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Original Paper

Routine Child Immunization during the COVID-19 Global Pandemic in Eswatini: Challenges, Loss of Gains and Benefits

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Abstract

Introduction: *Timely uptake of immunisations by all children at immunisation ages is key towards maintaining good health and protecting lives of the 80 million children worldwide. Disruptions of healthcare systems due to the impact and spread of coronavirus disease (SARS-CoV-2) created an issue of public health importance that required to be addressed in order to preserve gains in child survival statistics.*

Method: *This analysis aimed at assessing the performance of child immunisation initiatives in Eswatini during COVID-19. Data on child immunisation before and during COVID-19 (i.e. before December, 2019 and for the year January to December 2020) was sourced from vaccination records kept by the Expanded Programme on Immunisation (EPI) and from the Health Management Information System (HMIS) of the Ministry of Health in Eswatini.*

Results: *Most child immunization rates for different diseases in 2019, before COVID-19, were generally above the cumulative target. The only disease with cumulative immunisation rates below the cumulative target was MR2. The cumulative number of children unimmunised against MR1 shows an exponential increase in 2020 following implementations of strategies to reduce spread of COVID-19. Our study suggests that the implementation of routine immunisations between March 2019 and 2020 suffered logistical constraints such as: the supply of vaccines, delivery cold chain problems, staff shortage due to reallocation of nurses and doctors to work on COVID-19 and some testing positive to SARS-CoV-2 infection and having to go into quarantine and isolation.*

Discussion: *Delayed or missed immunisations created a large cohort of children that became susceptible to infection due to lost herd immunity. Increased number of unimmunised children against*

MR1 and the other vaccine preventable childhood diseases while the country focused on reducing transmission of COVI-19 is likely to have created a large pool of susceptible children from which epidemics could arise. As such, the reported outbreaks of mumps, measles, etc, could be as a result of the large pool of unvaccinated children resultant from COVID-19 partial lockdown.

Conclusion: *Epidemics of some of these vaccine preventable childhood diseases could result in catastrophic consequences of unimaginable proportions and deaths among children. Therefore, efforts should always be made to ensure gains in routine child immunisations are never lost during epidemics such as COVID-19.*

Keywords

SARS-CoV-2, Coronavirus Disease, COVID-19, Immunisation, Child Immunisable Diseases, Eswatini

Introduction

The Government of the Kingdom of Eswatini recommends that childhood vaccinations should be given timeously and routinely and this recommendation stood even during the outbreak of the COVID-19 pandemic. Among children of immunisable age, the risk of death from vaccine-preventable diseases outweighs by far the risk of death from COVID-19 contracted during visit to healthcare facilities (Abbas et al., 2020). The Expanded Programme on Immunisation (EPI) of the Kingdom of Eswatini engaged several strategies to identify 90% of children that were eligible for vaccination. Routine immunisation generally improved the health of many children and reduced mortality, especially among children in the Kingdom of Eswatini. The sustenance of gains achieved through many years of health promotion, particularly encouraging mothers to bring their children over to immunisation centres and health facilities needs to further advance the public health gains and maintain progress towards achievement of set goals such as the elimination of vaccine preventable diseases like poliomyelitis, measles, rubella and maternal tetanus. The Immunisation Agenda 2030 is a strategy of the World Health Organisation that was launched in 2020 with the aim of accelerating progress towards equitable access and use of vaccines over the new decade.

The outbreak of coronavirus disease in 2019 (COVID-19) was first reported in Wuhan, China and later described to be caused by a novel virus, SARS-CoV-2, that caused severe acute respiratory syndrome (Lu et al., 2020; Gorbalenya et al., 2020). Compared to the coronavirus that caused severely acute respiratory syndrome (SARS), the transmissibility of this virus was reported to be higher, with estimated basic reproductive number of 2.24 – 3.58 depending on the setting (Lai et a., 2020). By January 2020, the disease had spread to most countries in Europe and outbreaks were later reported in Africa (Nkengasong and Mankoula, 2020; WHO, 2020). On January 30, 2020, the World Health Organisation declared COVID-19 a public health emergency of international concern (WHO, 2020). In a study conducted at the peak of COVID-19 infections, scientists showed that the benefit of sustaining routine immunisation in Africa is much greater than the risk of COVID-19 deaths that could result from visiting health services for immunization (CMMID nCov Working Group, 2020). This evidence

underscored the value of immunisation during COVID-19 and provided justifications for rapid action from governments and their partners. Hence, policymakers were required to quickly identify robust and context-specific strategies to rapidly scale up routine immunisation in order to mitigate the impact of COVID-19 on their national immunisation performance.

