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Resilience of routine childhood immunization services in two counties in Kenya in the face of the COVID-19 pandemic

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Abstract

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Author contributions

M.K.N., E.O., J.D., N.O. and G.E.O. conceptualized the study. C.M., N.O. and J.D. developed the methodology for the study. R.J., P.K., L.I. and M.E. supervised the study. D.W., P.O. provided study approvals, supervision and project administration. R.J., P.K., J.G., E.N. and I.B. supervised the study. J.K., J.M., P.W., S.M., P.R., J.D. and H.M. were responsible for data collection and project administration. H.M., C.N., E. O., J.D. and M.K.N. developed the analysis plan of the manuscript. J.A., H.M. and C.N. carried out data analysis and curation. H.M., C.N. and J.D. developed the first draft of the manuscript. M.K.N., G.E.O., M.E. and L.I. acquired the financial support for the project. All authors reviewed the final manuscript and approved its submission for publication.

Informed consent statement

Written informed consent was obtained from the participants involved in the study.

Data availability statement

The data presented in this study are available upon request from the corresponding author.

Disclaimer

The findings and conclusions in this report are those of the author(s) and do not necessarily represent the official position of the Centers for Disease Control and Prevention/the Agency for Toxic Substances and Disease Registry.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

The recently emerged coronavirus disease 2019 (COVID-19) has caused considerable morbidity and mortality worldwide and disrupted health services. We describe the effect of the COVID-19 pandemic on utilization of childhood vaccination services during the pandemic. Using a mixed methods approach combining retrospective data review, a cross-sectional survey, focus group discussions among care givers and key informant interviews among nurses, we collected data between May and September 2021 in Mombasa and Nakuru counties. Overall, there was a <2 % decline in the number of vaccine doses administered during the pandemic period compared to the pre-pandemic period but this was statistically insignificant, both for the pentavalent-1 vaccine (ß = −0.013, p = 0.505) and the pentavalent-3 vaccine (ß = −0.012, p = 0.440). In government health facilities, there was 7.7 % reduction in the number of pentavalent-1 (ß = −0.08, p = 0.010) and 10.4 % reduction in the number of pentavalent-3 (ß = −0.11, p < 0.001) vaccine doses that were administered during the pandemic period. In non-government facilities, there was a 25.8 % increase in the number of pentavalent-1 (ß=0.23, p < 0.001) and 31.0 % increase in the number of pentavalent-3 (ß = −0.27, p < 0.001) vaccine doses that were administered facilities during the pandemic period. The strategies implemented to maintain immunization services during the pandemic period included providing messaging on the availability and importance of staying current with routine vaccination and conducting catch-up vaccinations and vaccination outreaches. Our findings suggest that the COVID-19 pandemic did not impact childhood vaccination services in Mombasa and Nakuru counties in Kenya. The private health facilities cushioned vaccination services against the effects of the pandemic and the strategies that were put in place by the ministry of health ensured continuation of vaccination services and encouraged uptake of the services during the pandemic period in the two counties in Kenya. These findings provide useful information to safeguard vaccination services during future pandemics.

Keywords

COVID-19; Pandemic; Vaccination; Essential health services; Kenya

1. Introduction

The coronavirus disease 2019 (COVID-19) has caused considerable morbidity and mortality worldwide since the disease was declared a pandemic by the World Health Organization (WHO) [1]. As of 25th July 2022, 575 million cases and 6.4 million deaths had been reported globally [2], with 337,339 cases and 5,670 deaths in Kenya (case fatality rate = 1. 7 %) [3]. Kenya confirmed its first case of severe acute respiratory syndrome corona virus 2 (SARS-CoV-2) on 13th March 2020 [4] and was experiencing the fifth wave of the pandemic by December 2021 [5]. In an effort to contain the spread of SARS-CoV-2, the government of Kenya implemented several measures including closure of international borders and learning institutions, movement restrictions, mandatory face mask wearing in public places, physical distancing, and suspension of mass gatherings [6].

Beyond the direct impact of the COVID-19 pandemic on the health of the Kenyan population, the pandemic also strained the health care system due to limited health infrastructure and redirection of resources to fight the pandemic [7,8]. This strain, combined with public anxiety around the pandemic and the public health mitigation measures, all

posed a risk to peoples' ability to access and utilize health services, such as routine vaccination [9,10]. Despite childhood vaccination significantly reducing morbidity and mortality from vaccine preventable diseases (VPDs) [11], one in every five African children do not receive basic childhood vaccines [12,13]. This is due to factors such as inadequate information on vaccines, misconceptions about vaccines, negative perceptions about vaccines, inaccessibility of health facilities, and poor provider-client relationships, all of which affect vaccine uptake [13,14]. As with other public health emergencies, the COVID-19 pandemic and the accompanying mitigation measures may have worsened access to and utilization of vaccination services [15].

Global disruptions in routine vaccination services were documented particularly in the early phases of the COVID-19 pandemic [16]. Similar trends have been shown in the past with other disease outbreaks that resulted in disruptions in vaccination service delivery with subsequent increases in mortality and morbidity related to VPDs such as measles and polio [17–20]. The past lessons from the Ebola outbreaks in West Africa on the breakdown of the public health care system and epidemics of VPDs [18] highlighted the need for preparations to maintain routine vaccination services during the COVID-19 pandemic. To address this challenge, WHO provided guidelines that prioritized continuation of vaccination services during the COVID-19 pandemic, with an emphasis on catch up vaccination strategies for those that had missed scheduled vaccines [12,13].

