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Original Article

Last mile delivery of COVID-19 vaccination to populations aged 15 years and above in Nyeri County, Kenya, March 2021-June 2022

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COVID-19, Vaccination, Last Mile Delivery, Public Health Emergencies, Vaccination Rollout Strategies.

ABSTRACT

Background: The COVID-19 pandemic in 2019 wreaked havoc on global economies and nearly paralysed health systems in some areas. Though mortality was moderate in African countries, the pangs of the disease were felt through the disruption of economic activities. Experimenting for vaccines started by December 2019 and Pfizer and AstraZeneca vaccines were authorised for emergency use in the same month. Mass immunisation campaigns started immediately. Kenya received its first vaccine consignment, AstraZeneca, on March 6, 2021 and commenced the rollout campaigns. This paper aims to highlight strategies and interventions towards the successful implementation of COVID-19 vaccination in Nyeri County. **Interventions:** Nyeri established the COVID-19 Vaccine Deployment Committee (CVDC), mandated to provide technical leadership, planning and strategising on the implementation process. The vaccination roll-out strategies that were adopted included capacity building of healthcare workers and establishment of COVID-19 vaccination static sites, among others. There is a paucity of data in the county on how strategic interventions affected vaccination coverage, as a campaign of such magnitude has not been carried out previously. Additionally, there was a lot of system downtime in the initial phases of the vaccination exercise, leading to manual registration, which could have led to a loss of data. Nyeri county population is varied; some sub-counties have a good road network connectivity, which could contribute to better access to vaccination. **Results:** Nyeri County had a total of 791,910 persons and had targeted to vaccinate 510,023 persons aged 15 years and above, from March 2021 to June 2022. 67.7% (95% CI: 67.55% - 67.81%) of persons were given the first dose of Covid 19 vaccine, while 40.3% (95% CI: 40.2% - 40.4%) of persons were given at least two doses of the COVID-19 vaccine. Increase in vaccination static sites from 5 to 17 resulted in an upward trend in vaccine uptake between March 2021 and June 2022, where 27,263 people received the first dose. Outreaches conducted brought an additional 55,071 individuals to be vaccinated. Supplemental Immunisation Activities contributed to 85,149 persons on the COVID-19 vaccine first dose. More females, at 55.20% (95% CI: 55.04%, 55.37%), accepted the vaccine than males at 44.80% (95% CI: 44.63% - 44.96%). Persons above 50 years returned for the second dose in comparison to ages below

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40 years. **Lessons learnt**: Aggressive roll-out campaigns, involving stakeholders at the onset of vaccine roll-out and targeted demand creation, placed the country at the forefront in the last-mile vaccine delivery. **Conclusion and implications**: More than two-thirds of the adult population in Nyeri County received at least 1 dose of the COVID-19 vaccine during that period. Documentation of best practices will help policymakers implement strategies that will deliver vaccines to the last mile. Counties struggling with low coverage can use some of the best practices to improve the uptake of vaccines.

APA CITATION

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INTRODUCTION

The most effective strategy known to prevent infections is through vaccination (WHO, 2020). Vaccines work with the body's natural defences to build protection against infections. Therefore, becomes a key component of primary health care and a key strategy in the prevention and control of infectious diseases (Pollard & Bijker, 2020). Currently, there are over 20 vaccine-preventable diseases worldwide, including the novel COVID-19(WHO, 2020). The World Health Organization (WHO) declared coronavirus disease (COVID-19) a pandemic on March 11, 2020, following its outbreak in December, 2019. Kenya confirmed its first case on March 12, 2020 (Ministry of Health, 2020a). The government, through the Ministry of Health (MoH) and in collaboration with other government ministries and departments, implemented various public health measures to control the spread of COVID-19, such as mandatory masking and social distancing (Ministry of Health, 2020b). Despite the government's efforts, several waves of outbreaks were experienced in the country.

By January 2020, scientists had published the DNA sequence for the COVID-19 virus and vaccine manufacturing was initiated by Moderna Company, with other companies such as Pfizer and BioNTech following soon after (Kaur & Gupta, 2020). By December 2020, Moderna and Pfizer were authorised for emergency use by the Food and Drug Administration (FDA) and mass immunisation campaigns started in Europe and America (WHO, 2021). To ensure equitable distribution of vaccines, especially in Low- and Middle-Income Countries (LMICs), WHO developed a vaccination strategy outlining actions required by the global community to achieve 70% global COVID-19 vaccine coverage among the eligible population by mid-2022 (WHO, 2022).

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The strategy was needed to ensure an equitable pace of vaccine rollout to LMICs and appropriate prioritisation of vaccine for those at highest risk. Consequently, WHO, Global Alliance for Vaccines and Immunization (GAVI), UNICEF (a delivery partner), and (the Coalition for Epidemic Preparedness Innovations (CEPI), formed the COVID-19 Vaccine Global Access Facility (COVAX), which was charged with the responsibility of procuring and equitably delivering COVID-19 vaccines to LMICs (WHO, 2022).(WHO, 2022).(WHO, 2022).

Kenya as one of the countries eligible for subsidized access to COVID-19 vaccines through COVAX, received her first vaccine consignment, AstraZeneca Vaccine, on March 6, 2021Click or tap here to enter text. (Africa CDC, 2021). The country commenced the rollout by conducting national Trainer of Trainers (ToT) trainings and cascading them down to the counties. Initial priority during vaccination was given to groups at highest risk of exposure to SARS-CoV-2 infection, including healthcare workers, teachers, uniformed officers, the clergy, and people with lowered immunity, that is, persons aged above 60 years, and those with comorbidities.

Nyeri County began the COVID-19 vaccine roll-out on March 9, 2021. Vaccine uptake was initially low, like in all other countries within the country, mostly due to infodemics, myths, misconceptions, vaccine stockouts and long queues in the health facilities. Consequently, Nyeri County made tremendous efforts to improve the vaccine uptake among its citizenry by employing various strategies and interventions. This saw a 67.7% (95% CI: 67.55% - 67.81%) coverage for the first dose and 40.3% (95% CI 40.2% - 40.4%) for the second dose as at June 2022, resulting in Nyeri County being awarded as the best performing county in COVID-19 vaccination on 10th May 2022 (Kenya News Agency). Nyeri County is the only county in Kenya that has been able to vaccinate above 50% of its eligible population.

