series).

All sites participating in the quality improvement project were eligible for inclusion in the study; sites self-excluded based on bandwidth to participate in the research study (ie, non-probability-based sampling). Data collection varied slightly in collection methods and scope across regions and is summarised in table 1.

Measures

Continuity of services

This study seeks to establish whether adequately supported CHW programmes supported the continuity of essential health services during the COVID-19 pandemic. Multiple metrics of service utilisation were chosen to (1) obtain balance across speed and coverage and (2) be indicative of a broad swath of CHW PHC activities across sites (ie, maternal, neonatal and child health). Given that catch-up campaigns are not possible for these maternal and child health interventions, metrics capturing delivery of these services were the focus for our analysis (table 2).

Preparedness and protection

In order to contextualise the findings about continuity of services, we also collected data on CHW programme implementation. The degree to which CHWs were supported in line with WHO Guidelines was captured via programme self-assessment using the Community Health Worker Assessment and Improvement Matrix (CHW AIM): Updated Program Functionality Matrix for Optimizing Community Health Programs,21 an evidence-based tool to identify design and implementation gaps in CHW programmes.

The degree to which CHWs were prepared and protected to respond to COVID-19 was captured via COVID-19-related metrics extracted from CHW monthly summary reports (table 3).

Analysis

Descriptive analysis, null hypothesis testing, and segmented linear regression analysis were used to assess the presence and magnitude of a possible disruption on December 24, 2023 by guest. Protected by copyright.
in care utilisation after the earliest reported cases of COVID-19.

Descriptive analysis
The monthly reported PHC data were first graphed for each metric across all sites. All metrics were calculated as proportions in order to avoid confounding with programme size. While the number of children under 5 assessments was initially reported as a count, the study team converted the metric to a proportion using the number of registered households in the catchment area as the denominator. The trend in the indicator data for 2018, 2019, 2020 and 2021, including any possible seasonal patterns, was described using descriptive statistics and limited to reported data for each month since January 2018 or the start of data reporting.

Testing the null hypothesis
The study team intended to compare data from the 26-month period before March 2020 and the 15-month period after March 2020. These time periods were selected because March coincided with the first cases of the COVID-19 pandemic in most regions as well as the start of lockdowns and January 2018–July 2021 were the months for which data were available. The magnitude and direction of the difference were assessed using the Wilcoxon signed-rank test.

Modelling disruption
The particular characteristics of time-series data—non-stationarity, seasonality and auto-correlation—mean it is not sufficient to compare average utilisation data before and during the pandemic. The risks arising from these specific properties were accounted for by using a segmented regression analysis. Monthly PHC data from January 2018 to February 2020 were used as a baseline against which to compare utilisation rates for April–June 2021. The segmented linear regression model was:

\[ Y_t = \beta_0 + \beta_1 \times \text{time} + \beta_2 \times \text{pandemic} + \beta_3 \times \text{postslope} + \beta_4 \times \text{region} + \epsilon \]

Where \( Y_t \) is the outcome variable at time \( t \); time (in months) is a continuous variable indicating time from January 2018 up to June 2021, the end of the period of observation. Pandemic (ie, the COVID-19 pandemic) is coded 0 for pre-pandemic time points and 1 for post-pandemic time points, with March 2020 as null, while postslope is coded 0 up to the last point before the pandemic phase and coded sequentially thereafter. \( \beta_0 \) captures the baseline level of the outcome at time 0 (January 2018, beginning of the period); \( \beta_1 \) estimates the structural trend or growth rate in utilisation, independently from the pandemic; \( \beta_2 \) estimates the immediate impact of the pandemic or the change in level in the outcomes of interest after the start of the pandemic; and \( \beta_3 \) reflects the change in trend, or growth rate in outcome, after the start of the pandemic. Region is a dummy variable for each of the five regions. The analysis relies on the assumption that the flexibly modelled trends observed before March 2020 would have persisted in the absence of the pandemic.

Auto-correlation was controlled by performing a Durbin-Watson test to test the presence of first-order auto-correlation and because auto-correlation was detected, using the Prais-Winsten generalised least squares estimator to estimate the regression coefficients.

Given that the WHO declared COVID-19 a global pandemic in mid-March (11 March 2020), sensitivity analysis was conducted in which the month of March 2020 was coded as post, rather than null.

