The COVID-19 pandemic and disruptions to essential health services in Kenya: a retrospective time-series analysis

Helen Kiarie, Marleen Temmerman, Mutono Nyamai, Nzisa Liku, Wangari Thuo, Violet Oramisi, Lilly Nyaga, Janette Karimi, Phidelis Wamalwa, Gladwell Gatheca, Valerian Mwenda, Loice Achieng Ombajo, S M Thumbi, on behalf of the Essential Health Services Data Monitoring and Evaluation sub-working group

Summary

Background Public health emergencies can disrupt the provision of and access to essential health-care services, exacerbating health crises. We aimed to assess the effect of the COVID-19 pandemic on essential health-care services in Kenya.

Methods Using county-level data routinely collected from the health information system from health facilities across the country, we used a robust mixed-effect model to examine changes in 17 indicators of essential health services across four periods: the pre-pandemic period (from January, 2018 to February, 2020), two pandemic periods (from March to November 2020, and February to October, 2021), and the period during the COVID-19-associated health-care workers' strike (from December, 2020 to January, 2021).

Findings In the pre-pandemic period, we observed a positive trend for multiple indicators. The onset of the pandemic was associated with statistically significant decreases in multiple indicators, including outpatient visits (28·7%; 95% CI 16·0–43·5%), cervical cancer screening (49·8%; 20·6–57·9%), number of HIV tests conducted (45·3%; 23·9–63·0%), patients tested for malaria (31·9%; 16·7–46·7%), number of notified tuberculosis cases (26·6%; 14·7–45·1%), hypertension cases (10·4%; 6·0–39·4%), vitamin A supplements (8·7%; 7·9–10·5%), and three doses of the diphtheria, tetanus toxoid, and pertussis vaccine administered (0·9%; 0·5–1·3%). Pneumonia cases reduced by 50·6% (31·3–67·3%), diarrhoea by 39·7% (24·8–62·7%), and children attending welfare clinics by 39·6% (23·5–47·1%). Cases of sexual violence increased by 8·0% (4·3–25·0%). Skilled deliveries, antenatal care, people with HIV infection newly started on antiretroviral therapy, confirmed cases of malaria, and diabetes cases detected were not significantly affected negatively. Although most of the health indicators began to recover during the pandemic, the health-care workers' strike resulted in nearly all indicators falling to numbers lower than those observed at the onset or during the pre-strike pandemic period.

Interpretation The COVID-19 pandemic and the associated health-care workers' strike in Kenya have been associated with a substantial disruption of essential health services, with the use of outpatient visits, screening and diagnostic services, and child immunisation adversely affected. Efforts to maintain the provision of these essential health services during a health-care crisis should target the susceptible services to prevent the exacerbation of associated disease burdens during such health crises.

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Division of Monitoring and Evaluation (H Kiarie MSc, N Liku MD, L Nyaga MSc, J Karimi MPH, G Gatheca MD, V Mwenda MD) **and National AIDS and STIs Control Programme** (V Oramisi MSc), **Ministry of Health, Nairobi, Kenya; Centre of Excellence in Women and Child Health, Aga Khan University, Nairobi, Kenya** (M Temmerman PhD); **Centre for Epidemiological Modelling and Analysis** (M Nyamai MSc, W Thuo MSc, L A Ombajo MMED, Prof S M Thumbi PhD), **Department of Clinical Medicine and Therapeutics, College of Health Sciences** (L A Ombajo), **and Institute of Tropical and Infectious Diseases** (Prof S M Thumbi), **University of Nairobi, Nairobi, Kenya; Paul G Allen School for Global Health, Washington State University, Pullman, WA, USA** (M Nyamai, N Liku, Prof S M Thumbi); **Options Consultancy Services, London, UK** (P Wamalwa MSc); **Institute of Immunology and Infection Research, School of Biological Sciences, University of Edinburgh, Edinburgh, UK** (Prof S M Thumbi)

Correspondence to:
Prof S M Thumbi, Centre for Epidemiological Modelling and Analysis, University of Nairobi, Nairobi 30197-00100, Kenya
thumbi.mwangi@wsu.edu

Introduction

Public health emergencies, such as disease outbreaks and epidemics, can have a substantial effect on the use of and access to essential health-care services, exacerbating morbidity and mortality from other diseases.[1–3] Data from the 2013 and 2014 Ebola virus epidemic in west Africa showed statistically significant declines in health-care use. Notable declines were observed in settings with a high incidence of Ebola cases, and inpatient care was more affected than outpatient care services.[2,4] Studies on the consequences of the Ebola epidemic have reported a decline in the use of primary health-care and maternal and child health services,[5,6] an increase in the population of children susceptible to measles and measles outbreaks associated with decreases in the number of vaccinations,[7,8] and increased malaria, HIV/AIDS, and tuberculosis deaths that were similar to or greater than the total number of deaths caused by the Ebola virus disease.[1,9,10]

Responses to the COVID-19 pandemic, such as lockdowns, stay-at-home orders, and restricted movement, as well as fear of contracting the virus in health facilities and the cancellation of elective and preventive visits to health-care facilities, have disrupted the use of different health-care services in multiple settings.[11–16] After several epidemics and their effects in the past few years, there is a recognised need for building resilient health systems that are able to protect human life and result in good health outcomes during and after a health crisis.[17] An analysis of studies on the effect of the pandemic on maternal, fetal, and neonatal outcomes has found adverse effects on these

Research in context

Evidence before this study

Health emergencies can have large effects on the provision of and access to essential health services. Maintaining these services during a health crisis is crucial to prevent the increased burden of diseases during epidemics. Few studies have investigated the effect of the COVID-19 pandemic on multiple essential health services to establish which are susceptible and which are resilient to disruptions. We searched PubMed using the terms "COVID-19", "SARS-COV-2", "disrupt", "interrupt", "effect", "impact", and "health services" up to April 20, 2022, in English. Although studies identified disruptions in essential services associated with the pandemic, a majority of the studies focused on a single category of indicators, rarely evaluating long-term trends for multiple indicators or assessing the effect of the pandemic while accounting for various non-pharmaceutical interventions, changes in attack rates over time across different regions in a country, or additional events such as health-care workers' strikes occurring during the pandemic.