In this paper, we provide a detailed description of various strategies, interventions and best practices employed by the Nyeri County Department of Health Services that can be adopted in other areas to accelerate the uptake of vaccines.

Description of the Intervention

Implementation Sites

Nyeri County is one of the forty-seven counties established under the Kenya Constitution 2010, located in the central region of Kenya, about 153km north of Nairobi, covering approximately 3,325 square kilometres. It's divided into eight administrative sub-counties, namely Kieni East, Kieni West, Mathira East, Mathira West, Nyeri Central, Tetu, Nyeri South, and Mukurwe-ini sub-counties. It has one hundred and twenty-nine (129) government health facilities distributed across the eight sub-counties: 1 County Referral Hospital (level V), 4 sub-county hospitals (level IV), 31 health centres (level III), and 93 dispensaries (level II). There are also private and faith-based health facilities which complement government facilities in providing health services within the county.

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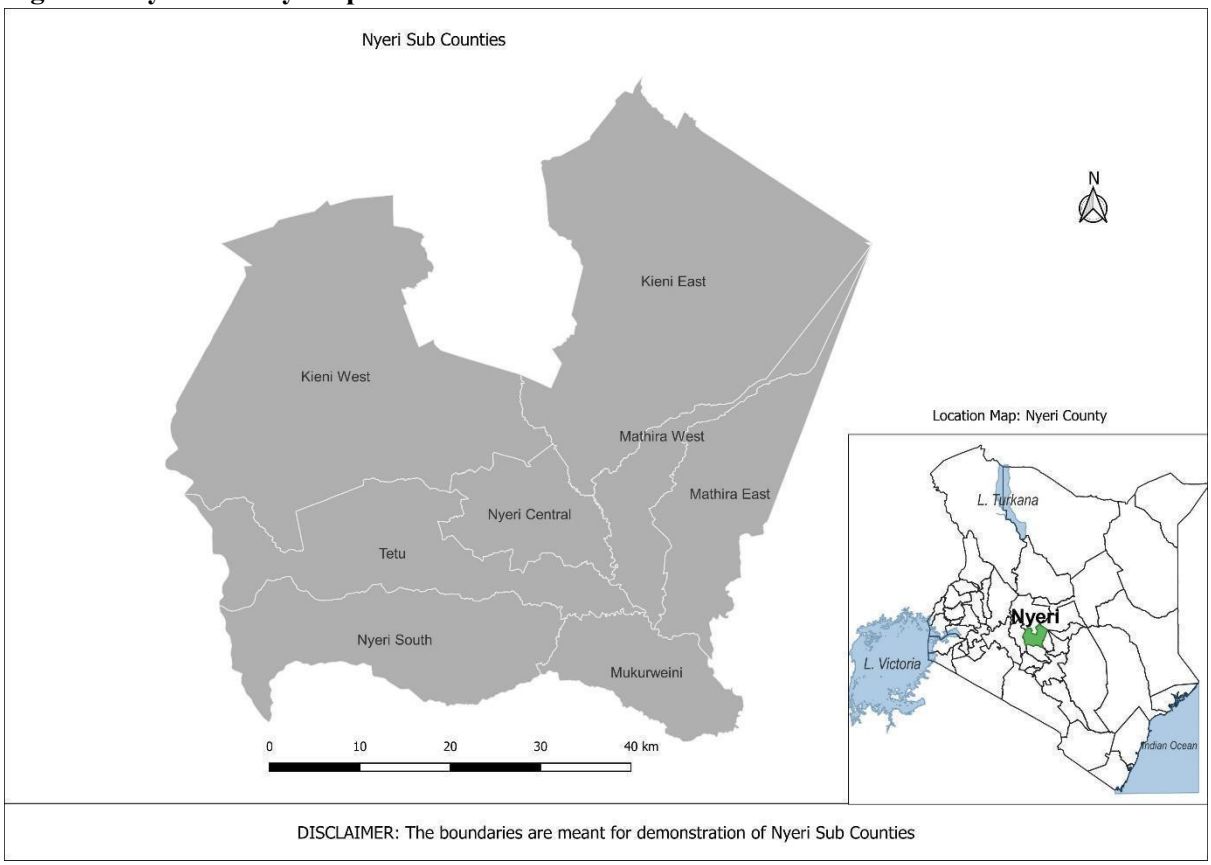
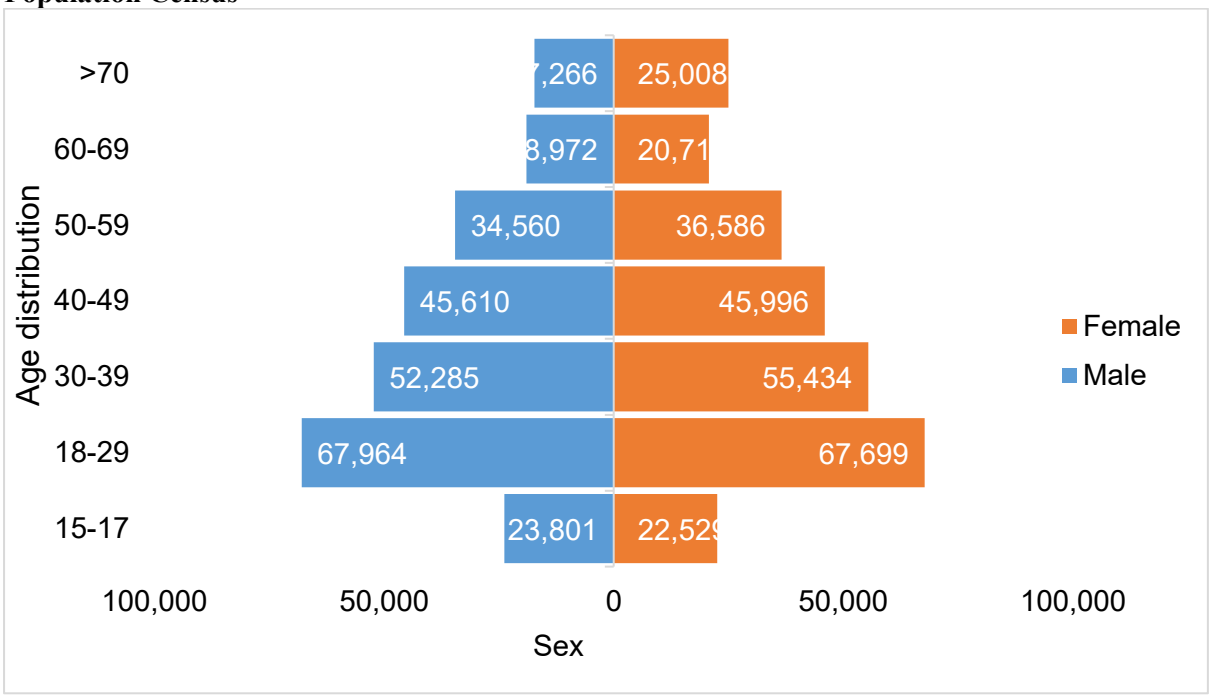
Figure 1: Nyeri County Map