In Kenya, as part of pandemic preparedness and response in the early phases of the pandemic, the Ministry of Health (MoH) distributed protocols to guide continuity of routine vaccination services to health facilities [21]. Guidelines by the MoH for health facilities included limiting the number of clients present during a vaccination session by holding several vaccination sessions at scheduled intervals to avoid overcrowding, providing separate spaces for vaccination away from sick patients, screening clients for COVID-19 symptoms and exposure, and minimizing exposure by asking patients to stay away from hospitals for non-urgent matters. Health facilities were also expected to inform the public on availability of vaccination services with support from community health volunteers and ensure that healthcare workers (HCWs) had personal protective equipment and hand hygiene facilities [22–24]. While these measures may have slowed down COVID-19 transmission [24], minimal data are available on their effect on the uptake of routine childhood vaccinations. We sought to investigate the possible impact of the COVID-19 pandemic and its mitigation measures on utilization of immunization services, and the strategies that were implemented by health facilities to support vaccination services during the pandemic. We used the pentavalent vaccine that consists of vaccine against diphtheria, pertussis, tetanus, hepatitis B and haemophilus influenzae type b to assess the effect of the pandemic on immunization services. Pentavalent vaccine is administered in three doses; the first dose (pentavalent-1) is administered at 6 weeks of age, followed by two more doses (pentavalent-2 and 3) administered at 4-week intervals. Pentavalent vaccine is used as an indicator for health system performance with pentavalent-1 and pentavalent-3 used to calculate accessibility and utilization of immunization indicators, respectively [25,26]. The findings from the study are intended to provide useful information to safeguard this essential health service during future pandemics.

2. Methods

2.1. Study sites

We conducted this study in Mombasa and Nakuru counties of Kenya between May and September 2021. Mombasa county is predominantly urban and is located in the coastal region [27] while Nakuru county is located in the Rift Valley region and has a mix of urban and rural populations [28]. Both counties were COVID-19 hotspots and reported high positivity rates of SARS-CoV-2 infections in the community throughout the study period [29,30]. Nakuru has 11 sub-counties and we purposively selected two rural sub counties (Njoro and Molo) and one peri-urban sub-county (Nakuru North) for the study based on ease of access. In Mombasa, we selected three (Jomvu, Likoni and Kisauni) out of the six urban sub counties.

2.2. Study design

Using a mixed methods approach we conducted a retrospective data review and cross-sectional survey to describe the provision of vaccination services in selected sub counties in Mombasa and Nakuru counties and evaluated vaccine uptake before (1st April 2019 to 31st March 2020) and after the first COVID-19 case was reported in Kenya in March 2020 (1st April 2020 to 31st March 2021) at the health facilities. In addition, we held focus group discussions and key informant interviews to identify possible barriers to optimal vaccination coverage during the pandemic.

For the cross-sectional survey and retrospective data review, we stratified health facilities by ownership (as government owned, private, or faith based); and by Kenya Essential Package for Health (KEPH) status as level 2 (dispensaries), level 3 (health centers), or level 4 (sub-county referral hospitals) [31] (Table 1). We then randomly selected one government-owned, private, and faith-based facility from each KEPH level.

In Mombasa, the level 2,3 and 4 health facilities that were selected for the study administered 28.2 %, 26.3 % and 30.8 % respectively of the total number of pentavalent 1 vaccine that were administered in the county per level in the year 2021. In Nakuru, the level 2,3 and 4 health facilities that were selected for the study administered 5.4 %, 9.1 % and 26.1 % respectively of the total number of pentavalent 1 vaccine that were administered in the county per level in the year 2021. This difference between the two counties in proportion of the vaccines administered in the health facilities relative to the vaccines administered in the entire county was due to the varying size of the two counties given that Mombasa County is small in size and has only 6 sub counties hence few health facilities while Nakuru county is expansive and has a total of 11 sub counties with many health facilities.

For the qualitative study, participants were purposively selected. Key informants were nurses who were identified by the county expanded programme on immunization (EPI) officer among healthcare workers providing vaccination services at health facilities within the participating sub counties while recruitment of the focus group discussion participants was done through community health volunteers. The focus group discussion participants were residents of the participating sub counties and adult care givers/parents of children aged ≤2 years as most childhood vaccinations in Kenya are given to children aged <2 years.

2.3. Data collection

Quantitative data were collected in 35 health facilities using a structured survey tool that was designed for this study and administered by trained research assistants. A pilot test was conducted in four health facilities in Mombasa county where the healthcare worker in charge of vaccination services was interviewed to establish the data collection tool's utility and modifications made. We conducted one survey per facility, targeting the healthcare worker in charge of routine vaccination services at the health facility. We collected data on the health facility characteristics, the effect of COVID-19 pandemic on utilization of immunization services, COVID-19 mitigation strategies that impacted patients' access to care, measures that health facilities took to minimize interruption to vaccination services, and strategies that were implemented by the facilities for catch up on vaccinations. The response categories for the open-ended questions were categorized before analysis. Additionally, retrospective data on the monthly numbers of the first and third doses of pentavalent vaccine administered were abstracted from daily vaccination tally sheets from April 2019 to March 2021. Where data was missing from the daily immunization tally sheets, which is the source document for routine data on immunization, data from the health facility monthly vaccination summary reports were used. To minimize errors, double data entry was carried out in Microsoft Excel by two independent research assistants and conflicting data entries were reconciled by referencing the source records.