In the Kingdom of Eswatini, the first case of coronavirus infection was confirmed on 11 March, 2020. By 06 April, the country had confirmed 10 cases and all had a history of external travel or contact with someone who had travelled. It was soon thereafter that cases with no history of travel or contact with someone who had travelled outside the country started to be reported, suggesting that local transmission could have started at or about the second week of April. The Government of the Kingdom of Eswatini declared COVID-19 a national disaster in terms of the Disaster Management Act No.1 on the 17th March, 2020 and subsequently promulgated the Coronavirus Regulations 2020 to guide national efforts towards containing the spread and effects of COVID-19 infections. One of the many initiatives to contain the spread and effects of COVID-19 was to enforce a partial lockdown with the objective of increasing physical distance through restriction of movements. Following the forced restriction of movement (partial lockdown, businesses, shops, healthfacilities, transport systems, etc closed down and persons that were found travelling were subjected to spot fines by police that supervised adherence to the partial lockdown regulations. The aim of this analysis was to determine whether child immunisation processes were affected during the COVID-19 pandemic and to establish what exactly could have caused the changes.

Methods

We analysed patient records from primary care to describe changes in delivery of first doses of DPT1, DPT3, MR1, MR2 and IPV coverage from January 2019 to December 2020. Data on child immunisation before and during COVID-19 (i.e. before December, 2019 and for the year January to December 2020) was sourced from vaccination records kept by the Expanded Programme on Immunisation (EPI) and from the Health Management Information System (HMIS) of the Ministry of Health in Eswatini. The data was entered into an excel spread sheet that was used to describe the data using tables, graphs and charts. Data on the population of children legible for immunisation in 2019 and 2020 was obtained from the Heath Statistics Offices (CSO). Chi-square was used to determine differences in the immunisation rates between similar periods in 2019 and 2020 using the t-test. A probability difference of $p < 0.05$ was considered significant.