Nyeri County has a population of 791,910 projected from the 2019 Kenya Population and Housing Census, of whom 510,023 were aged 15 years and above and targeted for the vaccination.

Figure 2: Nyeri County Population Pyramid as Projected from the 2019 Kenya Housing and Population Census



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Implementation Cycle: COVID-19 Vaccination Roll-out Strategies

The Implementation cycle included three main phases as described below:

- **Phase 1: Preparation stage**: Capacity building of HCWs, Establishment of vaccination sites and Public Awareness Campaigns
- **Phase 2: Demand Creation and Rollout Activities**: Vaccine Outreaches, Moonlight initiatives, Support groups, Chanjo 'PAP' at workplace and Vaccine Caravans
- **Phase 3: Follow-up and Sustainability Activities:** Integration of COVID-19 vaccination with Other Services, Routine monitoring and Safety, Defaulter Tracing and Supplemental Activities

Phase 1: Preparation Stage

a) Establishment of COVID-19 Vaccine Deployment Committee (CVDC)

Nyeri County established the COVID-19 Vaccine Deployment Committee (CVDC), whose mandate was to provide overall technical leadership, planning, and the strategic implementation process. The committee was comprised of the County Director of Health Services as chair, County Director of Nursing Services, County Expanded Program on Immunization Logistician (EPI), County Health Records and Information Officer (HRIO), County Health Promotion Officer, and County Community Strategy Coordinator. It worked in liaison with the National Vaccines and Immunization Program (NVIP) and other County vaccine deployment teams.

The committee reported to the County COVID-19 Inter-governmental Committee (CICC), chaired by His Excellency the Governor and comprised of heads of various Government departments and Ministries. The team met weekly to oversee the overall coordination of vaccination activities such as vaccine deployment, training, support supervision, community mobilisation, and coordination of various roll-out strategies.

b) Capacity Building for Health Care Workers

The MoH supported the County by training five TOTs who, in turn, sensitised 30 health care workers (HCWs) drawn from 10 health facilities, county and subcounty management teams, so each of the 8 sub-counties had a vaccination site. Given the above capacity, the county was quick and able to roll out vaccination from the allocated 2 national vaccination sites to 10 sites by March 2021. The trainings were then cascaded in a phased approach, and by June 2022, an estimated 448 HCWs from 135 immunising facilities had been trained on multiple COVID-19 vaccine administration and data management.

To support the vaccination activities, the county trained all 2510 Community Health Volunteers (CHVs) from the 251 community units on COVID-19 vaccination and social mobilisation for vaccine uptake. During capacity building, clustered training sessions were conducted concurrently across the sub-counties, ensuring a shortened training period. The trainings were a collaboration between the Ministry of Health (MoH), County Government and the implementing partners: Amref Health Africa, being key among others.

c) Establishment of COVID-19 vaccination static sites

The county initially had 2 COVID-19 vaccination sites (Nyeri County Referral Hospital) and Mwai Kibaki Hospital, but later established 5 additional sites in public and private health facilities. To increase COVID-19 vaccine access, the health department gradually increased vaccination sites to 17, then 24, 56 and later to 108 by June 2021, distributed in the 8 sub-counties. All immunisation sites identified met the criteria set by the MOH immunisation policy guidelines, such as adequate infrastructure like KEPI-recommended refrigerators and adequately trained staff to handle all vaccines and other health commodities. The established vaccination sites account for 80% of the immunisation coverage.

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d) Public awareness creation campaigns

The county deployed multipronged awareness creation strategies to create vaccine demand by building vaccine confidence among communities through consistent, transparent, and factual communication strategies.

Trusted community members participated in the COVID-19 vaccination promotion. These included the political leaders, national government administration, health care providers, religious leaders, the Ministry of Education, local chapters of professional societies, the local business community, such as motorbike riders (*boda boda)*, Public Transport (*matatu*) owners and Savings and Credit Organizations (SACCOs). The county developed poster messages that reached people, especially in rural areas that have minimal internet and media usage. Health workers and leaders provided information on vaccine availability and educated the public through public addresses, road shows, local TV, social media platforms, and local radio stations.

The department also implemented the sending of COVID-19 key messages in bulk through the short message service (SMS) to create community awareness on COVID-19 and the importance of getting vaccinated against the disease.

Phase 2: Demand Creation and Rollout Activities:

The county health department realised that there were sections of the population that remained unvaccinated despite the implementation of rollout strategies. Therefore, there was a need to re-strategise and formulate interventions to increase vaccine access to these unvaccinated population pockets. This population included people working in the informal sector, a section of people working in the offices between 8 a.m. and 5 p.m., as well as coffee and tea farm workers. Consequently, the county initiated various interventions such as outreaches with support from Amref Health Africa and other partners. The other interventions included moonlight (late evening) vaccination outreaches in major towns, vaccination drives during public holidays and in public gatherings by setting camps in markets, religious places, Public transport (matatu) termini, during community functions, and at coffee and tea buying centres.

Further, the Nyeri County Governor and the County Commissioner held joint media briefings to provide updates on COVID-19 disease and vaccination coverage and garner local support. The Governor also initiated a 100-day Rapid Result Initiatives (RRIs) implemented by the health department with the aim of accelerating COVID-19 vaccine uptake and this yielded excellent outcomes.