Qualitative data were collected using 12 focus group discussions (2 per sub county) and 18 key informant interviews (3 per sub county) to identify perceived barriers to uptake of vaccines and the impact of the pandemic on immunization services. The focus group discussions were conducted between May and September 2021 in the local language among caregivers of children <2 years and comprised 10–12 people. Of the two focus group discussions held in each sub county, one comprised of men and the other women to ensure gender parity in representation of the caregivers and that specific perspectives were collected without undue influence from either gender. The key informant interviews were conducted among the nurses working in the immunization clinic. The focus group discussions lasted between 45 and 90 min while the key informant interviews lasted for between 30 and 60 min each and the interviews were recorded on audio tapes and note-books. The qualitative experts used interview guides when conducting the focus group discussions and key informant interviews. The research assistant transcribed the audio recordings which the qualitative expert reviewed for quality assurance.

2.4. Data analysis

2.4.1. Quantitative data analysis—We summarized the characteristics of health facilities and compared differences between government and non-government health facilities using the chi-square test or Fisher's exact test, where necessary. To account for over dispersion and observed seasonal trends in vaccination, we used a time series maximum likelihood estimation method employing a negative binomial regression to model and assess the potential effect of the COVID-19 pandemic on administration of pentavalent-1 and pentavalent-3 vaccines. Considering the seasonality of vaccine uptake, the categorical month variable which was an indicator of the individual months and time which was an indicator of the pre-pandemic, or the pandemic period were used as exploratory variables. Differences in

doses administered in the two time periods were assessed overall and comparing government and non-government health facilities using negative binomial regression models and risk ratios and p-values reported. Although the first case of COVID-19 in Kenya was reported on March 12th, 2020, we used 1st April 2020 as the comparison point to compare vaccine uptake before (1st April 2019 to 31st March 2020 – pre-pandemic period) and after pandemic onset (1st April 2020 to 31st March 2021 – pandemic period), allowing the 2 weeks (March 14–31, 2020) for government containment measures to take effect. Statistical significance was considered at a p-value <0.05. Data were analyzed using STATA version 15.0.

2.4.2. Qualitative data analysis—The audio recordings were transcribed and translated into English. The transcripts were then uploaded on NVIVO software version 12.5.0 for analysis. Analysis involved coding the transcripts under the emerging sub-themes.

2.4.3. Ethical considerations—This study protocol was approved by the Kenya Medical Research Institute (KEMRI/SERU/CGHR/344/4087) and reliance approval was provided by Washington State University Institutional Review Board based on in-country ethical approvals. This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy as provided for in the Code of Federal Regulations (45 C.F.R part 46 and 21 C.F.R. part 56). Verbal consents were obtained from healthcare workers participating in the cross-sectional survey, while written consents were obtained from all focus group discussion and key informant interview participants prior to initiation of any study activity.

3. Results

3.1. Health facility and study participants' profiles

A total of 35 out of the 124 health facilities (28.2 %) that provided vaccination services in the two counties were selected for the study (Table 2). Of the 35 health facilities that participated in the study, 18 (51.4 %) were from Nakuru County and 17 (48.6 %) from Mombasa County. Overall, out of the possible 92 level 2 health facilities in the six sub counties, 17 (18.5 %) were selected for the study, out of the possible 20 level 3 facilities, 12 (60.0 %) were selected for the study and out of the 12 level four health facilities, half (50.0 %) were selected for the study.

All the 18 key informants were nurses aged between 25 and 55 years, of which 8 (44.4 %) had worked at the immunization department for at least five years or more. More than three-fourths (77.8 %) of the key informants were female. An equal number of men (N = 73) and women (N = 73) participated in the 12 focus group discussions.

We presented survey results together with the interview data to provide context and to help explain the findings from the survey.

3.2. Provision of vaccination services during the pandemic

Of the 35 study health facilities, 27 (77.1 %) offered vaccination services for at least 5 days a week. Among the 8 (22.9 %) facilities that offered vaccination services for less

than 5 days a week, seven (87.5 %) were non-government. Twenty-two facilities (62.9 %) provided all routine childhood vaccines during vaccination days and of these 13 (59.1 %) were government facilities. However, some vaccines were not offered on all vaccination days but on specific days; for example, Bacille Calmette-Guérin (BCG) vaccine was offered on specific days in 8 (22.9 % facilities, human papillomavirus (HPV) in 4 (11.4 %) and inactivated polio vaccine (IPV) in 1 (2.9 %) health facility respectively. The vaccines not offered daily were packaged in multi-dose vials and had short expiry after reconstitution. As a result, unused doses had to be discarded at the end of each vaccinating day. Facilities therefore batched patients for vaccination on specific days of the week to minimise on wastage:

> "We schedule clients on specific days depending on the vaccine. For example, measles is provided on Wednesdays and BCG on Mondays, but for pentavalent and polio vaccines we offer them daily. This is because when we access 10 BCG doses daily, the vaccines may end up expiring because we might vaccinate only two or three children only and the rest will go to waste"
>
> (Key informant interview, Mombasa a)

In the 3 months preceding the survey, 2 (5.7 %) facilities reported oral polio vaccine (OPV) and 4 (11.4 %) rotavirus vaccine stockouts. Though infrequent, healthcare workers described how stock outs contributed to low vaccine uptake:

> "At times a certain antigen maybe out of stock like there was a time we were out of BCG for some months, another time we were out of measles and even influenza (from the demonstration project) there are times we get stock outs. So, you give the first dose then when they come for the second one it's not there"
>
> (Key informant interview, Nakuru a)

We found that four (4/35, 11.4 %) health facilities in both counties reported suspending vaccination services at some point during the pandemic, of which 2/4 had resumed the services in full at the time of data collection. No health facility reported lengthening the interval between the multidose vaccines schedule.