Data management and confidentiality
Data were analysed using R V.4.0.3 and RStudio V.1.3.1093. No individual-level or identifiable patient data were used. Nonetheless, a Health Insurance Portability and Accountability Act (HIPAA)-compliant database and cloud-based data transfer processes were used.

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

Table 4  Site profiles

| Regions | Catchment area population | Number of CHWs | Date of first COVID-19 case |
|---------|---------------------------|----------------|-----------------------------|
| Region 1 | 1.3 million               | 1696           | 13 March 2020               |
| Region 2 | 85 000                    | 296            | 13 March 2020               |
| Region 3 | 3.5 million               | 4400           | 21 March 2020               |
| Region 4 | 192 000                   | 225            | 25 March 2020               |
| Region 5 | 144 322                   | 1228           | 2 April 2020                |

CHWs, community health workers.
| Region 1 | COVID-19 waves |
|----------|----------------|
| 5 districts in Western and Central Kenya | First wave in March 2020 |
| | Second wave in October 2020 |
| | Third wave in March 2021 |
| Movement restrictions | Restrictions from March to September 2020 |
| | Phased reopening of economy and schools, with schools opening in September and October 2020 before closing again March 2021 |
| Touch-free protocol | Maintenance of 3 m distance during household visits, parental support in screening visits for children |
| | Transition to low-touch protocols with PPE in September 2020 before the second wave of COVID |
| | CHWs provided with and reminded to wear PPE during every household visit |
| | Hand hygiene reminders via digital tools during household visits |
| | CHWs equipped with both medical and non-medical (ie, cloth) masks |

**Changes in the work environment**

- Remote learning and supervision for CHWs
- Changes to CHW compensation, including new incentive structure
- Free medicines and supplies for CHWs
- Increased access to mHealth resources, including replacement phones
- Phone-based remote supervision approach

**Changes in the clinical approach**

- Integrated COVID-19 screening workflows into mHealth tools, including option to conduct visit remotely

| Region 2 | COVID-19 waves |
|----------|----------------|
| 1 district in Southern Kenya | First wave in March 2020 |
| | Second wave in October 2020 |
| | Third wave in March 2021 |
| Movement restrictions | Restrictions from March to September 2020 |
| | Phased reopening of economy and schools, with schools opening in September and October 2020 before closing again March 2021 |
| Touch-free protocol | Shift to primarily phone-based care delivery model with limited in-person visits |
| | Household COVID-19 screening via phone prior to care delivery |
| | Use of ‘no touch’ and ‘low touch’ protocols for care delivery |
| PPE protocol | PPE, including both medical and non-medical (ie, cloth) masks and other protective equipment, collected and distributed among CHWs and supervisors |
| | Reminders to wear PPE and encourage community members to wear cloth masks and engage in hand hygiene measures |
| | CHW use of PPE for household visits, including ‘low touch’ and ‘no touch’ protocols |

**Changes in the work environment**

- Shift to digitally supported CHW health check prior to household visits, includes both PPE and COVID-19 symptoms
- Phone-based COVID-19 screening for households in the catchment area prior to care delivery
- Limited in-person training, small groups with PPE, focused on COVID-19 adaptations
- Pre-emptive COVID-19 testing for CHWs, supervisors as available using rapid diagnostic tests (RDTs) and polymerase chain reaction (PCR) tests (as available)

**Changes in the clinical approach**

- Increased number of remote household visits to try to decongest clinics
- Stopped large group care activities during pandemic
- Limited malaria RDTs and use of presumptive diagnoses instead
- Mapping of economically impacted families and support with cash transfers and other in-kind assistance

| Region 3 | COVID-19 waves |
|----------|----------------|
| 19 districts in Central-Eastern Uganda | March 2020 |
| | October 2020 |
| | March 2021 |
| Movement restrictions | Mobility restrictions and public gatherings limited in March 2020, including air travel and business closures, which ran through August 2020 and became increasingly restrictive over time |
| | Impacts on delivery of public services noted in news reporting, including impacts on delivery of essential health services |
| Touch-free protocol | Maintenance of 6 m distance during household visits |
| | Transition to low-touch protocols with pregnant and postpartum women in September 2020 |
| PPE protocol | CHWs provided with and reminded to wear PPE during every household visit |
| | Hand hygiene reminders via digital tools during household visits |
| | CHWs equipped with both medical and non-medical (ie, cloth) masks |