Added value of this study

Our study provides a detailed assessment of the long-term trends of multiple indicators before the COVID-19 pandemic, during the pandemic, and during a nationwide health-care workers' strike that occurred amidst the pandemic in Kenya. We analysed 17 infectious and non-infectious indicators of essential health services over a 47-month period (27 months before and 20 months during the pandemic). We identified indicators that displayed a resilience to the pandemic (skilled deliveries, antenatal care, people with HIV infections newly started on antiretroviral therapy, and confirmed cases of malaria and diabetes), and those that were susceptible, either showing a decline (outpatient visits; screening and diagnostic services for HIV, tuberculosis, malaria, and cervical cancer; and child immunisation) or an increase (sexual violence). Diarrhoea and pneumonia cases and cases of children attending welfare clinics who were underweight also reduced.

Implications of all the available evidence

Our study highlights the differences in the susceptibility and resilience of essential health services, and the variation across different regions of the country. These findings underscore the need for urgent strategies by the Kenyan government and policy makers to ensure there is adequate prioritisation of resources for the susceptible essential services during health emergencies, to prevent reversing the gains made in reducing morbidity and mortality.

health indicators, especially in low-income and middle-income countries, and has shown disparities in health care within and between countries.[18,19]

This variation in the magnitude and direction of the effect on different indicators of essential health services suggests a need for more targeted interventions based on not only vulnerable populations, but also vulnerable health indicators. A few studies have estimated the effects of the COVID-19 pandemic on some indicators of essential health services in Kenya, and reported declines in both outpatient and inpatient services.[20,21] However, a comprehensive analysis examining the effect of the COVID-19 pandemic on the use of multiple health-care services, while accounting for time-varying attack rates and non-pharmaceutical interventions implemented across the country, has not been done to establish which populations are resilient or vulnerable. Monitoring the use of health-care services during the pandemic is necessary for the identification of potentially impactful negative changes in the provision of and access to health-care services, for the institution of interventions to minimise these effects, and for the allocation of resources to maintain the health of the population during and after the pandemic.

In this study, we aimed to assess the effects of the COVID-19 pandemic on the use of essential health services in Kenya by comparing key health indicators before and during the pandemic, and before and during a national health-care workers' strike occasioned by the pandemic. We aimed to identify the indicators of essential health-care services that were susceptible to disruptions caused by the pandemic, while accounting for the SARS-CoV-2 infection rates and restrictions imposed across the country; and aimed to discuss the mitigation measures put in place to maintain the use of essential services and protect public health from the indirect effects of the pandemic in Kenya.

Methods

Study design

To examine the effects of the COVID-19 pandemic on the use of essential health services, we did a retrospective time-series analysis, examining data at the county level for Kenya. Because this study used existing routine aggregated health information that does not qualify as human patient research, written informed consent was not required. The use of these data was approved by Kenya's Ministry of Health.

Data sources and outcomes

Kenya has implemented a health information system that captures health data from the lowest level of health facilities across the country, which are then reported monthly to a central national database.[22] By means of District Health Information Software (DHIS2)—the main national data aggregation platform deployed in most health facilities in Kenya and used by all public health facilities—the data are reported as aggregate numbers for each subcounty, county, and at the national level. The monthly reporting rate is calculated on the basis of the

number of registered facilities, and the number of monthly reports submitted per month. We used the reporting rate to calculate an adjusted estimate of the monthly aggregate for each county.

Using this dataset, we abstracted aggregated county-level data on indicators of the use of primary health-care services; reproductive, maternal, newborn, child, and adolescent health; sexual violence; communicable and non-communicable diseases; and the reporting rates for each indicator (appendix p 1). The indicators used were: primary health-care use, skilled deliveries, antenatal care, children presenting with pneumonia, vitamin A supplements, number of third doses of the diphtheria, tetanus toxoid, and pertussis vaccine (DTP3) administered, children attending a child welfare clinic who are underweight, children treated for diarrhoea, sexual violence, HIV tests conducted, people with an HIV infection newly started on antiretroviral therapy, number of notified tuberculosis cases, patients tested for malaria, confirmed cases of malaria, cervical cancer screening, hypertension cases, and diabetes cases.

The data were obtained as monthly aggregates for the period from January, 2018 to October, 2021. During the pandemic period, a nationwide health-care workers' strike, primarily involving clinical officers and nurses, occurred in the months of December, 2020 and January, 2021. The health-care workers were advocating for the adequate provision of personal protective equipment and insurance to protect themselves while responding to the pandemic. An exploratory data analysis on the trends of the essential health services showed four unique periods: the pre-pandemic period (from January, 2018 to February, 2020), the two pandemic periods before and after the health-care workers' strike (from March to November 2020 and February to October 2021), and the within-pandemic period when there was a national health-care workers' strike (from December, 2020 to January, 2021). The first case of SARS-CoV-2 in Kenya was reported on March 13, 2020.

We obtained data on human movement in Kenya during the pandemic period from Google and Facebook.[23,24] The Google mobility anonymised data were used to estimate the within-county human mobility. This estimate was done by comparing visits to specific categories of locations (eg, retail shops, parks, workplaces, residential areas, and public transport areas) during the pre-pandemic period (baseline) and the pandemic period. The baseline values were the median values for each day of the week over a 5-week period from Jan 3 to Feb 6, 2020. Data from Facebook were used to estimate the between-county mobility data by comparing the number of individuals moving between defined administrative regions before and during the pandemic period in Kenya. A monthly average of the between-county and within-county movement data was used as a measure of adherence to movement restrictions for each county during the pandemic period.

Data on the number of people tested and the daily cases of COVID-19 confirmed in Kenya were obtained from Kenya's Ministry of Health. A monthly attack rate (number of new cases divided by the total population per 100 000) was computed for each county and incorporated in the model. We maintained a record of the type of COVID-19 restrictions that were instituted, and the dates when these restrictions came into effect and when they were lifted (appendix p 2). For the night curfew that was implemented as a partial lockdown measure, we used data on the total number of curfew hours each month in each county and incorporated these data into the models to account for the stringency of movement restrictions.

See Online for appendix

Statistical analysis

Our analysis aimed to answer the two following questions: firstly, did the COVID-19 pandemic lead to statistically significant changes in the chosen indicators of essential health services in Kenya? Secondly, what was the direction and magnitude of the change in these indicators?

To answer these questions, we planned to: firstly, establish the monthly incidence of each indicator per county; secondly, conduct a robust mixed-effect regression model for each indicator comparing the pre-pandemic, pandemic, and health-care workers' strike periods; and thirdly, compare the estimates of the slopes for each indicator at the end of each study period and the intercept estimate of the indicators at the start of the next period to establish the magnitude of change in the indicators associated with the pandemic and the health-care workers' strike.