3.3. Strategies implemented by health facilities to maintain routine vaccination services

All facilities reported implementation of additional measures to sustain vaccination services during the pandemic. Compared to the non-government facilities, government health facilities provided messaging to the community to stay current with routine vaccination (17/17, 100 % vs 13/18, 72.2 %, p = 0.019) and were more likely to have conducted outreaches for clients overdue for vaccination (12/17, 70.6 % vs 6/18, 33.3 %, p = 0.028) (Table 3). Outreaches, i.e., planned visits by health facility staff to the community to offer health services, were mentioned as a strategy that improved the uptake of routine vaccines:

> "Yes, and also outreach. When we go for outreaches, the hospital does these for family planning, immunization, and other things. This too will be helpful. And when we go for outreach then we also promote and educate on new vaccines"
>
> (Key informant interview, Nakuru b)

To maintain vaccination services while adhering to the COVID-19 physical distance guidelines, some facilities scheduled individual vaccination appointments on specific days:

> "We book our clients because our facility is small and because of COVID-19 we should practice social distance"
>
> (Key informant interview, Mombasa b)

A total of 29/35 (82.9 %) facilities reported implementation of strategies for catch up vaccination services. Of these, sixteen (16/29, 55.2 %) facilities utilized community health volunteers (CHVs) to trace defaulters while 12/29 (41.4 %) called the caregivers via phone. About a quarter (24.1 %) of the facilities provided vaccination related health education to caregivers. CHVs played an important role in provision of health education that was targeted towards improving the uptake of vaccination services among mothers and tracing caregivers and children who had missed routine vaccines.

> We also have CHVs who give a lot of information in the community. They do community outreaches and even go door-to-door outreaches. They help with passing information, and they also do defaulter tracing. Those mothers who have defaulted, we use a register. So, they call the mothers or they go to them directly because they know them and bring them to the facility
>
> (Key informant interview, Nakuru c).

3.4. Trends of administered vaccine doses in the pre-pandemic (April 2019-March 2020) and pandemic periods (April 2020-March 2021)

We observed a seasonal trend in the number of vaccine doses administered in Mombasa with an increase in the number of vaccines administered between the months of April to July and a decline between the months of November to February. In Nakuru sub counties which are predominantly rural, a similar number of vaccines were administered throughout the year. In Mombasa, there was decline in number of vaccines that were administered in February 2020 and an increase in the vaccines that were administered in March 2020. (Figs. 1 and 2).

Accounting for the seasonal trends in the time series models, there was a <2 % but not statistically significant reduction in the number of vaccine doses administered for both pentavalent-1 (16,177 vs 15,886 doses, ß = −0.013, p = 0.505) and pentavalent-3 (15,361 vs 15,124 doses, ß = −0.012, p = 0.440) in the two counties during the pandemic period (Figs. 1 and 2).

On site specific analysis, Mombasa showed a 2.3 % decline in the number of pentavalent-1 vaccines administered comparing pre-pandemic (1st April 2019 – 31st March 2020) and pandemic periods (1st April 2020 – 31st March 2021) (8,704 vs 8,503 doses, ß = −0.023, p = 0.461). Pentavalent-3 vaccine had a <1 % decline in the number of vaccine doses administered during the pandemic period (8,390 vs 8,348 doses, ß = −0.008, p = 0.808).

Nakuru County recorded approximately a <1 % decline in the number of pentavalent-1 vaccines administered (7,473 vs 7,383 doses, ß= −0.012, p = 0.460) during the pandemic period compared to the pre pandemic period. There was 2.8 % decline in the number of pentavalent-3 vaccines administered during the pandemic period compared to the pre-

pandemic period, but this too was not statistically significant (6,971 vs 6,776 doses, ß= −0.028, p = 0.096).

3.5. Trends of administered vaccine doses in the pre-pandemic (April 2019-March 2020) and pandemic periods (April 2020-March 2021) comparing government and non-government facilities

Accounting for the seasonal trends in the time series models, overall, there was a 7.7 % reduction in the number of pentavalent-1 (15032 vs 14411, ß = −0.08, p = 0.010) and 10.4 % reduction in the number of pentavalent-3 (14320 vs 13433, ß = −0.11, p < 0.001) vaccine doses that were administered in government health facilities during the pandemic period. In non-government facilities, there was a 25.8 % increase in the number of pentavalent-1 (3065 vs 4979, ß=0.23, p < 0.001) and 31 % increase in the number of pentavalent-3 (3398 vs 5570, ß=0.27, p < 0.001) vaccine doses that were administered in non-government health facilities during the pandemic period (Figs. 3 and 4).

In Mombasa County, government health facilities showed a 21.3 % decline in the number of pentavalent-1 (6513 vs 5549 doses, ß = −0.24, p = 0.019) and 22.1 % decline in the number of pentavalent-3 (6353 vs 5307 doses, ß = −0.25, p = 0.007) vaccines administered comparing pre-pandemic and pandemic periods. In non-government facilities, there was a 29.7 % increase in the number of pentavalent-1 (2555 vs 4041 doses, ß=0.26, p < 0.001) and 33.6 % increase in the number of pentavalent-3 (2892 vs 4657 doses, ß=0.29, p < 0.001) vaccines administered comparing pre-pandemic and pandemic periods.