**Changes in the work environment**

- Remote learning and supervision for CHWs
- Changes to CHW compensation, including new incentive structure
- Free medicines and supplies for CHWs
- Increased access to mHealth resources, including replacement phones
- Phone-based remote supervision approach

**Changes in the clinical approach**

- Integrated COVID-19 screening workflows into mHealth tools, including option to conduct visit remotely
- CHWs limiting mRDTs and instead making presumptive diagnoses
- Continued with digital tools and distanced diagnostics

Continued
Table 5  Continued

| Site | COVID-19 service adaptations |
|------|-------------------------------|
| **Region 4** 1 district in Southern Mali | COVID-19 waves |
| | ► March–June 2020 |
| | ► December 2020 |
| | ► April 2021 |
| **Movement restrictions** | ► Restrictions from March to July 2020, including mobility and healthcare professionals |
| | ► Election in April 2020 followed by political instability resulting in various changes to protocols over the course of the pandemic, coup included governmental transition |
| **Touch-free protocol (used in few weeks before PPE was available)** | ► CHWs make home visits from a distance of 2 m with all members of the household and treat them presumptively. (eg, fever+vomiting and/or shivering treated as malaria) |
| | ► Distance at CHW discretion |
| **PPE protocol (used as standard practice)** | ► Mandatory wearing of PPE by CHWs and patient assessment according to the standard protocol (ie, with touch, within 6 m), which included medical masks, gloves and goggles |
| **Changes to the work environment** | ► Self-checking of symptoms by all CHWs and CHW supervisors on a daily basis |
| | ► Sick patients no longer visit the CHWs’ home. Patient either calls CHW or sends a healthy person to pick up the CHW. |
| | ► CHWs no longer accompany patients to the clinic in the case of a referral. |
| | ► Screening for malnutrition in healthy children from 6 months to 59 months of age was stopped to lower contact between CHW and children (NB: screening for malnourished sick children continued) |
| | ► Cessation of group meetings between CHWs and CHW supervisors. Individual supervision (direct observation of CHWs, etc) continued, with distancing |
| **Changes to the clinical approach** | ► Addition of the search for suspected COVID-19 cases to CHW tasks |
| | ► Gather information on risk factors for worsening of COVID-19 for all patients |
| | ► Continue with distanced care when PPE not available, supportive home care for patients |

| Region 5 1 district in Southern Malawi | COVID-19 waves |
| | ► June–August 2020 |
| | ► January 2021 |
| | ► July 2021 |
| **Movement restrictions** | ► Limited restrictions in April 2020, followed by a more comprehensive movement restriction implemented in January 2021 during the second wave of the pandemic |
| **Touch-free protocol** | ► No touch policy for all CHWs, removing hands-on screening and TB sputum collection |
| | ► Maintain a 6 m distance when possible |
| **PPE protocol** | ► Non-medical (ie, cloth) masks and hygiene materials provided to CHWs for use during household visits |
| | ► Used in conjunction with touch-free protocols, including mHealth tools and distanced care delivery when possible |
| **Changes in the work environment** | ► Training on COVID-19 and work adjustments for CHWs, including use of PPE at all times and maintaining 6 m distance when possible |
| | ► CHW self-screening for COVID-19 integrated into mobile application and task-based workflows |
| **Changes in the clinical approach** | ► Addition of screening for COVID-19 cases to CHW tasks in mobile application |
| | ► Identification of suspected COVID-19 cases referred to health facility or activated district rapid response |
| | ► CHW follow-up suspected or confirmed cases to ensure home-based care, home isolation and support with contact tracing |
| **COVID-19 vaccination** | ► Aggressive push for COVID-19 vaccination following January 2021 second wave of the pandemic, with focus on frontline health workers |

CHWs, community health workers; PPE, personal protective equipment; TB, tuberculosis.

RESULTS

Sample characteristics

Twenty-seven sites across four countries in sub-Saharan Africa participated in the study. Data were collected from 5 districts in Western and Central Kenya, 1 district in Southern Kenya, 19 districts across Central-Eastern Uganda, 1 district in the capital region of Mali and 1 district in Malawi (table 4). The sites had a total catchment population >5.2 million served by 7845 CHWs. The catchment area population of each site varied from 85,000 to 3.5 million. The CHW to population ratio ranged from ~1:200–900, reflecting differences in local geography, transport availability and cost, and other factors noted in the WHO Guideline and CHW AIM tool. Each country included in the analysis had its index case of COVID-19 in March 2020, save Malawi (table 4).