Vaccination Outreaches

The experience of responding to COVID-19 has shown that creating the demand and providing a mix of vaccine delivery mechanisms to reach key priority groups is an effective way to improve vaccine uptake and achieve greater equity in coverage. The vaccination teams conducted COVID-19 vaccination community outreach in all 8 sub-counties, integrating it with the delivery of Human papillomavirus (HPV) vaccination in schools and this strategy helped reach teachers with COVID-19 vaccination as well.

The health department took advantage of already formed crowds in high traffic areas to offer vaccination, such as Public Holidays, such as Mashujaa Day celebrations, burial ceremonies, political rallies, organised community field days, etc, to reach more unvaccinated people in the county. Makeshift vaccination centres were mounted in bus-parks, markets, eateries, and prayer centres in all 8 sub counties major towns. The Sub-County teams also liaised with the local secondary schools to reach the above 15 years in schools to provide the Pfizer vaccine and this greatly improved our numbers as these were readily available populations. The outreach sites were selected based on population social socioeconomic behaviour and other dynamics that influenced their availability in a specific locality within the sub-counties. Sites with the likelihood of reaching a high population were mostly selected during outreaches.

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Moonlight Vaccination Initiative

The County Government, in partnership with Amref Health Africa, implemented the night outreaches dubbed "Moonlight vaccination" initiative, which sought to reach a larger population who could not access the vaccination services during the day. The initiative was conducted for ten days at Gakere road, Nyeri town's busiest street, offering COVID-19 vaccination services from 3 pm to 9 pm, with a target to administer 200 doses daily.

'Mashujaa' Chanjo Day

The Department of Health took advantage of the *Mashujaa* holiday to reach more unvaccinated people in the county by implementing the *Mashujaa* weekend COVID-19 vaccination drive. The department mounted make-shift vaccination centres in bus-parks, markets and eateries in the county's major towns and a total of 3,313 people were vaccinated, further increasing the vaccination coverage in the county.

a) Support groups of People Living with Non-Communicable Diseases

People with Non-Communicable Diseases (NCDs) are more likely to contract COVID-19 and therefore more vulnerable to having severe illness or even death than the general population (Fikre Bojola et al, 2021). NCDs account for 44% of all deaths in the county and the most affected age group is residents above the age of 40, Michael A.T. et al (2016). The Department of Health Services noted that people living with NCDs and other immunocompromising conditions refrained from going to health facilities for COVID-19 vaccination due to fear of contracting COVID-19. The department embarked on a strategic COVID-19 vaccination drive to reach these people in their support groups. Local leaders and CHVs took part by mobilising people in the villages.

b) "Chanjo pap'' at workplaces

The *"Chanjo pap''* at workplaces was coined to complement the 'Moonlight' initiative. Vaccinating teams drawn from various facilities visited nearby places of work and vaccinated staff. This initiative reached people (staff and customers/clients) at tea and coffee factories, banking institutions, casuals in informal sectors, among others.

c) Vaccination caravans

The Nyeri County came up with COVID-19 vaccination caravans to reach the rural population through support from Amref Health Africa. The caravans consisted of an entertainment truck with a public address system to draw people and a vaccination van offering the vaccine to the people. The 'Zangalewa Group' dancers provided entertainment and the health promotion team spread COVID-19 vaccine information on the road, in market centres, and towns. This initiative brought vaccines closer to the people and increased the coverage. During the period, 207,500 persons were reached with health messages on COVID-19, while 897 persons received the COVID-19 vaccination.

Phase 3: Follow-up and Sustainability Activities

a) Integration of COVID-19 Vaccination with other Services

Promoting an integrated systems approach means that services are more people-centred and able to respond to their needs. The Department of Health integrated COVID-19 vaccinations during the periodic intensification of routine immunisation (PIRI) being carried out in the vaccination sites and schools, reaching more teachers and students.

b) COVID-19 vaccines defaulter tracing

Findings from a cross-sectional analysis of COVID-19 vaccination on the Chanjo platform in November 2021 revealed over 9,000 second-dose vaccine defaulters. The Department of Health, with support from Amref Health Africa, conducted defaulter tracing through phone calls and a total of 6921 clients were contacted through phone calls. They were asked why they had not taken the second dose of vaccine and responses were recorded.

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The feedback was analysed and the department used the information to provide targeted interventions to counter defaulting and increase second-dose coverage. 221 people were randomly sampled from the contacted defaulters and their details cross-checked in the chanjo system to check if they received their second doses. 134 (60.6% 95% CI: 54.2% - 60.0%) of the defaulters took their second dose from the phone reminders

Supplemental Immunisation Activities

As a way of ramping up COVID-19 vaccination coverage in the country, the Ministry of Health supported all 47 counties, including Nyeri, to carry out a 17-day Supplemental Immunization Activity (SIA). Fixed vaccination sites and mobile sites that included markets, churches, institutions of higher learning, among other strategies, were used. Vaccination targeting children 15-17 years was also initiated in the county during the SIA. The total number of persons vaccinated using this initiative was 85,149 first doses and 57,654 second doses.

c) Routine monitoring and safety surveillance

The introduction of COVID-19 vaccines required the development of monitoring systems to measure progress. MoH created the online Chanjo system to enable tracking of the vaccination rollout across the country. The vaccinator or the Health Records Information Officer (HRIO) captured the vaccinee's details on the platform, such as demographic information, health status, date vaccinated, the vaccine antigen given, and date of the subsequent doses. The platform also served as an online vaccine ledger assisting the vaccination in-charges at the various ordering and issuing sites to keep track of the vaccine stocks.

The Department of Health implemented a vaccination monitoring system to track daily COVID-19 vaccine uptake since the commencement of the activity in March, 2021. The department consolidated reports from all vaccination sites and made efforts to maintain data completeness and accuracy in the MoH Chanjo system. Routine monitoring of stock status ensured an adequate supply of vaccines through ordering from the regional vaccine warehouse, restocking and redistribution to all vaccination sites.

In June 2021, the county realised the need to have a county vaccine deployment micro plan to review performance. Micro plans were first developed at the Sub-County level and consolidated into a county micro plan. The micro plan was used to assign targets to immunising sites and to monitor progress.

Situational reports were compiled and shared with relevant stakeholders on a daily basis on COVID-19 issues, including the county vaccination status. By June 2022, 327 situation reports had been compiled, shared and stored in the health repository. The reports guided in tracking vaccination progress with respect to the set target and action planning.