Government facilities in Nakuru County recorded approximately a 2 % reduction in the number of pentavalent-1 (7039 vs 6925 doses, ß = −0.02, p = 0.285) and 4 % reduction in the number of pentavalent-3 vaccines (6536 vs 6270 doses, ß = −0.04, p = 0.001) vaccines administered comparing pre-pandemic and pandemic periods. In non-government facilities, there was 5 % but not statistically significant increase in the number of pentavalent-1 vaccines administered (510 vs 938 doses, ß= 0.05, p = 0.411) and 16.2 % increase in the number of pentavalent-3 vaccines (506 vs 913 doses, ß= 0.15, p = 0.003) vaccines administered comparing pre-pandemic and pandemic periods.

3.6. Perception on impact of the COVID-19 pandemic and the government pandemic mitigation measures on vaccination services

In 31/35 (88.5 %) health facilities, healthcare workers reported that the COVID-19 containment measures had negatively impacted patient access to care. Of these, most facilities (23/31, 74.2 %) reported that restriction on movement had the greatest effect on health care utilization. Four (4/31, 12.9 %) health facilities reported limiting the number of clients seen daily at some point during the pandemic to ensure adherence to physical distancing guidelines.

A total of 22/35 (62.9 %) survey respondents from both counties reported that the pandemic affected utilization of health services at their health facilities. Of these, 18/22 (82.0 %) health facilities reported low turnout of clients seeking vaccination services during the pandemic, primarily due to fear of contracting the SARS-CoV-2 virus at the facility:

> "Sometimes the numbers drop like during this COVID-19 period we realized a drop but after COVID-19 many of the mothers who were fearing to come to the hospital came"
>
> (Key informant interview, Nakuru d)

> "Some are afraid of exposing their children to the hospitals where there are many people, to protect them from COVID-19"
>
> (Men focus group discussion, Nakuru a)

> "When COVID-19 came, many were not coming to the hospital because they perceived that there was COVID-19 at the hospital"
>
> (Key informant interview, Mombasa c)

Of the facilities which reported that the pandemic affected utilization of health services, two non-government health facilities in Mombasa reported higher workload, either due to closure of some public facilities or fear of contracting SARS-CoV-2 virus in the usually congested public facilities (2/22, 9.1 %). One facility in Nakuru reported closure of the maternal child health (MCH) department (1/22, 4.5 %) as a result of HCWs working at the MCH department contracting the SARS-CoV-2 virus and their subsequent isolation.

> "The biggest challenge is congestion, in fact three of our staff have contracted COVID-19 because of the congestion. There is a time we were not able to run the MCH because of that"
>
> (Key informant interview, Nakuru d).

Another reason for the perceived decline in utilization of vaccination services included confusing routine vaccines with COVID-19 vaccine (1/22, 4.5 %). Due to myths and misconceptions, some community members had not fully accepted the COVID-19 vaccine and they mis-construed other routine vaccines as the COVID-19 vaccines, and this led to hesitancy:

> "During this COVID-19 period, we were given vitamin A to administer but mothers were reluctant to have their children vaccinated because of claims that the COVID-19 vaccine had been mixed into the other vaccines. We even had our CHV uniforms, but they still declined, so that was the challenge because they were thinking that the vaccine was for corona virus."
>
> (Womenfocus group discussion, Nakuru a).

We also noted that many public health facilities in both counties had delayed routine childhood checks such as weight monitoring 10 (58.9 %) in government health facilities compared to 2 (11.1 %) in non – government health facilities). A MoH directive to avoid monthly weight monitoring checks and to limit healthcare access to only essential services, meant that growth monitoring was only done when a child was scheduled to receive a vaccine. However, in some cases, this led to children defaulting from the routine vaccine schedule as a result of staying away from health facilities for long and therefore caregivers forgetting to bring the children for scheduled vaccines, especially for schedules that were far apart, as reported in two health facilities in Mombasa County:

> "The challenge started during COVID-19 when mothers were told to stay at home unless they are coming for vaccination. Some mothers will tell us that they were told at another facility that after 14 weeks, the next visit should be at 9 months [for measles vaccination]. When you stay for long, some end up forgetting the dates and that is why we are getting children at one year and they have not gotten the first dose of measles vaccine"
>
> (Key informant interview, Mombasa d).

> "Mothers delayed for a long time to bring their children for vaccination especially during COVID-19. In many public health facilities, mothers were informed to stay at home to reduce congestion at such facilities, but this contributed to mothers overstaying. You may find a mother whose child got vaccines at 14 weeks and now the child is one year, and the mother has never appeared at a health facility"
>
> (Key informant interview, Mombasa e)

4. Discussion

Our study found that overall, the COVID-19 pandemic did not significantly disrupt routine vaccination services in Mombasa and Nakuru counties. However, there was a decline in the number of vaccines that were administered in government health facilities and an increase in vaccines that were offered in non-government facilities during the pandemic period. The strategies that were put in place by the ministry of health ensured continuation of vaccination services and encouraged uptake of the services during the pandemic period in Kenya.

The decline in vaccines that were administered in government health facilities and the increase in vaccines that were administered in private health facilities during the pandemic period was more pronounced in Mombasa county where over 80 % of the health facilities are non-government [32,33]. During the pandemic, some government health facilities were designated as COVID-19 isolation centres which resulted in clients seeking health services in private health facilities [34]. Despite majority of the Kenyan population relying on public health care, during the pandemic period people may have sought health services in private facilities since it was perceived that one was likely to contract COVID-19 in government health facilities which often experience overcrowding and this may have contributed to the increased numbers of clients seeking vaccination services in non-government health facilities despite them charging a fee for vaccine administration [35,36]. This corroborates the reports by health care workers in public health facilities on reduction in the number of clients seeking childhood vaccination services and reports by non-government health facilities on higher workload during the pandemic compared to the pre-pandemic period.