Preparedness and protection

Sites self-assessed the level of functionality of different CHW programme components using the evidence-based CHW AIM tool. Across all sites included in this study, CHWs are generally supported in line with the WHO CHW Guideline in that they receive fair pay, ongoing training, supportive supervision and adequate supplies (see online supplemental table 1).

Within 45 days of the first case in their country, all CHWs’ service delivery protocols and accompanying data collection tools were adapted to the COVID-19 context (see table 5 for a list of protocol modifications) and CHWs at each region received training on COVID-19 (including: how COVID-19 spreads; common symptoms; how to protect themselves; how to talk with community members about COVID-19; and roles they will take in combating the spread of the virus,
including protocol additions and modifications). The vast majority of CHWs (>85%) received personal protective equipment (PPE) in the first 45 days and nearly all CHWs were equipped with PPE for the duration of the pandemic period. There were no CHW deaths reported (table 6 and online supplemental table 2).

**Descriptive analysis**

Figure 1 shows the fluctuation in the monthly values for each of the six PHC indicators from January 2018 to June 2021.

The graph indicates the per cent of deliveries at a health facility (deliveries coverage) and per cent of women with home delivery receiving first postnatal care (PNC) visit within 48 hours of delivery (PNC Speed) were largely consistent over time. The ratio of assessments of children under 5 to households registered in the CHW catchment area (U5 Coverage) improved until early 2019 at which point it remained largely consistent over the period under study until a slight drop in June of 2021. The per cent of households visited at least one time per month (where family was home—Proactive Coverage) also increased over the examination period before a slight drop in June 2021, while the per cent of pregnancies registered in first trimester (Pregnancy Speed) and per cent of children under 5 assessed with a symptom of malaria, diarrhoea or pneumonia, within 24 hours of symptom onset (iCCM Speed) experienced a slight drop in the second quarter of 2020 before quickly rebounding to their previous highs. The study team also examined quarterly trends across metrics and sites, which yielded similar insights to those outlined above (see online supplemental table 3 for mean values for all metrics by quarter, online supplemental table 4 for descriptive trends in numerator and denominator by metric and month, online supplemental table 5 and online supplemental table 6 for data coverage for PHC and COVID-19 metrics, and online supplemental figures 1 and 2 for visualised trends by quarter and month for PH and COVID-19, respectively).

**Null hypothesis testing**

Five of the six metrics were not significantly different in the pre-pandemic (January 2018–February 2020) and pandemic (April 2020–June 2021) periods. Proactive coverage statistically significantly improved compared with the period before the pandemic (table 7 and figure 2).

**Modelling disruption**

Table 8 illustrates that no immediate negative effect of the pandemic was identified across any of the metrics included in the analysis (β2 p>0.05, see also online supplemental figure 3). For one metric, iCCM Speed, the growth rate in outcome declined slightly following the pandemic (β3=−0.69). This indicates that the per cent of children under 5 assessed with a symptom of malaria, diarrhoea or pneumonia, within 24 hours of symptom, decreased faster during the pandemic than before the pandemic, though by less than 1% per month.
Three alternative, exploratory regression models were run for the purpose of sensitivity analysis in which the model above was modified by: (1) removing the region term, (2) adding a preslope term and (3) adding a year term, respectively (see online supplemental tables 7 and 9, figures 4–6). Given some variability across regions, the region term was ultimately retained in the final model, whereas the preslope and year terms were excluded in favour of capturing the secular trend with a simple time variable ($\beta_1$). In any case, like the model above, none of these three alternative models found a significant immediate negative effect of the pandemic on the community health services assessed.

**DISCUSSION**

CHWs supported in line with the WHO Guidelines (eg, paid, in-stock, consistently supervised) and consistently equipped with PPE were able to maintain continuity of community-based maternal and child health services across five regions in sub-Saharan Africa during the COVID-19 pandemic. While pandemics often cause severe disruptions to health service provision, we found no disruptions to the speed and coverage of community-based iCCM assessments, proportion of women receiving timely pregnancy registration and PNC, or the coverage of facility-based deliveries or proactive, monthly household visits. These results indicate that health systems with well-supported CHWs who were equipped and prepared for the pandemic were able to maintain speed and coverage of community-delivered care, even during a pandemic.