We estimated the population sizes and population density of each county per year using the 2019 Kenya Census Data and World Bank population growth rate estimates, which were 2·31 for 2018 and 2·27 for 2019. We assumed an estimated growth rate of 2·23 (because we assumed a 0·04 reduction in growth rate from 2·27 to 2·23, as observed between 2018 and 2019) for the years 2020 and 2021 because these data were unavailable. We calculated the incidence of each indicator per month, expressed as the number of cases per 100 000 people. For indicators that concerned women of childbearing age, we used the estimated population of women aged between 15 and 49 years to calculate the incidence of these indicators. To estimate the incidence of cervical cancer screening, we used the female population aged between 25 and 49 years, in accordance with the Ministry of Health Kenya National Cancer Screening Guidelines.[25]

To establish the effect of the COVID-19 pandemic on the use of and access to essential health services, we used a robust mixed-effect model with random intercepts and random slopes for each county over time on each of the 17 indicators of essential health services across the pre-pandemic period, the pandemic period, and the period during the health-care workers' strike.[6] The robust mixed-effect model was selected to account

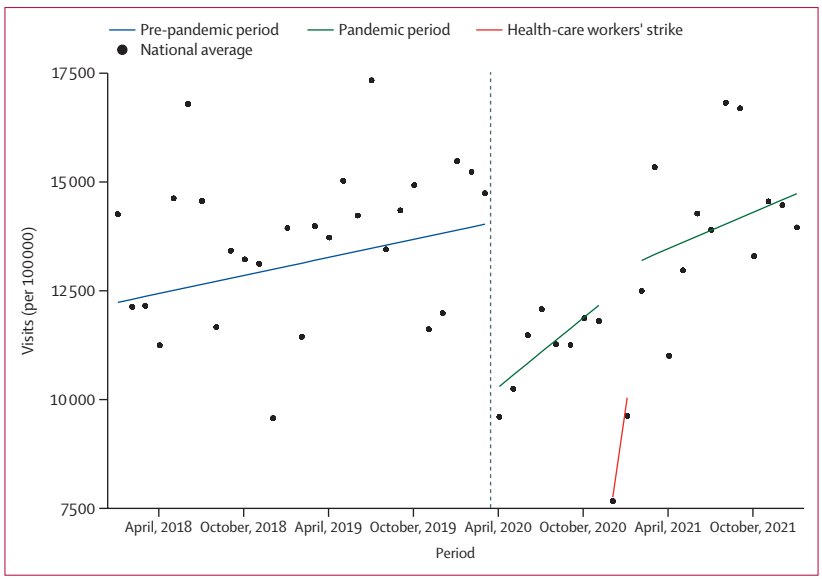

Figure 1: **Model fit for primary health-care use**
Figure shows the period before the pandemic, during the pandemic, and during the health-care workers' strike. The dashed line represents the period when the first confirmed case of SARS-CoV-2 was reported in Kenya.

For **R statistical software** see https://www.r-project.org/

for the correlation between observations from the same county, and to minimise the influence of outliers or other contamination on model estimates.[26] Before running the robust mixed-effect models, we analysed the time-series data for each indicator to test for seasonality using the Friedman rank test implemented in the R package seastest.[27] For indicators with a seasonal effect, we included the month as a fixed effect in the model. The model equations used are as shown here:

$$Y_t=\beta_0+\beta_1T_t+\beta_2X_t+\beta_3X_tT_t+\beta_4S_t+\beta_5S_tT_t+\beta_6Z_t+\beta_7 Z_tT_t+\beta_iW_t+\gamma+\varepsilon_t$$

Where Y_t represents a study indicator of essential health services, β_0 represents the estimated incidence for every indicator at the beginning of the pre-pandemic period, β_1 represents the average monthly change in the incidence over the pre-pandemic period, T_t represents the time since the start of the study period, β_2 is the change in incidence immediately after the COVID-19 period, which is represented by X_t, β_3 represents the average difference in trend in incidence between the pandemic and pre-pandemic period, β_4 is the change in incidence before and immediately after the health-care workers' strike, which is represented by S_t, β_5 represents the estimated difference between the pandemic period before the health-care workers' strike and the strike period, β_i represents other independent variables, W_t, which comprise the hours of the nationwide dusk-to-dawn curfew, mobility, attack rate, population density, and seasonality. β_6 is the change in incidence immediately after the end of the health-care workers' strike, which was still a pandemic period represented by Z_t. β_7 is the average difference in trend in incidence between the pandemic period during and after the strike period. The monthly curfew hours, mobility (both within and between countries), and attack rate were averaged for every county during the pandemic period, with a value of 0 given for the months before the pandemic. The random effects (county) were represented by γ and the error terms were represented by ε_t. The linear trend during the pandemic ($\beta_1+\beta_3$) and during the health-care workers' strike period ($\beta_1+\beta_5$) were calculated. All the analysis and data visualisation was done using R statistical software (version 4.0.2).

Role of the funding source

The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

Results

The trends in the chosen indicators of essential health services in the pre-pandemic period were heterogeneous. We observed significant positive trends in the following indicators, with an average increase in the monthly incidence of: the number of outpatient visits, skilled deliveries, children presenting with pneumonia, children attending child welfare clinic who are underweight, cases of sexual violence, people with HIV infection who newly started antiretroviral therapy, patients who tested for malaria, hypertension cases, and diabetes cases (figures 1–5). The number of notified tuberculosis cases had a negative trend, with a monthly estimated incidence of –0·1 (–0·1 to <–0·1). The trends for the rest of the indicators (antenatal care, vitamin A supplements, DTP3 doses administered, children treated for diarrhoea, number of HIV tests conducted, confirmed cases of malaria, and cervical cancer screening) had no significant increase or decrease in their average incidence during this period (table; appendix p 3).