Besides the private sector cushioning against the effects of the pandemic on vaccination services, the government of Kenya and the health facilities also put in place mitigation measures to support continuity of vaccination services during the pandemic period. The strategies that were implemented to ensure maintenance of vaccination services during the pandemic included sustained supply of vaccines and vaccine delivery protocols to the health facilities during the pandemic, and the support by health facilities and stakeholders for

access to vaccination services [21,32]. In addition, publicizing scheduled vaccination days, intensive defaulter tracing via telephone and community health volunteers, and aggressive government messaging on importance of vaccination to healthcare workers and the general public contributed to minimizing disruptions [37,38].

We observed a decline in the number of pentavalent vaccines administered in February 2020. However, this may have been due to the country wide measles vaccine stock outs between November 2019 and February 2020 [34]. It is commonly noted from the past that whenever health facilities experienced stock out for a specific vaccine, there was a generalized community perception that all vaccines are out of stock at the health facility which led to a decline in the overall number of children vaccinated during specific vaccine stock out periods [39]. The measles vaccine became available in March 2020. This explains the increase in the vaccines that were administered in March 2020 because children that had missed their scheduled vaccines were now coming for the catch -up vaccination and this coincided with the reporting of the first COVID-19 case in the country.

Our findings are consistent with other studies from Kenya that used publicly available Kenya Health Information System (KHIS) data to assess the indirect impact of the pandemic on routine vaccination services and found no effect [34,36,40]. However, contrary to our findings, elsewhere in Africa, in the United States of America, and Europe remarkable disruption in vaccination services was reported [41,42]. The African countries of Angola, Senegal, Burundi, Gabon, Guinea and Nigeria, reported nation wide pandemic-associated decline of 10–15 % in vaccination services 2–4 months into the pandemic [43]. Comparably, the United States reported roughly up to 20 % decline in uptake of the measles vaccine among children below 24 months 2–4 months into the pandemic in 2020 [41,44]. Similarly, the United Kingdom also recorded approximately 20 % decline in measles vaccine uptake during the same period [45]. Notably these studies assessed a much shorter period than our study. Nevertheless, the non-government health facilities in the two counties were instrumental in cushioning immunization vaccination services against the effects of the pandemic and this may have contributed to the resilience of the Kenya expanded programme on immunization in vaccine service provision to ensure continuation of vaccination services with minimal interruptions. Private health facilities are fundamental in ensuring continuity of health services provision during public health emergencies particularly in the urban settings where besides majority of the population relying on private healthcare, they are also disproportionately affected by pandemics. Inclusion of the private sector in strategic plans for pandemic mitigation with clear frameworks of their roles in ensuring continuity of essential services is key [46]. Such preparations provide a basis for developing guidelines to prevent disruptions in routine vaccination in the face of future pandemics.

There was a seasonal trend in the number of pentavalent-1 and pentavalent-3 vaccine doses administered in Mombasa with a notable decline in vaccines administered between the months of November and February, which was not observed in Nakuru. This finding is similar to a study conducted in Madagascar that reported seasonality in vaccine coverage over the year with a decline in routine vaccination during the rainy season and the periods around vaccination campaigns [42]. Possibly, this trend may be associated with the increase in migration rates around the end of the year and start of the new year that reduce the

utilization of health services and result in seasonal variation in utilization of vaccination services in urban centers [47]. This trend was not observed in Nakuru whose participating sub counties were predominantly rural and the number of vaccines administered were consistent over time.

Participants in our study identified movement restrictions as having the greatest impact on access to health care, in general. These measures banned travel across counties which presented challenges for clients living close to the county borders that sought vaccination services in neighboring counties. The fear of contracting COVID-19 at the health facilities was one of the main barriers to seeking care and this resulted in losses to follow up in essential services such as vaccinations [34]. In addition, the health facilities limited the number of clients that were served at a time to adhere to the physical distancing guidelines. This led to increased waiting times and consequently made people avoid going to health facilities for subsequent illness [9]. These findings are in keeping with a systematic review of the impact of COVID-19 pandemic on health care systems in Africa which reported reduced patient flow and missing scheduled appointments as the main impact of the pandemic on health services [48].

5. Strengths and limitations

The use of a mixed methods approach enabled triangulation to validate and contextualize our findings which was a strength of this study. Our study had some limitations. First, the collection of data one year after pandemic onset and nine months since the phased lifting of mitigation measures was prone to recall bias especially regarding the events that happened early during the pandemic. Second, although our study offers useful insights, it was conducted only in two counties therefore limiting the ability to generalize our findings to other counties. Third, the selection criteria of one health facility per level and ownership irrespective of the number of facilities in the strata could have been a potential source of selection bias in our study. Lastly, our study used a relatively short time series with only twelve months from the pre-pandemic period included in the analysis and thus may not have provided a robust baseline for comparison.

6. Conclusion

Our findings suggest that the COVID-19 pandemic did not impact childhood vaccination services in Mombasa and Nakuru counties in Kenya. The private health facilities cushioned vaccination services against the effects of the pandemic and the strategies that were put in place by the ministry of health ensured continuation of vaccination services and encouraged uptake of the services during the pandemic period in the two counties in Kenya. These findings provide useful information to safeguard vaccination services during future pandemics.

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Data availability

Data will be made available on request.