As indicated in the introduction, there are a number of supply-side and demand-side reasons a pandemic may have an impact on service delivery. When interpreting these results, it is important to emphasise that multiple supply-side and demand-side factors likely to interrupt service delivery were present in all study areas during the study period. On the supply side, each of the four countries studied experienced three ‘waves’ of COVID-19 during the period of observation, with at least one-third and up to one half of the post-March 2020 observation period in each country qualifying as a ‘severe outbreak’ (figure 3).

As noted elsewhere, these case numbers are likely to be under-reported. Data from regions with equivalent caseloads suggest disruption to health service provision was widespread. In a 2021 WHO national pulse survey on continuity of essential health services during the COVID-19 pandemic, 66% of 112 responding countries reported disruptions to essential health services due to unavailability of health workers. On the demand side, mobility restrictions were present for substantial portions of the period under observation in each of the four countries (table 5). In the aforementioned WHO pulse survey, 57% of countries reported disruptions to essential health services due to community fear or mistrust in seeking healthcare. The presence of this fear (in terms of patients ceasing to seek care for fear of contracting COVID-19 and avoidance of and discrimination...
Figure 2  Box plots for PHC metrics, before and during COVID-19 from January 2018 to June 2021, metrics 1–6. PHC, primary healthcare; PNC, postnatal care.
Table 8  Results of regression, including estimates, SE and p values across six metrics

| Metric             | Independent variables | Coefficient | SE   | P value       |
|--------------------|-----------------------|-------------|------|---------------|
| ICCM Speed         | Constant (β0)         | 23.80       | 2.05 | <0.0001***    |
|                    | Time (β1)             | 0.48        | 0.11 | <0.0001***    |
|                    | Intervention (β2)     | -1.62       | 2.11 | 0.44          |
|                    | Postslope (β3)        | -0.69       | 0.28 | 0.0165*       |
|                    | Region 2              | -4.33       | 0.85 | <0.0001***    |
|                    | Region 4              | 55.24       | 0.86 | <0.0001***    |
| Pregnancy Speed    | Constant (β0)         | 9.91        | 2.16 | <0.0001***    |
|                    | Time (β1)             | 0.11        | 0.12 | 0.34          |
|                    | Intervention (β2)     | 4.10        | 2.55 | 0.11          |
|                    | Postslope (β3)        | -0.34       | 0.27 | 0.20          |
|                    | Region 2              | 3.51        | 2.02 | 0.08          |
|                    | Region 3              | 16.54       | 2.13 | <0.0001***    |
|                    | Region 4              | 68.14       | 2.04 | <0.0001***    |
|                    | Region 5              | 17.59       | 2.20 | <0.0001***    |
| PNC Speed          | Constant (β0)         | 79.24       | 7.15 | <0.0001***    |
|                    | Time (β1)             | 0.55        | 0.45 | 0.22          |
|                    | Intervention (β2)     | -10.07      | 12.34| 0.42          |
|                    | Postslope (β3)        | -0.83       | 1.15 | 0.48          |
|                    | Region 2              | 3.51        | 2.02 | 0.08          |
|                    | Region 3              | 16.54       | 2.13 | <0.0001***    |
|                    | Region 4              | 68.14       | 2.04 | <0.0001***    |
|                    | Region 5              | 17.59       | 2.20 | <0.0001***    |
| Proactive Coverage | Constant (β0)         | 41.46       | 9.67 | <0.0001***    |
|                    | Time (β1)             | 1.18        | 0.34 | <0.0001***    |
|                    | Intervention (β2)     | -1.24       | 2.84 | 0.66          |
|                    | Postslope (β3)        | -0.77       | 0.75 | 0.31          |
|                    | Region 2              | 28.07       | 5.81 | <0.0001***    |
|                    | Region 3              | 6.44        | 6.90 | 0.35          |
|                    | Region 4              | -5.78       | 8.22 | 0.48          |
|                    | Region 5              | 24.55       | 9.39 | 0.009801**    |
| US Coverage        | Constant (β0)         | 31.06       | 7.97 | 0.000142***   |
|                    | Time (β1)             | 0.31        | 0.21 | 0.13          |
|                    | Intervention (β2)     | 0.00        | 1.74 | 1.00          |
|                    | Postslope (β3)        | -0.57       | 0.52 | 0.27          |
|                    | Region 2              | -22.80      | 4.25 | <0.0001***    |
|                    | Region 3              | 0.90        | 6.65 | 0.89          |
|                    | Region 4              | -33.47      | 7.78 | <0.0001***    |
|                    | Region 5              | 42.33       | 9.70 | <0.0001***    |
| Deliveries Coverage| Constant (β0)         | 92.71       | 0.65 | <0.0001***    |
|                    | Time (β1)             | 0.00        | 0.04 | 0.96          |
|                    | Intervention (β2)     | 1.34        | 0.87 | 0.12          |
|                    | Postslope (β3)        | -0.02       | 0.08 | 0.80          |
|                    | Region 3              | 4.60        | 0.57 | <0.0001***    |
|                    | Region 4              | -4.98       | 0.55 | <0.0001***    |
|                    | Region 5              | 3.14        | 0.59 | <0.0001***    |