At the executive level, county intergovernmental meetings were held on a weekly basis to discuss progress in the county and take corrective actions where necessary. The meetings were co-chaired by the County Governor and the County Commissioner, where participants were drawn from various departments, both national and county structures of government. The County Director of Health was the secretary to the intergovernmental meeting. The meetings deliberated on the progress, challenges and formulation of strategies and timely implementation.

The County Department of Health consistently held weekly virtual performance review meetings to discuss vaccination status, where the County Health leadership, CHMT, hospital management teams (HMT), Sub-County health management teams (SCHMT), and partners participated. The meetings were chaired by the county director of health services. A total of 94 review meetings were held during the period. The meetings helped the deployment team discuss the progress, gaps in vaccine delivery, share feedback on performance, and action points to improve performance.

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Supportive supervision by a team comprising CHMT and the SCHMTs members visited all immunising facilities to check their compliance with COVID-19 vaccination protocols. The supervision centred on IPC, cold chain maintenance, data management (including stock keeping), vaccine administration, and monitoring of adverse events following immunisation (AEFIs). The department formulated a standard supervision checklist, which was used to identify areas of improvement and inform further interventions.

RESULTS

a. COVID-19 vaccine, first dose monthly uptake

The Nyeri County COVID-19 vaccine first dose uptake indicates three distinct vaccination peaks from March 2021 to June 2022. The highest peak was in April 2021, with 27,263 people receiving their first doses. The peak was followed by a dip, with June 2021 being the lowest, where only 220 people got the vaccine. September 2021 had the highest of the second peak with 55,071 individuals receiving their first doses. The third peak was in February 2022, where 85,149 individuals received the first COVID-19 vaccine. The monthly coverage then dipped, with only 804 people getting the first dose vaccine in May 2022. These peaks coincide with the accelerated periods with support from Partners such as Amref Health Africa, the MoH, among others.

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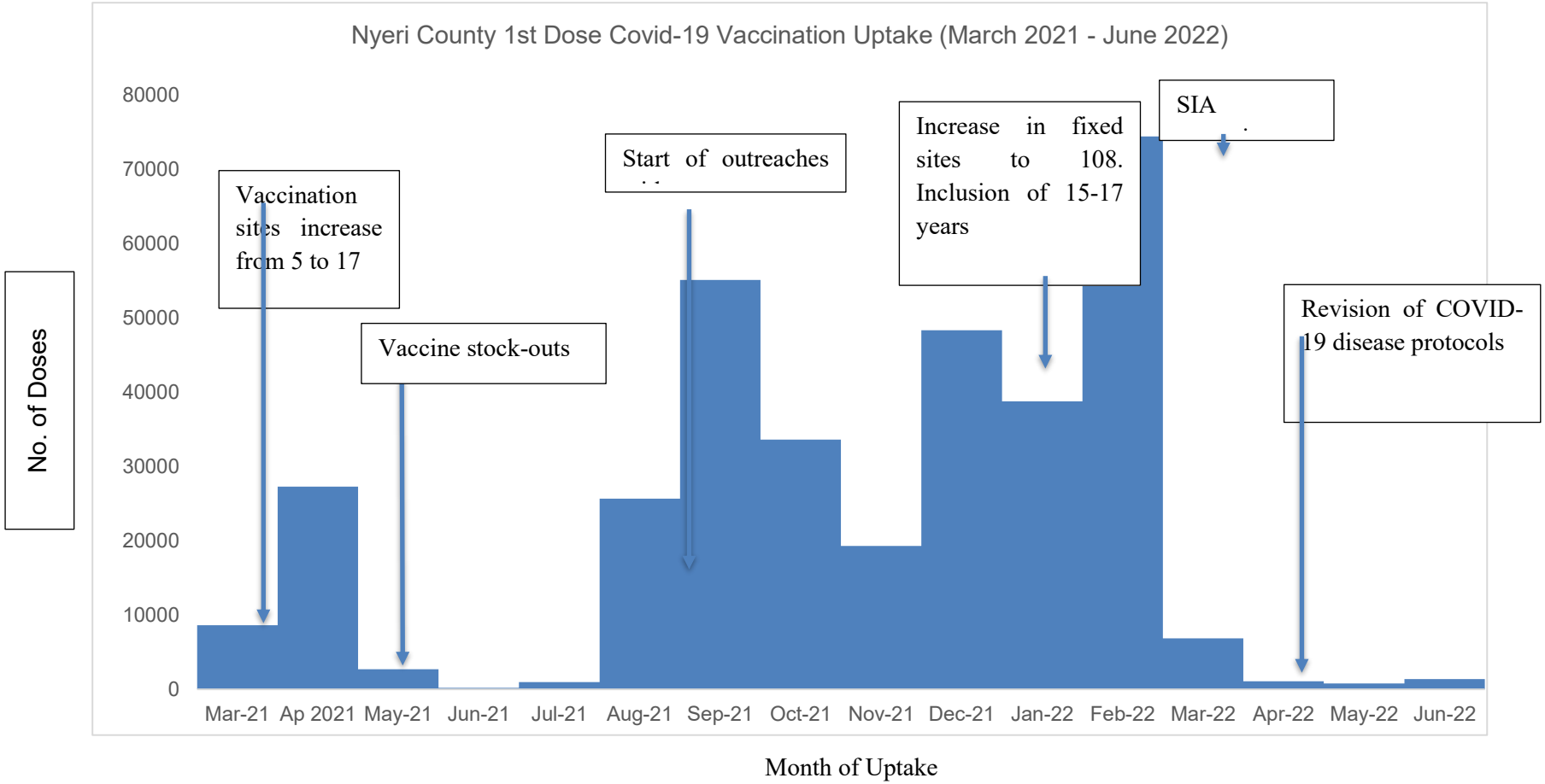
Figure 3: Nyeri County COVID-19 vaccine dose 1 uptake from March 2021 to June 2022