Immediately after the onset of the pandemic in Kenya in March, 2020, there was a significant decrease in multiple health indicators. Outpatient visits reduced in April, 2020, compared with March, 2020, representing an estimated 28·7% (16·0–43·5%) decline in the use of primary health-care services. Additionally, there were significant declines in the number of children presenting with pneumonia by 50·6% (31·3–67·3%), cervical cancer screening by 49·8% (20·6–57·9%), number of HIV tests conducted by 45·3% (23·9–63·0%), children treated for diarrhoea by 39·7% (24·8–62·7%), underweight children attending a child welfare clinic by 39·6% (23·5–47·1%), patients tested for malaria by 31·9% (16·7–46·7%), number of notified tuberculosis cases by 26·6% (14·7–45·1%), hypertension cases by 10·4% (6·0–39·4%), those receiving vitamin A supplements by 8·7% (7·9–10·5%), and the number of DTP3 doses administered by 0·9% (0·5–1·3%). Cases of sexual violence increased by 8% (4·3–25·0%). The rest of the indicators (skilled deliveries, antenatal care, people with HIV infection who newly started on

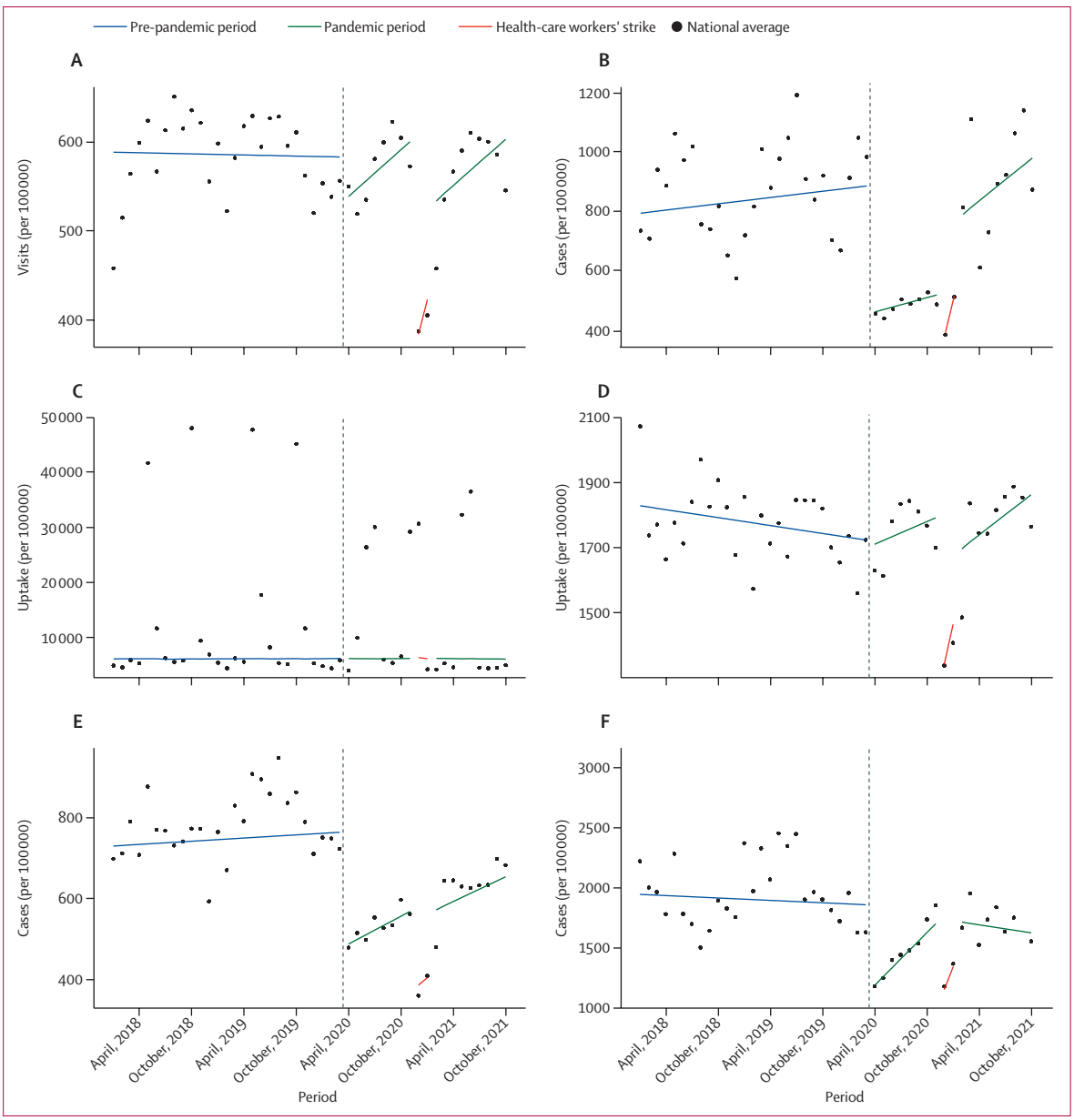

Figure 2: **Model fit for reproductive, maternal, and newborn and adolescent health indicators**
Figure shows the period before the pandemic, during the pandemic, and during the health-care workers' strike. The dashed line represents the period when the first confirmed case of SARS-CoV-2 was reported in Kenya. The indicators shown are antenatal care visits (A), children presenting with pneumonia (B), vitamin A supplements (C), three doses of the diphtheria, tetanus toxoid, and pertussis vaccine administered (D), children attending a child welfare clinic who are underweight (E), and children treated for diarrhoea (F).

antiretroviral therapy, confirmed cases of malaria, and diabetes cases) did not decrease significantly after the onset of the pandemic in the country (table).

After the nadir of most indicators of essential health after the start of the pandemic in Kenya, there were statistically significant monthly increases in the incidence (per 100 000 people) of outpatient visits (199·0; 95% CI 91·0 to 306·0), the administration of vitamin A supplements (274·0; 27·0 to 521·0), the number of HIV tests conducted (36·0; 19·0 to 53·0), cervical cancer screening (15·0; 10·0 to 19·0), children treated for diarrhoea (77·0; 59·0 to 95·0), DTP3 doses administered (12·0; 5·0 to 20·0), underweight children attending a child welfare clinic (10·0; 3·0 to 17·0), antenatal care (9·0; 5·0 to 13·0), diabetes cases (1·0; 0·3 to 2·0) and number of notified tuberculosis cases (0·3; 0·1 to 0·5) during the pandemic period and before the national health-care workers' strike. Cases of sexual violence continued to increase at an incidence of 0·7 (0·5 to 1·0) monthly. We observed a significant negative trend in the