Significance codes: ***0.001; **0.01; *0.05.

PNC, postnatal care.
against health workers was documented in each of the four study countries, even prior to the first wave. In the absence of a control, well-supported CHWs cannot be isolated as the sole reason health service delivery was maintained without serious disruption for more than a year during the COVID-19 pandemic in the areas under study. However, well-supported CHWs unfortunately remain rare and this paper presents robust outlier evidence across 4 countries and 27 districts of the maintenance of essential health service delivery in places where such prepared and protected CHWs delivered care. The community-based care analysed in this paper was provided by CHWs supported in line with the WHO Guideline on health policy and system support to optimise community health worker programmes; each programme scored highly on the UNICEF/U.S. Agency for International Development (USAID) quality tool and CHW AIM (see online supplemental table 1). Over 85% of CHWs were equipped with PPE and trained on COVID-19 response within 6 weeks of the first case appearing in their country and remained equipped with PPE for the duration of the period studied.

Our results provide an important counternarrative to the prevailing discourse on COVID-19 and essential health service delivery in which critical disruptions were expected, identified and even understood as inevitable. The large sample size of the proposed study, both in terms of records aggregated and long retrospective review, contributes to the robustness of any findings. Nonetheless, limitations of these findings include: (1) not all regions were able to report all data for all metrics (full coverage of tables can be found in online supplemental tables 5 and 6). (2) This analysis does not include exhaustive data from health facilities and thus is

Figure 3  Descriptive trends in estimated and confirmed COVID-19 infections for March 2020–June 2021 for five sites using Institute for Health Metrics and Evaluation (IHME)’s COVID-19 estimates.
only a partial picture of changes to service delivery. (3) Despite measures taken to ensure accuracy, data quality can vary across and within sites (eg, reporting errors, oversights in verification). (4) The pandemic may have precipitated changes in reporting that do not capture actual changes in the services provided. (5) Proportions can mask decreases in raw counts. We mitigate this by presenting raw numbers across all metrics included in this analysis. In examining these numbers, we observed multiple instances of increasing raw counts during the pandemic period, even as rates remained constant (see online supplemental table 4). (6) While this analysis provides critical insight into the role CHWs played in continuing essential services and supporting the health of their communities during the pandemic, these services alone do not capture the full impact of the work done by community-based cadres.

CHWs who were prepared and protected were able to maintain essential services for 5.2 million people across five regions in four different country contexts. Given that the majority of CHWs globally remain unpaid and largely unsupported, this paper suggests that the opportunity cost of not professionalising CHWs may be larger than previously estimated, particularly as we look to better understand the true value of CHWs.

CHWs who were prepared and protected were able to maintain essential services for 5.2 million people across five regions in four different country contexts. Given that the majority of CHWs globally remain unpaid and largely unsupported, this paper suggests that the opportunity cost of not professionalising CHWs may be larger than previously estimated, particularly as we look to better prepare for future pandemics.

**Author affiliations**

1Community Health Impact Coalition, London, UK
2Department of Global Health and Health System Design, Icahn School of Medicine at Mount Sinai, New York, New York, USA
3Medic Mobile, San Francisco, California, USA
4Muso, Bamako, Mali
5Living Goods, Nairobi, Kenya
6Living Goods, Kampala, Uganda
7Lwala Community Alliance, Rongo, Kenya
8Department of Global Health and Social Medicine, Harvard Medical School, Boston, Massachusetts, USA
9Partners In Health, Boston, Massachusetts, USA
10Community Health Impact Coalition, New York, New York, USA
11Partners In Health, Neno, Malawi

**Twitter** Madeleine Ballard @DMBallard

**Acknowledgements** The study authors would like to acknowledge the CHWs and CHW supervisors across all five regions for their continued service. We thank the monitoring and evaluation team in Kenya, Mali (especially Lassina Malle and Mohamed Bana Traoré), Uganda and Malawi (especially Basimenyah Nlena, Moses Aron, Emilia Connolly and Chiyembekeza Kachimanga) for their role in quality assurance and improvement. We are grateful to Lucas Goldstone and Dr Aaron Aron, Emilia Connolly and Chiyembekeza Kachimanga for their role in the regression analysis. We thank the Ministries of Health in all four countries for their collaboration. Thanks also to Ifoma Ibeal and Laura Sola Shellaby for their copyedit.