Results

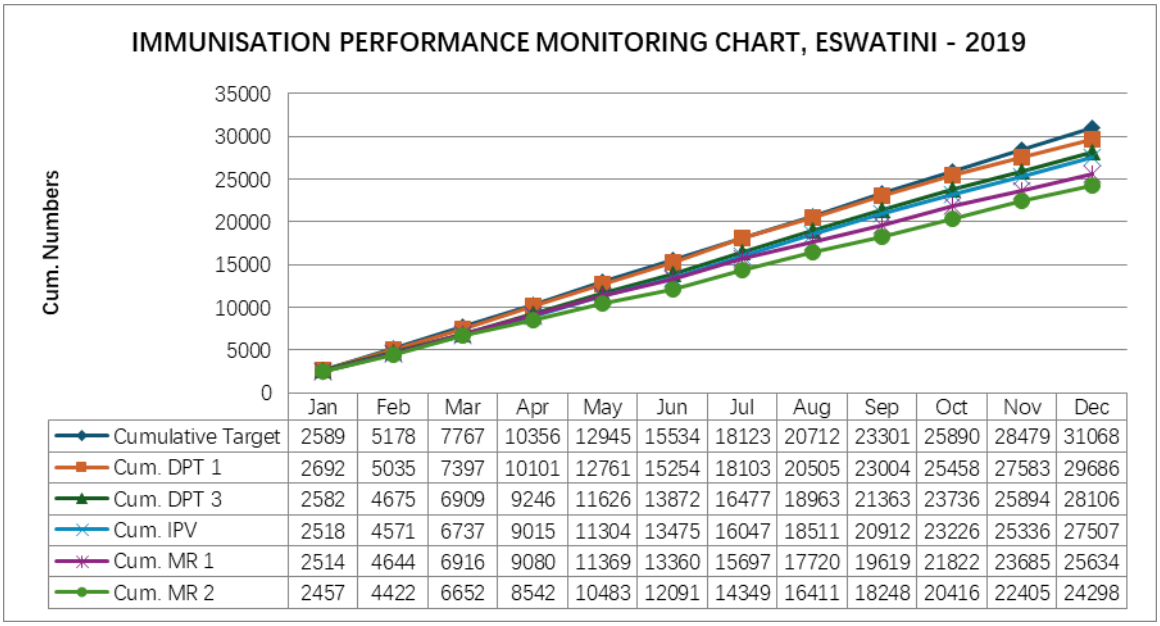
COVID-19 Outbreak and Response

On December 31, 2019 reports of the outbreak of an “unknown pneumonia-like viral infection” were received from Wuhan, China, and was immediately referred to as 2019 coronavirus (WHO, 2019a,b). The Kingdom of Eswatini confirmed the first case of coronavirus disease (COVID-19) on March 11,

2020. Following this event, the country's government, acting on recommendation from the Ministry of Health and the World Health Organisation, immediately implemented a partial lockdown. The lockdown involved restriction of movement and closure of schools in order to reduce transmission of COVID-19 by contacts. Schools remained closed for almost a whole year from March 2020 to March 2021. Child immunisation was impossible during the partial lockdown which lasted for more than a year mainly because mothers of children were also restricted from making any movement along the streets. Public transport which is used by many mothers when taking their children to health facilities, was also not available.

Immunisation rates

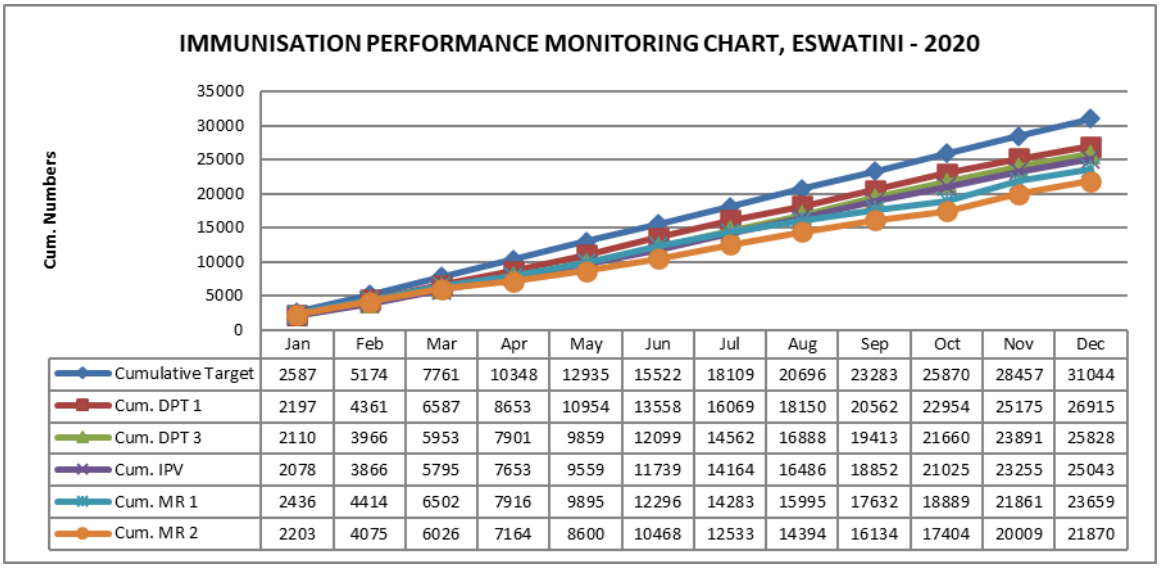
Most child immunisation rates for different diseases in 2019, before COVID-19, were generally above the cumulative target. The only disease with cumulative immunisation rates below the cumulative target was MR2 (Figure 1).