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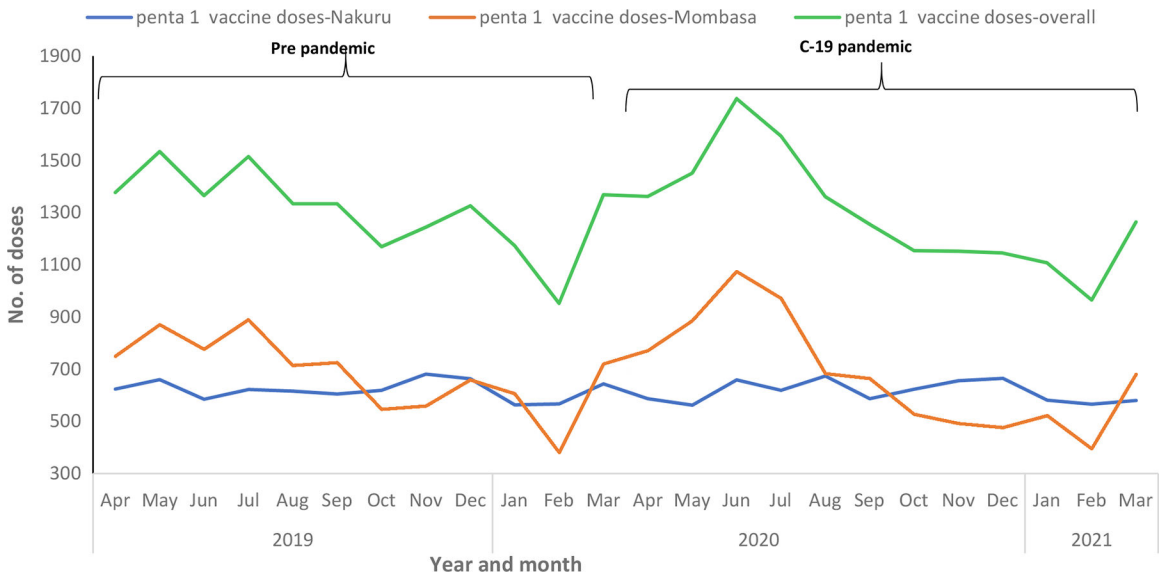

Fig. 1.

Time series analyses of pentavalent-1 vaccine doses administered in the pre-pandemic and pandemic periods in Mombasa and Nakuru counties and in both counties combined.

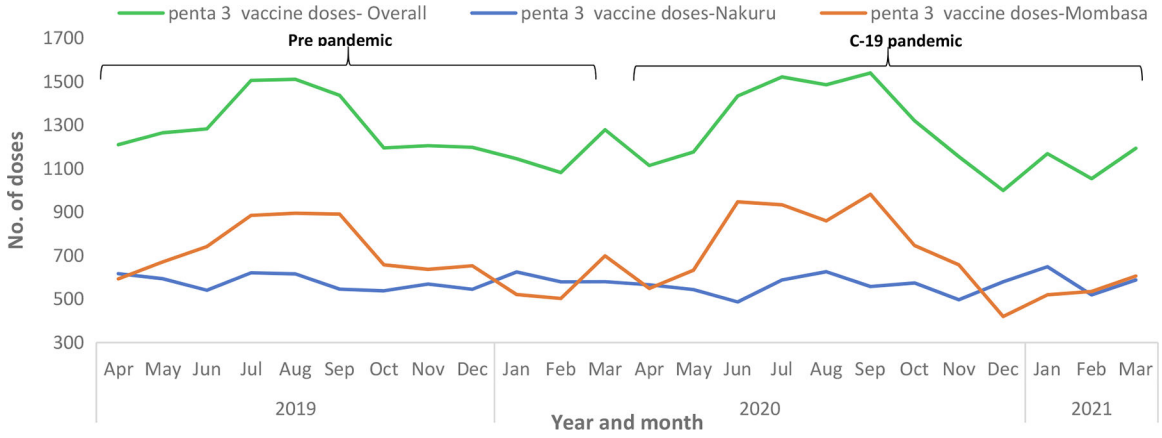

Fig. 2.

Time series analyses of pentavalent-2 vaccine doses administered in the pre-pandemic and pandemic periods in Mombasa and Nakuru counties and in both counties combined.

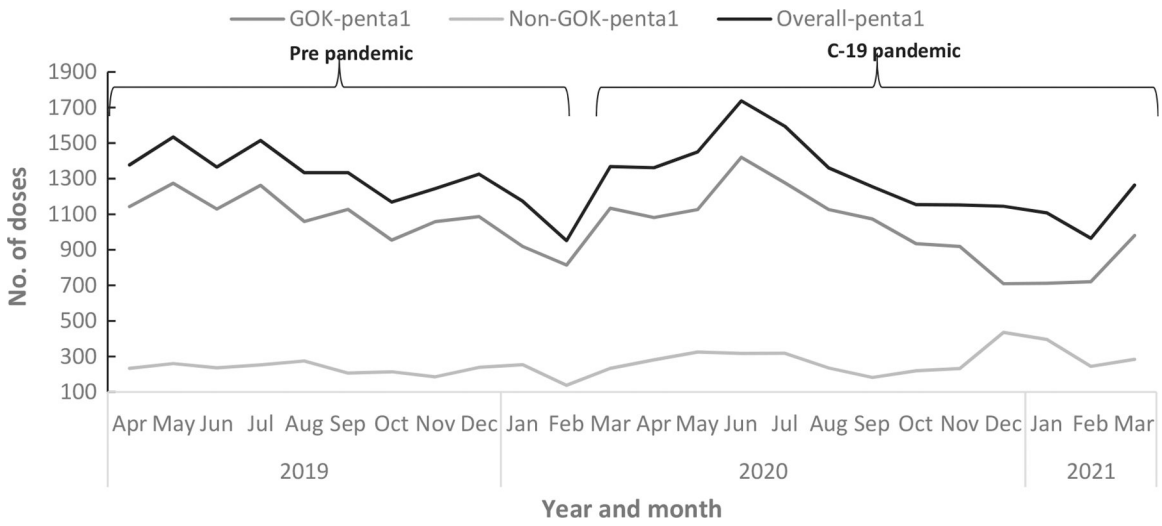

Fig. 3.