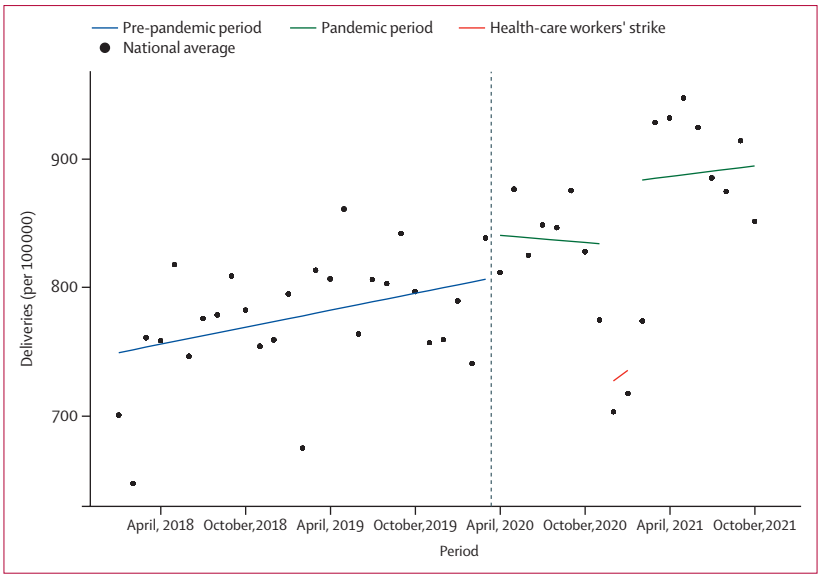

Figure 3: **Model fit for skilled deliveries**
Figure shows the period before the pandemic, during the pandemic, and during the health-care workers' strike. The dashed line represents the period when the first confirmed case of SARS-CoV-2 was reported in Kenya.

incidence of people with HIV infection newly started on antiretroviral therapy (–0·5; –0·7 to –0·2) and confirmed cases of malaria (–8·0; –14·0 to –2·0). The trends of several indicators (skilled deliveries, children presenting with pneumonia, patients tested for malaria, and hypertension cases) did not show statistically significant changes during this period (table; figures 1–5).

Immediately after the health-care workers' strike began, all indicators, including those that had been resilient during the pandemic, declined to numbers that were much lower than during the pandemic, except for the number of notified tuberculosis cases, which increased slightly by 0·3 (95% CI 0·2–0·5). During and after the strike period, we observed a continued recovery of the numbers for most indicators. Outpatient visits continued to increase, recovering to monthly estimates higher than those observed at the start of the pandemic (figure 1). Statistically significant increases were observed for outpatient visits, antenatal care visits, children presenting with pneumonia, DTP3 doses administered, underweight children attending child welfare clinics, cases of sexual violence, and patients tested for malaria in the pandemic period after the health-care workers' strike (table). Several indicators, including skilled deliveries, children treated for diarrhoea, HIV tests conducted, number of notified tuberculosis cases, confirmed cases of malaria, cervical cancer screening, and number of hypertension cases did not show statistically significant changes during the period after the health-care workers' strike (table).

Discussion

In this study, we provide a comprehensive analysis of routine surveillance data on 17 indicators of essential health services collected during the pre-pandemic (27 months) and pandemic (20 months) periods in Kenya. Using these data, we estimated the immediate effects and the trends in these indicators at the onset and during the COVID-19 pandemic in the country. We established the indicators that were susceptible (adversely affected by the pandemic) and those that were resilient (had relatively unchanged trends throughout the pandemic) to the COVID-19 pandemic, and the health-care workers' strike that occurred during the same period. We report a mixture of effects of the pandemic, with several key services (the use of primary health care measured through outpatient visits; screening and diagnostic services for HIV, tuberculosis, malaria, cervical cancer, and hypertension; and people with HIV infection newly started on antiretroviral therapy) showing susceptibility to the onset of the pandemic through large and significant declines, whereas other indicators (skilled deliveries and antenatal care) were resilient and largely unaffected at the onset of and during the pandemic.

It is argued that resilient health systems include those that are able to provide adequate and effective care in response to a health crisis, while maintaining the provision of essential health services and producing good health outcomes for all.[17] The onset of the pandemic was associated with a large decline in the number of outpatient visits compared with the pre-pandemic period. A similar reduction in the use of primary health-care services induced by the pandemic has been reported across multiple countries.[15] Understanding the effect of this missed care (increased morbidity or mortality), or absence of it (no harm caused), and knowing which specific outpatient care was least prioritised is crucial for improving preparedness to minimise these declines in use and their effect during future health threats. Such effects have included an increase in out-of-hospital cardiac arrests, as has been reported in France,[28] or decreased antibiotic prescriptions associated with decreased hospital visits.[29]

The negative effects of the pandemic observed in Kenya on the provision of essential services, including testing for HIV and malaria, cervical cancer screening, those newly started on antiretroviral therapy, and tuberculosis case notifications has been reported in multiple countries in Africa.[30,31] Available anecdotal evidence points to declines in the use of health services, such as testing for HIV or the initiation of antiretroviral therapy, being caused by less available space in clinics because of physical distancing, clinicians not having adequate personal protective equipment, reduced opening times for clinics because of lockdowns and curfews, and the diversion of staff working on HIV to COVID-19 response activities.[31–34] The negative effect of the pandemic on HIV programmes might have been ameliorated by the mitigation measures that were implemented early on in the pandemic to retain people on HIV treatment,