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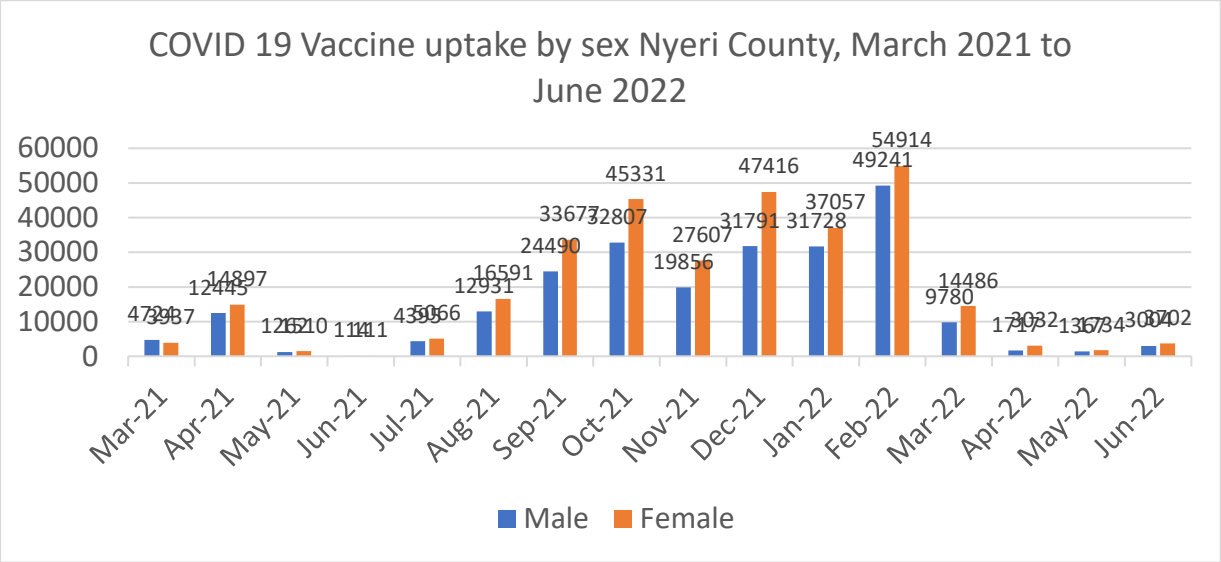
b. COVID-19 vaccination uptake by sex

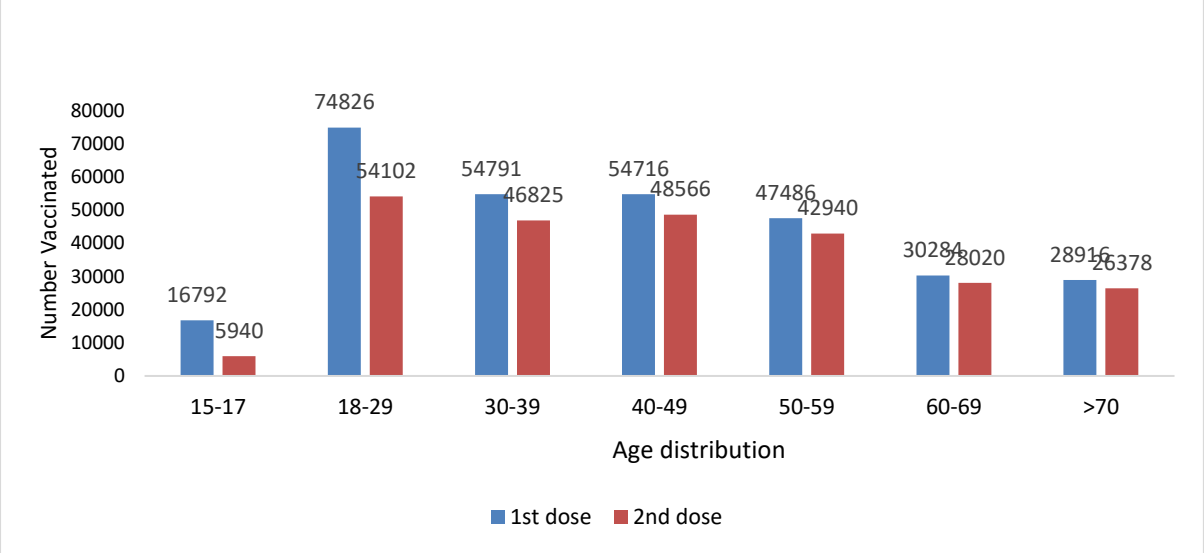
COVID-19 vaccine uptake was high among females across the whole period, with the exception of March 2021. February 2022 had the highest vaccination coverage, with 54,914 females and 49,241 males receiving their first doses. Only 1367 males and 1734 females were vaccinated in May 2021, making the month have the lowest vaccination coverage in the period.

Figure 4: COVID-19 Vaccine First Dose Uptake by Sex from March 2021 to June 2022



Uptake of the first dose was higher than the second dose across all the age cohorts in the period between March 2021 to June 2021. On the other hand, most adult population (above 50 years) returned for the second dose of vaccine in comparison to persons aged below 40 years.

Figure 5: COVID-19 Vaccine Coverage by Age for First and Second Doses



Drivers to Success

Aggressive Rollout Campaign

Immediately after the National TOTs training, the county cascaded the training to service providers, hence the county was able to roll out vaccination sites from the allocated 2 national sites to 10 sites by March 2021. More training in a phased approach gradually saw an increase in immunising facilities from 10 sites to 17, then 24, 56 and later to 135 by June 2021.

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Two thousand five hundred and ten Community Health Volunteers (CHVs) from 251 Community Units were also trained to support immunisation services across all sub-counties. They mainly helped in sensitising the citizenry, hence creating demand for immunisation services. They also played a crucial role in dispelling the myths and misconceptions at that time, something that contributed to increased demand for the vaccines among community members.

County Leadership

Before the actual roll out of vaccination strategies, the County established the COVID-19 Vaccine Deployment Committee (CVDC), whose mandate was to provide overall technical leadership, planning, and strategising implementation process headed by the County Director of Health.

CVDC, together with the County COVID-19 Inter-governmental Committee (CICC), chaired by His Excellency the Governor, met weekly to oversee the overall coordination of vaccination activities.

Outreach Services

Nyeri County was quick to initiate outreach services to the unreached populations within the county. Vaccination teams conducted COVID-19 vaccination community outreach in all 8 sub-counties, integrating it with the delivery of Human papillomavirus (HPV) vaccination in schools.