**Contributors** MB set up the collaborative network with vital early support from HEO and AV and serves as the guarantor. MB, HEO and AM designed the study with critical input from all authors. AM did the coding and ran the statistical analysis. MB, HEO and AM took the lead in interpretation of the results and drafting of the manuscript. AN, MC, DJR, WOG, DL, CWethoven, JY, DP, DT and FM led data collection and provided substantial contributions to interpretation of the results and drafting of the manuscript. CWethoven, CWestgate and JY made significant content contributions to the final draft of the report. All authors critically reviewed and approved the final version.

**Funding** This research was funded by Focused Philanthropy (no grant number) and Patrick J McGovern Foundation (no grant number).

**Competing interests** None declared.

**Patient and public involvement** Patients and/or the public were not involved in the design, conduct, or reporting, or dissemination plans of this research.

**Patient consent for publication** Not required.

**Ethics approval** The study team received an IRB exemption from the University of Washington’s Human Subjects Division.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data availability statement** No data are available. The data that support the findings of this study are available from Ministries of Health in Kenya, Malawi, Mali and Uganda. Restrictions apply to the availability of these data, which were used under licence for this study.

**Supplemental material** This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

**Open access** This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: http://creativecommons.org/licenses/by-nc/4.0/.

**ORCID iD**

Madeleine Ballard http://orcid.org/0000-0003-0107-4047

**REFERENCES**

1 Wilhelmi JA, Hellinger S. Utilization of non-Ebola health care services during Ebola outbreaks: a systematic review and meta-analysis. *J Glob Health* 2019;9:010406.
2 Chang H-J, Huang N, Lee C-H, et al. The impact of the SARS epidemic on the utilization of medical services: SARS and the fear of SARS. *Am J Public Health* 2004;94:562–4.
3 Jensen C, Mckenna NH. Child health services during a COVID-19 outbreak in KwaZulu-Natal Province, South Africa. *S Afr Med J* 2020;2020;92:13185.
4 Myoinhan R, Sanders S, Michaleff ZA, et al. Impact of COVID-19 pandemic on utilisation of healthcare services: a systematic review. *BMJ Open* 2021;11:e045343.
5 World Health Organization. Pulse survey on continuity of essential health services during the COVID-19 pandemic: interim report, 27 August 2020 World Health Organization; 2020.
6 United Nations Department of Economic and Social Affairs. The 17 goals. Available: https://sgds.un.org/goals
7 WHO. COVID-19 who African region: external situation report 15; 2020. https://apps.who.int/iris/bitstream/handle/10665/332321/SITREP_COVID-19_WHOAFRO_20200610-eng.pdf.
8 Kirkpatrick JN, Hull SC, Fedson S, et al. Scarce-Resource allocation and patient triage during the COVID-19 pandemic. JACC review topic of the week. *J Am Coll Cardiol* 2020;76:85–92.
9 Park CY, Kim K, Roth S, Asian Development Bank. Global shortage of personal protective equipment amid COVID-19: supply chains, bottlenecks, and policy implications. 2020.
10 Olickaj JJ, Chhinakali P, Suryanarayana BS, et al. Effect of COVID19 pandemic and national lockdown on persons with diabetes from rural areas availing care in a tertiary care center, southern India. *Diabetes Metab Syndr* 2020;14:1967–72.
11 Khatana SAM, Groeneveld PW. Health disparities and the coronavirus disease 2019 (COVID-19) pandemic in the USA. *J Gen Intern Med* 2020;35:2431–2.
12 et alAhmed T, Fernandez PA. Global Financing Facility. Monitoring continuity of essential health services during the COVID-19 pandemic. 2020. Available: https://www.globalfinancingfacility.org/monitoring-continuity-essential-health-services-during-covid-19-pandemic#.xzn1
13 Ballard M, Madore A, Johnson A. Concept note: community health workers. Boston, MA: Harvard Business Publishing, 2018. https://www.globalhealthdelivery.org/files/gbd/files/gbd-c11_chw_concept_note.pdf

MBallard M, et al. BMJ Open 2022;12:e052407. doi:10.1136/bmjopen-2021-052407

11 May 2022. Downloaded from http://bmjopen.bmj.com on December 24, 2023 by guest. Protected by copyright.
Luckow PW, Kenny A, White E, et al. Implementation research on community health workers’ provision of maternal and child health services in rural Liberia. Bull World Health Organ 2017;95:113–20.