Time series analyses of pentavalent-1 vaccine doses administered in the pre-pandemic and pandemic periods in government and non-government health facilities in Mombasa and Nakuru counties and in both counties combined.

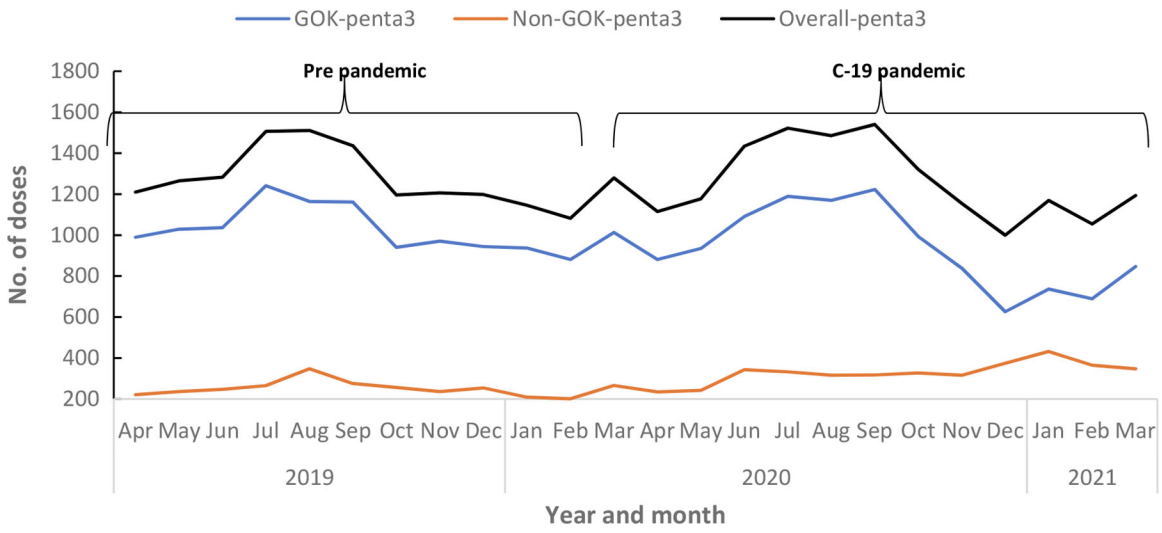

Fig. 4.

Time series analyses of pentavalent-3 vaccine doses administered in the pre-pandemic and pandemic periods in government and non-government health facilities in Mombasa and Nakuru counties and in both counties combined.

Table 1

Number of health facilities in each sub county in Nakuru and Mombasa counties, Kenya.

Level	Nakuru sub counties									Mombasa sub counties								
	Njoro			Nakuru North			Molo			Jomvu			Likoni			Kisauni		
	Public	Private	Faith based	Public	Private	Faith based	Public	Private	Faith based	Public	Private	Faith based	Public	Private	Faith based	Public	Private	Faith based
2	19	9	3	2	5	3	8	5	2	4	4	2	2	5	3	7	9	0
3	3	1	0	2	2	0	3	1	0	1	1	1	2	2	0	1	0	0
4	2	0	0	3	0	0	2	0	0	0	0	0	3	0	0	1	1	0
Total	37			17			21			13			17			19		

Table 2

Number of selected study sites per county stratified by ownership category and Kenya Essential Package for Health Level.

County	Level	Government n/N (%)	Non-government		Total n/N (%)
			Private n/N (%)	Faith-based n/N (%)	
Mombasa	2	3/13 (23.1)	3/18 (16.7)	2/5 (40.0)	8/36 (22.2)
	3	3/4 (75.0)	2/3 (66.7)	1/1 (100.0)	6/8 (75.0)
	4	2/4 (50.0)	1/1 (100.0)	0/0 (0.0)	3/5 (60.0)
Nakuru	2	3/29 (10.3)	3/19 (15.8)	3/8 (37.5)	9/56 (16.1)
	3	3/8 (37.5)	3/4 (75/100)	0 (0.0)	6/12 (50.0)
	4	3/7 (42.8)	0/0 (0.0)	0/0 (0.0)	3/7 (42.8)
Total n/N (%)		17/65(26.2)	12/45 (26.7)	6/14(42.8)	35/124 (28.2)

Table 3

Strategies implemented by the health facilities to support vaccination services during the pandemic.

Strategies implemented by the health facilities	Health facility implementing the strategy		
	Government n = 17 (%)	Non-government n = 18 (%)	Chi square *p*-value
Provided messaging on availability of routine vaccines	17(100)	15(83.3)	0.078
Provided messaging on importance of staying current with routine vaccination	17(100)	13(72.2)	**0.019**
Held immunization sessions away from other patient areas	4(23.5)	6(33.3)	0.521
Conducted vaccination outreaches	12(70.6)	6(33.3)	**0.028**
Scheduled individual vaccination appointments on specific days	1(5.9)	1(5.6)	0.969