The county also took deliberate efforts to take advantage of already formed crowds and high traffic areas to offer vaccinations, such as Public Holidays like Mashujaa Day celebrations, burial ceremonies, political rallies and organised community field days to reach more unvaccinated people in the county. Other initiatives included the Moonlight Vaccination initiative, which involves vaccinating at night, Chanjo pap'' at workplaces, among other initiatives.

Integration of COVID-19 Vaccination with other Services

The Department of Health integrated COVID-19 vaccinations during the periodic intensification of routine immunization (PIRI) being carried out in the vaccination sites and schools, reaching more teachers and students. Promoting an integrated systems approach meant that services were more people-centred and able to respond to their needs.

COVID-19 Vaccine Default Tracing

Nyeri County has been able to conduct active defaulter tracing through phone calls with support from Amref Health Africa. A total of 6921 defaulters were identified through the chanjo system from March to November 2021. Clients were asked why they had taken the second dose of the vaccine. The feedback was analysed and the department used the information to provide targeted interventions to counter defaulting and increase second-dose coverage.

Supplemental Immunisation Activities

With support from the Ministry of Health, all 47 counties carried out a 17-day Supplemental Immunization Activity (SIA) and this greatly boosted our vaccination coverage. Fixed and mobile sites were used in vaccine delivery. This yielded 85,149 first doses and 57,654 second doses.

Challenges/Barriers

Weak Pharmacovigilance

Many people experienced side effects, but few reported back to the health care facilities. This was mostly due to health education initially given in health facilities, where people were not given clear instructions to report side effects.

Poor data management: Initially, data capture was through tablets provided by the Ministry of Health. They were few compared to the number of people seeking immunisation services. Coupled with system down times in the initial phases of vaccination rollout could have led loss of data.

Vaccine stockouts: In the first phase of COVID-19 vaccination, major concerns among community members were about the availability of the second dose. Healthcare facilities in densely populated areas quickly depleted their stock after giving first doses and experienced restocking delays by the time people were due for their

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second doses. These uncertainties contributed to low uptake of vaccines as there was no clear information on the effects of delaying the second dose on vaccine efficacy and probable side effects.

Confidence Barriers and Physical/Convenience Barriers

Willingness to receive a vaccine is paramount for a successful vaccination program; hesitancy revolves around vaccine safety and effectiveness as perceived by the person to be vaccinated. In Nyeri county, analysis of 10 months' data on defaulters showed that 1,070 (36% 95% CI 34.28%-37.73%) of the defaulters had not received a second dose for no apparent reason and it would be important to understand the reasons along the continuum of hesitancy barriers.

In the initial phase of vaccine introduction, five facilities were offering COVID-19 vaccination services. Most of these sites were located in the major urban centres and towns, hindering access to a vast majority of the rural population. However, with time, the health department increased the vaccination sites to the current 135, reaching all the primary health care facilities within the communities.

Infodemics

There was a lot of misinformation targeting COVID-19 vaccines, especially during the first phase of the vaccination. Communities were exposed to video posts and text messages containing vaccine falsehoods circulating on social media. Some of the COVID-19 vaccine falsehoods in Nyeri County included that the vaccines were introduced to kill older persons, the vaccines cause infertility, low libido, among others. Populations resulted in a lack of confidence in the vaccine, leading to the government putting in place COVID-19 vaccination regulations in addition to public education campaigns to counter the misinformation.

Adverse Events Following Immunisation AEFIs

Adverse Events Following Immunisation, both reported and unreported, adversely affected vaccine uptake, especially the second dose vaccine. In a defaulter tracing exercise through phone follow-up carried out in Nyeri County in the month of August 2021, 6% of the vaccine defaulters cited vaccine side effects as reasons for not getting a second dose. It was also noted that most clients who came for 2nd dose had experienced mild to moderate AEFI, which could be the reason for the low turn up. AEFIs were largely self-reported, which could have could lead to underreporting, hence incomplete capture of adverse events. In addition, reporting of AEFIs was not emphasised enough, as those with mild symptoms were encouraged to take plenty of oral fluids and analgesics, hence, reporting could have been suboptimal.

DISCUSSION

Demographic Characteristics of Vaccinated Persons

Nyeri County recorded a higher COVID-19 vaccine uptake among females, at 55.20% (95% CL: 55.04%, 55.37%), than males at 44.80% (95% CI: 44.63%, 44.96%). This coincides with a report compiled by the Africa CDC from 15 African countries on COVID-19 vaccine perceptions, which depicted that vaccination coverage was relatively lower among males in comparison to females. This can be attributed to trust in health care providers, together with frequent engagement with maternal health services, which was a critical platform for vaccine delivery (Nganga et al., 2019). Women engage more with health care systems through antenatal care, postnatal care, child welfare clinics and family planning clinics, which fosters trust in health care providers. The same study also elicited that women's role as caregivers also motivates them to seek prevention services could be attributed to better vaccine uptake.

Vaccine uptake among the youth lagged behind and most of the vaccine dropout was seen in the younger age groups, below 39 years. A study on

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determinants of COVID-19 vaccine uptake in Kenya revealed that youths exhibited vaccine hesitancy due to fears of potential side effects and safety issues. Their concerns included rumours about fertility, erectile dysfunction, among other side effects. According to the same study, there was a lot of misinformation circulating on social media, which was the primary source of information for the youths, which fueled the rumours (Osur et al.,2022). Karijo and team (2022) also identified that most youths adopted a cautious approach influenced by uncertainty and low risk perception (Karijo et al., 2021). Africa CDC publication 2021 also stated that young people are more sceptical towards COVID-19 vaccines in comparison to the elderly population (CDC, 2021).

Three-fifths of the target population had received at least a single dose of a COVID-19 vaccine. This is a higher uptake in comparison to the second dose, where less than half of the eligible population were vaccinated. These findings are similar to those of the Ministry of Health COVID-19 vaccine situation report, which equally cites a disparity between first and second dose uptake.

Vaccination Roll-out Strategies and Interventions

The initial rollout strategies for COVID-19 vaccination as shared by the Ministry of Health, Kenya included capacity building for health care workers, public awareness campaigns and establishment of COVID-19 static vaccination sites. A few weeks into the vaccination, the county employed interventions that were geared towards addressing the accessibility barriers to COVID-19 vaccination uptake. Geographical access has been reported as an important factor for any effective vaccination program (Muchiri et al., 2022).