15 Cometto G, Ford N, Pfaffman-Zambruni J, et al. Health policy and system support to optimise community health worker programmes: an abridged who guideline. Lancet Glob Health 2018;6:e1397–404.

Rowe AK. Potential of integrated continuous surveys and quality management to support monitoring, evaluation, and the scale-up of health interventions in developing countries. Am J Trop Med Hyg 2009;80:571–9.

17 Regeru RN, Chikaphupha K, Bruce Kumar M, et al. ‘Do you trust those data?’-a mixed-methods study assessing the quality of data reported by community health workers in Kenya and Malawi. Health Policy Plan 2020;35:334–45.

18 Wagenaar BH, Sherr K, Fernandes Q, et al. Using routine health information systems for well-designed health evaluations in low- and middle-income countries. Health Policy Plan 2016;31:129–35.

19 López Bernal J. The use of interrupted time series for the evaluation of public health interventions. London School of Hygiene & Tropical Medicine, 2018.

20 Community health impact coalition. Available: www.chwimpact.org

21 Ballard M, Bonds M, Burey J, Community Health Impact Coalition. Community health worker assessment and improvement matrix (CHW AIM): updated program functionality matrix for optimizing community health programs; 2018.

22 Agarwal S, Sripad P, Johnson C, et al. A conceptual framework for measuring community health workforce performance within primary health care systems. Hum Resour Health 2019;17:86.

23 Box GEP, Tiao GC. Intervention analysis with applications to economic and environmental problems. J Am Stat Assoc 1975;70:70–9.

24 Lagarde M, do Hto. How to do (or not to do). Assessing the impact of a policy change with routine longitudinal data. Health Policy Plan 2012;27:76–83.

25 ActNow C. Risk levels & key metrics, 2020. Available: https://covidactnow.org/covid-risk-levels-metrics

26 Adams J, MacKenzie MJ, Amegah AK, et al. The conundrum of low COVID-19 mortality burden in sub-Saharan Africa: myth or reality? Glob Health Sci Pract 2021;9:433–43.

27 World Health Organization. Second round of the National pulse survey on continuity of essential health services during the COVID-19 pandemic, 2021. Available: https://apps.who.int/iris/bitstream/handle/10665/275474/9789241550369-eng.pdf?ua=1

28 Pallangyo E, Nakate MG, Maina R, et al. The impact of covid-19 on midwives’ practice in Kenya, Uganda and Tanzania: a reflective account. Midwifery 2020;89:102775.

29 Oluoch-Ardj J, Chelagat T, Nylkun MM, et al. COVID-19 effect on access to maternal health services in Kenya. Front Glob Womens Health 2020;1:599267.

30 Kamulegeya LH, Bwanika JM, Musinguzi D, et al. Continuity of health service delivery during the COVID-19 pandemic: the role of digital health technologies in Uganda. Pan Afr Med J 2020;35:43.

31 Bagnchi S. Stigma during the COVID-19 pandemic. Lancet Infect Dis 2020;20:782.

32 Ridde V, Coulibaly A, Zinszer K, et al. Au coeur de l’Hôpital du Mali Bamako lors de la première vague de Covid-19. 10. France: The Conversation, 2021.

33 World Health Organization. Who guideline on health policy and system support to optimize community health worker programs World Health Organization; 2018. https://apps.who.int/iris/bitstream/handle/10665/275474/9789241550369-eng.pdf?ua=1

34 Ballard M, Westgate C, Alban R, et al. Compensation models for community health workers: comparison of legal frameworks across five countries. J Glob Health 2021;11:04010.

35 Dahn B, Woldemariam A, Perry H. Strengthening primary health care through community health workers: investment case and financing recommendations. Geneva: Office of UN Secretary General’s Special Envoy for Financing the Health Millennium Development Goals and for Malaria., 2015.