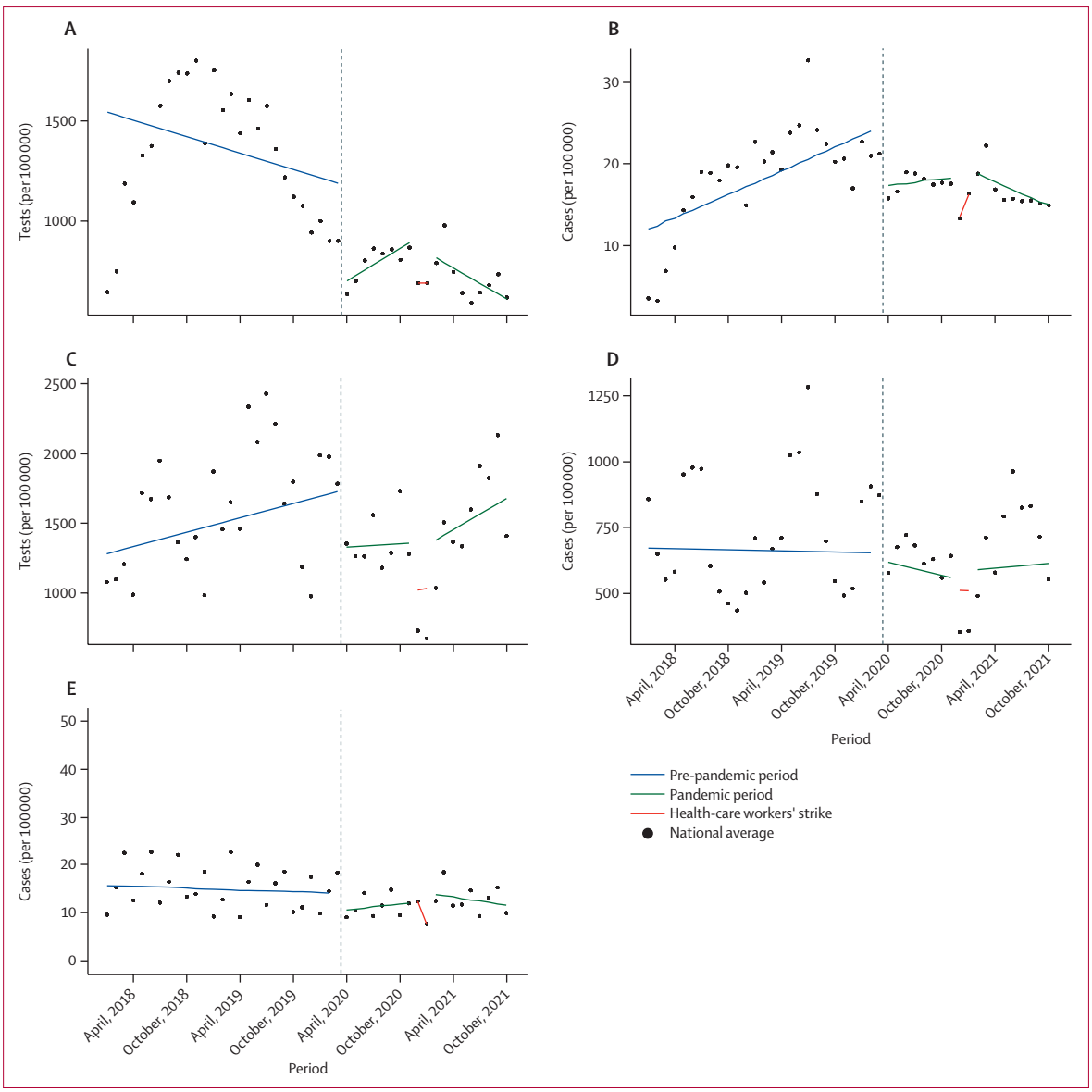

Figure 4: **Model fit for indicators of communicable diseases**
Figure shows the period before the pandemic, during the pandemic, and during the health-care workers' strike. The dashed line represents the period when the first confirmed case of SARS-CoV-2 was reported in Kenya. The indicators shown are HIV tests conducted (A), people with HIV infection newly started on antiretroviral therapy (B), patients tested for malaria (C), confirmed cases of malaria (D), and the number of notified cases of tuberculosis (E).

including the provision of a 3-month supply of antiretroviral therapy (ART), the promotion of inter-facility and community ART pick-up points, outreach innovations including the use of virtual outreaches, and the increased use of HIV self-testing kits.[32]

Previous studies have associated disruptions to essential health services with several different factors, including the halting of preventive and elective procedures, the fear of patients contracting infections at health facilities, the redirecting of resources and personnel away from regular health services to address the pandemic, as well as responses such as restricted movement aimed at reducing disease spread.[5,35] For the COVID-19 pandemic, some of the analysis of the relative contribution of these different factors has suggested that it was the immediate health-care response, rather than the restrictive measures such as lockdown, that might have contributed to the heterogeneity observed for many indicators of essential health services.[19] A comparison of essential health services across multiple low-income, middle-income, and high-income countries revealed no particular patterns of disruptions by the income grouping of the country or the intensity of the pandemic, but the disruptions often preceded the waves of the pandemic.[16]

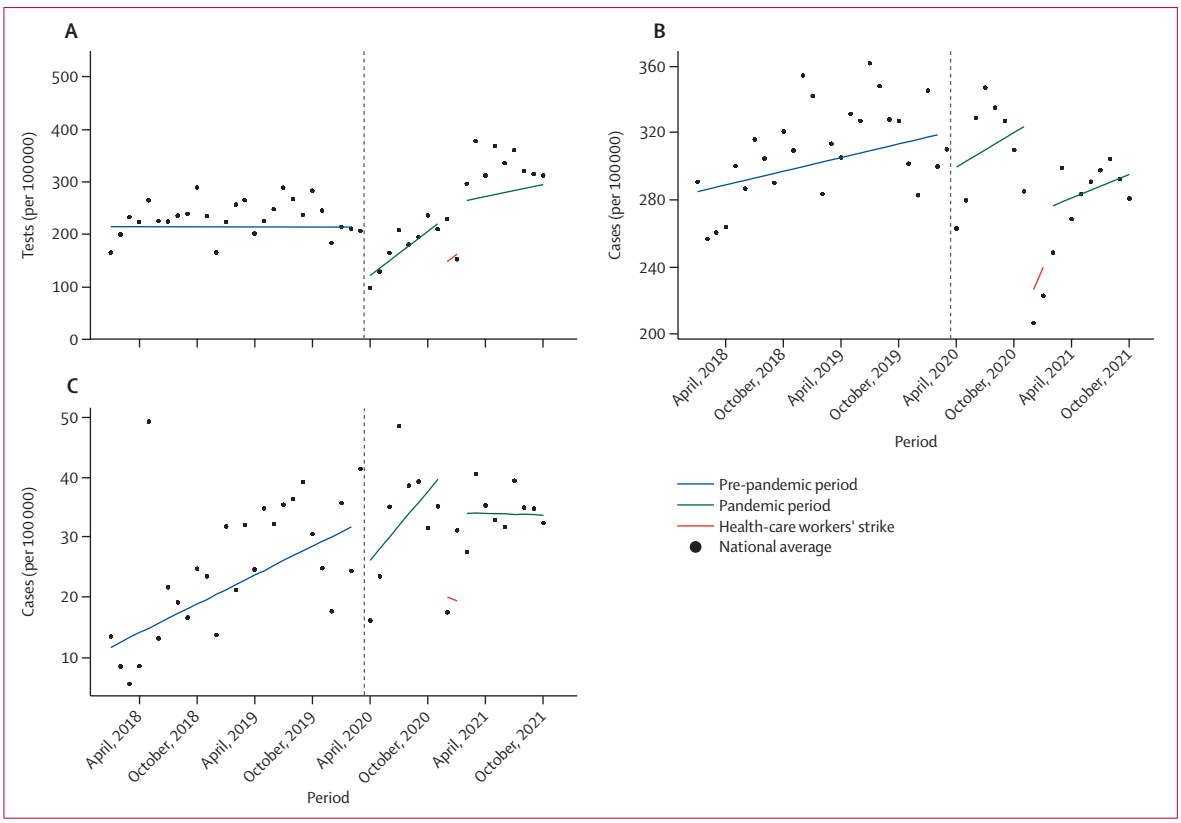

Figure 5: **Model fit for indicators of non-communicable diseases**
Figure shows the period before the pandemic, during the pandemic, and during the health-care workers' strike. The dashed line represents the period when the first confirmed case of SARS-CoV-2 was reported in Kenya. The indicators shown are cervical cancer screening tests (A), hypertension cases (B), and diabetes cases (C).