This, coupled with the patient population, was among the factors considered for additional vaccination sites established in Nyeri County. One month after the initiation of COVID-19 vaccination, the static sites increased to seventeen from eight, which was thought to have impacted the vaccine coverage as reported by the end of April 2021.

Given the gradual spread and increase of vaccination sites across the County, accessibility barriers were no longer envisaged to be supply-dependent but demand-dependent. This created the need for other interventions, mostly outreach initiatives, that targeted the hard-to-vaccinate populations. These were defined as hesitant; reachable but difficult to vaccinate due to distrust, religious beliefs, lack of awareness of vaccine benefits and recommendations, poverty or low socioeconomic status, lack of time to access available vaccination services, or gender-based discrimination(Tao et al., 2021). A study conducted in Kenya identified concerns regarding vaccine safety and effectiveness, religious and cultural reasons, and no perceived COVID-19 infection risk among reasons for COVID-19 vaccine hesitancy (Al-Metwali et al., 2021). The County addressed the misperceptions and misinformation by including a health education package in vaccination outreach campaigns. The County engaged trained community health volunteers (CHVs), who are the link persons between health facilities and the local community and these played a critical role in addressing wrong beliefs, distrust, and inadequate knowledge (Jacobson et al., 2015). Community strategies included several outreach interventions that have been reported to significantly increase vaccination coverage. The introduction of “moonlight vaccination”, COVID-19 vaccination campaigns at employer-sponsored events and other outreach activities were designed to combat misinformation and increase coverage among the hard-to-vaccinate groups. In a multisite study conducted in 2013, worksite interventions were found to increase the rate of Influenza vaccination among employees and families, where more than 90% received vaccination at employer-sponsored events (Gagneux-Brunon et al., 2021).

Barriers to Vaccination

The barriers to successful vaccination identified in Nyeri County were: low vaccine uptake among the youth, vaccine stock-out, infodemics and physical inaccessibility.

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Only eight facilities were offering vaccination services during the first phase of the COVID-19 vaccination. Almost all of these sites were located in the major urban centres and towns in Nyeri County, hindering access to a vast majority of the rural population. However, with time, the health department increased the vaccination sites to the current 124, reaching all the primary health care facilities within the communities. This was achieved through the training of additional nurses drawn from selected health care facilities in the county on COVID-19 vaccine administration and data management. A study to identify county-level barriers to achieving rapid COVID-19 vaccine coverage and validate the index against vaccine rollout data conducted across U.S. counties found several barriers that hinder vaccine uptake. These included resource-constrained healthcare systems and healthcare accessibility (Wang et al., 2020).

Data collected over a 10-month period showed that 36% of the people who had received the first dose did not go for a second dose despite vaccines being available in the County.

There was a lot of misinformation targeting COVID-19 vaccines, especially during the first phase of the vaccination. Communities were exposed to video posts and text messages containing vaccine falsehoods circulating on social media. To counter this, the government put in place COVID-19 vaccination regulations in addition to public education campaigns. Similarly, a study on barriers to vaccination for coronavirus disease 2019 in the U.S. found that misinformation on the COVID-19 vaccine was being spread rapidly through social media (Lazarus et al., 2021).

From our findings, healthcare facilities in densely populated areas quickly depleted their stock after giving first doses and experienced restocking delays by the time people were due for their second doses. These uncertainties contributed to low uptake of vaccines because there was no clear information on the effects of delaying the second dose on vaccine efficacy and probable side effects. In contrast, a study in Saudi Arabia reported that even though there was enough vaccine supply throughout the first and second dose vaccine administration, vaccine demand and uptake slowed down during the second phase (Al-Mohaithef & Padhi, 2020).

CONCLUSION AND RECOMMENDATIONS

For the county to achieve at least 80% vaccination coverage among the adult population, deliberate efforts should be made to reduce barriers to vaccination. Creating an enabling environment through increasing the number of vaccination sites will ensure that vaccines are available to the entire population. Similarly, harnessing social influences will ensure that misinformation and disinformation will not deter people from getting vaccinated. At the same time, tailoring health messages specifically to young people will reduce the number of unvaccinated youths in the county.

Demand Creation

Demand creation, especially among the youth, will play a key role in increasing COVID-19 vaccine uptake. Various strategies, such as the use of mass media, reviving outreach services in schools, offering incentives to the youth, among others, can be employed to boost vaccine uptake among the youth.

Breaking Access Barriers

As a standard practice in immunisation, everybody who is eligible and desires to get a vaccine should ideally be able to access it. However, the current situation is that access to vaccines is not fairly distributed either due to distance to health facilities, inadequate outreach services, insufficient information, among others. To ensure fair access to vaccines, Nyeri County has worked tirelessly to ensure that COVID-19 vaccination his integrated into the routine immunisations. This has ensured that vaccines are brought closer to people. The county has also made all efforts to ensure that COVID-19 vaccination has been embedded in other activities, such as school health services, especially HPV vaccination and vitamin A supplementation. This

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has seen a continuous increase in vaccine coverage over the months.

Youth and Access to Services

COVID-19 vaccination coverage has been the lowest among the youth in Nyeri County. The low coverage among this section of the population is evident across Kenya. Nyeri County, and Kenya at large, has to make deliberate interventions to address the complacency and demand barriers and create vaccine demand among its youth. The county department of health services should develop youth-specific COVID-19 messaging on the research findings highlighting the long-term health effects of contracting the disease to disqualify the youths' notion of not being at risk of COVID-19-related complications. Similarly, the department should engage various partners to hold targeted COVID-19 vaccine promotion and vaccination outreaches to learning institutions to bring vaccines closer to the youth and respond to their questions. The main source of information, especially among the youth, was social media. The County can use social media influencers on major platforms such as TikTok, Facebook, Instagram, Twitter, among others, with targeted health messages. The observed differences in demand across gender and age also call for gender sensitive strategies.

Effective Communication Strategies

Health promotion strategies to communicate COVID-19 risk and the importance of COVID-19 vaccination should be tailored towards the targeted sections of the population. The government should continue utilising the established media stations with wide coverage, including the vernacular stations using simple language that local people can relate to and understand. Further, use champions who describe their real-life experiences to demystify misinformation while highlighting the risk COVID-19 continue to pose to individuals and communities. Trained healthcare workers should spearhead the COVID-19 vaccination strategies to avoid the spread of misinformation.

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