Although the decline in outpatient visits in Kenya was recovering over time during the pandemic, there was a renewed decline during the health-care workers' strike. Multiple countries have reported health-care workers' strikes during the pandemic.[36] Nearly all indicators of essential health services were negatively affected by the health-care worker crisis within the pandemic, highlighting the need for investments in the health system, including human resources.

Maternal health indicators, including attendance at antenatal care clinics and deliveries in health facilities, showed resilience to significant change over the pandemic period, only decreasing in December, 2020 because of the health-care workers' strike, and recovering from February, 2021 onwards after the strike had ended. This resilience of these maternal health indicators is unexpected, given that other studies have shown these to be adversely affected in many low-income and middle-income countries.[11,19,35] The resilience might be because of the early issuance of permits to allow the movement of expectant mothers during curfew hours, initiatives such as the Wheels for Life ambulance system that transports pregnant mothers to health facilities during curfew hours, the issuance of guidelines on the continuity of reproductive and maternal health services, and possible commitments by the pregnant women to deliver in hospitals despite the prevailing pandemic because they had already preplanned antenatal care and their deliveries.

For more on **Wheels for Life** see https://khf.co.ke/w4l/

The decline in cases of children presenting with pneumonia and those treated for diarrhoea might be associated with COVID-19 preventive measures, including school closures, handwashing, physical distancing, and wearing masks, which reduces contact and therefore probably reduced the transmission of pneumonia and diarrhoea. A similar decrease in the number of pneumonia cases among children has been reported, even as excess pneumonia cases were reported during the COVID-19 pandemic for those older than 15 years.[37]

Sexual violence cases increased sharply after the onset of the pandemic in March, 2020, and were high during the pandemic. Studies reported similar increases during other health emergencies and disasters, with factors such as increased financial pressure, challenges in seeking legal or medical services, sexual and reproductive health workers having a lower capacity to appropriately respond to sexual and gender-based violence cases as a result of disrupted referral pathways to health facilities, and psychological health issues related to isolation, loneliness, and uncertainty, threatening the safety of women.[38,39]

	Pre-pandemic period (from January, 2018 to February, 2020)		Pandemic period before the health-care workers' strike (from March, 2020 to October, 2021)		Health-care workers' strike period (from December, 2020 to January, 2021)		Pandemic period after the health-care workers' strike (from February, 2021 to October, 2021)	
	Incidence of each indicator at the beginning of the period	Average monthly change	Incidence of each indicator at the beginning of the period	Average monthly change	Incidence of each indicator at the beginning of the period	Average monthly change	Incidence of each indicator at the beginning of the period	Average monthly change
Outpatient visits	11 937·0 (10 433·0 to 13 040·0)	68·0 (47·0 to 88·0)*	−4106·0 (−3930·0 to −4115·0)	199·0 (91·0 to 306·0)*	−4462·0 (−3508·0 to −4580·0)	2136·0 (1164·0 to 3108·0)*	3198·0 (3045·0 to 3284·0)	188·0 (98·0 to 278·0)*
Skilled deliveries	745·0 (557·0 to 933·0)	2·0 (1·0 to 3·0)*	42·0 (41·0 to 45·0)	−3·0 (−7·0 to 0·2)	−117·0 (−123·0 to −115·0)	−5·0 (−27·0 to 38·0)	168·0 (167·0 to 169·0)	−1·0 (−4·0 to 2·0)
Antenatal care	583·0 (542·0 to 625·0)	−0·4 (−1·3 to 0·4)	−47·0 (−46·0 to 50·0)	9·0 (5·0 to 13·0)*	−224·0 (−287·0 to −180·0)	38·0 (6·0 to 71·0)*	122·0 (123·0 to 124·0)	9·0 (6·0 to 12·0)*
Children presenting with pneumonia	775·0 (675·0 to 876·0)	3·0 (1·0 to 5·0)*	−465·0 (−469·0 to −463·0)	5·0 (−6·0 to 15·0)	−137·0 (−141·0 to −132·0)	121·0 (26·0 to 216·0)*	302·0 (296·0 to 303·0)	19·0 (10·0 to 29·0)*
Vitamin A supplements	4898·0 (3962·0 to 5833·0)	11·0 (−24·0 to 45·0)	−6318·0 (−6744·0 to −5583·0)	274·0 (27·0 to 521·0)*	1346·0 (1302·0 to 1370·0)	−1192·0 (−1418·0 to −965·0)*	3653·0 (−3403·0 to 3505·0)	−690·0 (−895·0 to −484·0)*
DTP3 doses administered	1827·0 (1772·0 to 1881·0)	−1·0 (−4·0 to 2·0)	−11·0 (−14·0 to −16·0)	12·0 (5·0 to 20·0)*	−462·0 (−469·0 to −464·0)	28·0 (−63·0 to 118·0)	259·0 (252·0 to 267·0)	21·0 (15·0 to 28·0)*
Children attending a child welfare clinic who are underweight	648·0 (525·0 to 770·0)	2·0 (0·2 to 4·0)*	−320·0 (−324·0 to −319·0)	10·0 (3·0 to 17·0)*	−215·0 (−301·0 to −201·0)	16·0 (−48·0 to 79·0)	150·0 (−149·0 to 159·0)	9·0 (3·0 to 15·0)*
Children treated for diarrhoea	1878·0 (1705·0 to 2050·0)	−4·0 (−7·0 to 0·1)	−751·0 (−778·0 to −525·0)	77·0 (59·0 to 95·0)*	−626·0 (−839·0 to −607·0)	195·0 (31·0 to 358·0)*	404·0 (391·0 to 412·0)	−9·0 (−25·0 to 6·0)
Sexual violence	20·0 (16·0 to 23·0)	0·1 (0·1 to 0·2)*	3·0 (0·5 to 5·0)	0·7 (0·5 to 1·0)*	−13·0 (−15·0 to −8·0)	−2·0 (−5·0 to 0·3)	5·0 (3·0 to 12·0)	0·2 (<0·1 to 0·4)*
HIV tests conducted	1231·0 (913·0 to 1548·0)	−7·0 (−14·0 to 0·3)	−569·0 (−577·0 to −567·0)	36·0 (19·0 to 53·0)*	−206·0 (−223·0 to −195·0)	13·0 (−141·0 to 168·0)	136·0 (−123·0 to 143·0)	−14·0 (−28·0 to 1·0)
People with an HIV infection newly started on antiretroviral therapy	8·0 (6·0 to 11·0)	0·5 (0·4 to 0·5)	−9·0 (−16·0 to 5·0)	−0·5 (−0·7 to −0·2)*	−5·0 (−11·0 to −4·0)	2·0 (0·4 to 4·0)*	3·0 (2·0 to 4·0)	−1·0 (−1·3 to −0·9)*
Number of notified tuberculosis cases	15·0 (13·0 to 17·0)	−0·1 (−0·1 to <−0·1)*	−4·0 (−5·0 to −2·0)	0·3 (0·1 to 0·5)*	0·3 (0·2 to 0·5)	−5·0 (−6·0 to −3·0)*	7·0 (3·0 to 17·0)	<−0·1 (−0·2 to 0·2)
Patients tested for malaria	881·0 (625·0 to 1137·0)	15·0 (11·0 to 18·0)	−599·0 (−609·0 to −595·0)	−13·0 (−30·0 to 5·0)*	−701·0 (−707·0 to −679·0)	−3·0 (−161·0 to 155·0)	568·0 (554·0 to 577·0)	20·0 (4·0 to 36·0)*
Confirmed cases of malaria	354·0 (215·0 to 493·0)	0·1 (−0·9 to 1·1)	−132·0 (−120·0 to 151·0)	−8·0 (−14·0 to −2·0)*	−258·0 (−270·0 to −247·0)	−2·0 (−57·0 to 52·0)	299·0 (296·0 to 310·0)	4·0 (−1·0 to 9·0)
Cervical cancer screening	191·0 (145·0 to 236·0)	−1·0 (−2·0 to 1·0)	−120·0 (−123·0 to −114·0)	15·0 (10·0 to 19·0)*	−3·0 (−11·0 to −1·0)	13·0 (−28·0 to 55·0)	188·0 (125·0 to 201·0)	3·0 (−1·0 to 7·0)
Hypertension cases	212·0 (163·0 to 261·0)	2·0 (1·5 to 3·0)	−36·0 (−43·0 to −14·0)	2·0 (<−0·1 to 4·0)	−117·0 (−150·0 to −87·0)	12·0 (−7·0 to 31·0)	51·0 (48·0 to 54·0)	1·0 (−1·0 to 2·0)
Diabetes cases	67·0 (49·0 to 84·0)	1·0 (0·7 to 1·2)*	−8·0 (−11·0 to 10·0)	1·0 (0·3 to 2·0)*	−23·0 (−25·0 to −22·0)	−1·0 (−9·0 to 7·0)	3·0 (2·0 to 4·0)	−1·0 (−1·6 to −0·3)*

Data are presented as incidence (95% CI). The estimates are for the starting values and the change per month for each indicator for the pre-pandemic period (from January, 2018 to February, 2020), pandemic period (from March to November, 2020 and February to October, 2021), and the period during the national health-care workers' strike (from December, 2020 to January, 2021). DTP3=three doses of the diphtheria, tetanus toxoid, and pertussis vaccine. *p value <0·05.

Table: **Estimates on the effect of the COVID-19 pandemic on specific indicators of use of essential health services**

To mitigate the low uptake in health services use, Kenya's Ministry of Health established a working group on the maintenance of essential services to ensure that the increased indirect morbidity and mortality because of the COVID-19 pandemic were prevented and mitigated. Specific actions identified by the working group and implemented to ensure the continuity of essential services included: the prioritisation of essential health services and the adaptation of service delivery systems to changing contexts as the pandemic evolved, the development and dissemination of guidelines to health-care managers on the provision of essential health services during the COVID-19 pandemic in Kenya, recommending key governance and coordination mechanisms needed to support timely action such as strengthening coordination and communication linkages between county and national departments to support essential services, and developing and sending messages to amplify key public health awareness and catalysing conversations with communities to prevent and reduce

the spread of COVID-19, especially for groups at a high risk. These actions, priorities, and recommendations were communicated regularly to the national COVID-19 response and management taskforce and were also disseminated to the subnational levels for actioning.

The main study limitation was that our data were mainly drawn from the national reporting system (DHIS2), which is predominantly used by public, non-governmental, and faith-based health facilities. Private facilities, which provide health care to approximately a third of the population in Kenya, do not report regularly into the DHIS2 system, making the data not fully representative of the Kenyan population. Although the robust mixed-effect regressions addressed the limitation associated with outliers, our use of aggregate data at the county level did not include any subcounty or health-facility-level data quality audits and did not confirm the consistency, validity, or reliability of the data. The inclusion of covariates including attack rates, partial lockdowns through curfew, and movement restrictions did not accurately measure the amount of adherence to these restrictions, which might bias the estimates on the effect of the pandemic on essential health services. Although we observed changes in essential health services associated with the pandemic and the health-care workers' strike, it is plausible there might be additional unknown factors that might have resulted in the observed changes.

By assessing the patterns of multiple indicators of essential health services before and during the COVID-19 pandemic, we have revealed the variations in the effect of the pandemic on these indicators. We underscore the need for careful monitoring and immediate mitigation responses to minimise the excess mortality and morbidity from other diseases that might be associated with vertical responses to a public health threat that ignore the need for the maintenance of essential health services. The identification of which indicators of essential health services are susceptible and which are resilient is important for targeting interventions, and in the prioritisation of resources to minimise the effect of the pandemic and reduce the risk of reversing progress and gains made in public health in Kenya.

Contributors

HK, MT, and SMT conceptualised the study. All authors designed the methods. HK, MN, WT, and SMT curated the data and validated the data. MN and SMT analysed and visualised the data. HK and SMT did the supervision and project administration. MN, HK, and SMT accessed and verified the data. HK, MT, SMT, NL, VO, LN, JK, PW, GG, VM, and LAO reviewed and edited the final draft.

Declaration of interests

We declare no competing interests.

Data sharing

The data and the data analysis codes used for this manuscript are available at: https://osf.io/8smjq/.

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