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cumulative Target	2589	5178	7767	10356	12945	15534	18123	20712	23301	25890	28479	31068
Cum. DPT 1	2692	5035	7397	10101	12761	15254	18103	20505	23004	25458	27583	29686
Cum. DPT 3	2582	4675	6909	9246	11626	13872	16477	18963	21363	23736	25894	28106
Cum. IPV	2518	4571	6737	9015	11304	13475	16047	18511	20912	23226	25336	27507
Cum. MR 1	2514	4644	6916	9080	11369	13360	15697	17720	19619	21822	23685	25634
Cum. MR 2	2457	4422	6652	8542	10483	12091	14349	16411	18248	20416	22405	24298

Figure 1. Routine Child Immunisation Performance before COVID-19 in Eswatini, 2019

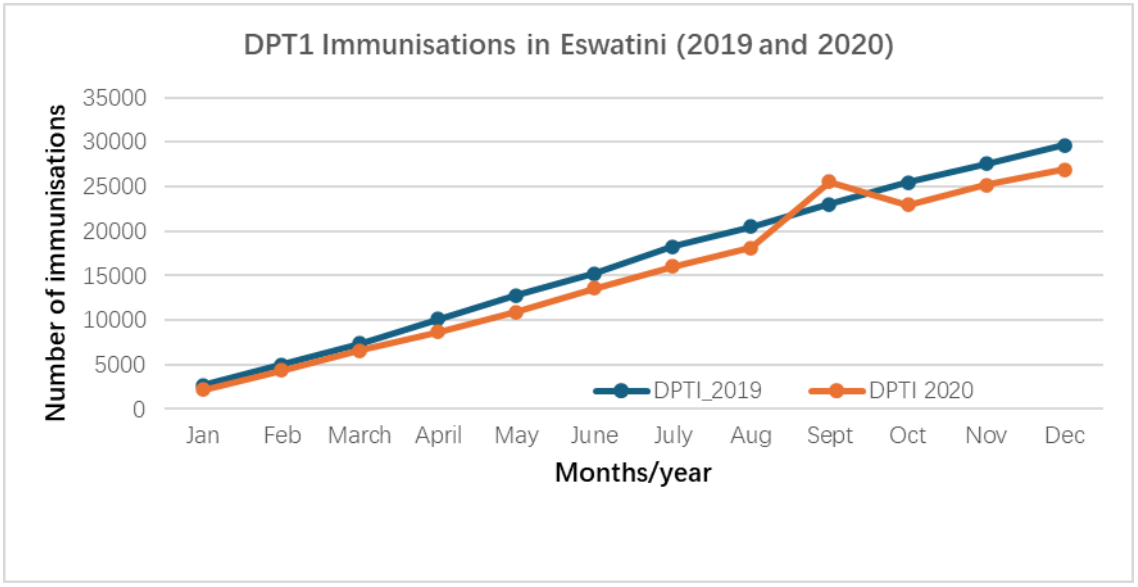
Following introduction of COVID-19 in the country in 2020 and implementation of strategies to reduce transmission, including physical distancing and travel restriction or partial lockdown, all cumulative child immunisation rates fell below the cumulative target in Eswatini (Figure 2). Prior to implementation of COVID-19 restrictions, the country had achieved its targets of 90% and above on most immunisation of the vaccine preventable diseases.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cumulative Target	2587	5174	7761	10348	12935	15522	18109	20696	23283	25870	28457	31044
Cum. DPT 1	2197	4361	6587	8653	10954	13558	16069	18150	20562	22954	25175	26915
Cum. DPT 3	2110	3966	5953	7901	9859	12099	14562	16888	19413	21660	23891	25828
Cum. IPV	2078	3866	5795	7653	9559	11739	14164	16486	18852	21025	23255	25043
Cum. MR 1	2436	4414	6502	7916	9895	12296	14283	15995	17632	18889	21861	23659
Cum. MR 2	2203	4075	6026	7164	8600	10468	12533	14394	16134	17404	20009	21870

Figure 2. Routine Child Immunisation Performance during COVID-19 in Eswatini, 2020.

Increased number of unimmunised children against all child vaccine preventable diseases while the country focused on reducing transmission of COVI-19 is likely to have created a large pool of susceptible children from which epidemics could arise. Post-COVID-19, the Ministry of Health in Eswatini and those of other countries in similar situations cannot guarantee that epidemics from immunizable diseases will not occur. Reduced immunisation rates has created a pool of unimmunised children and it reduces herd immunity among children in the community.



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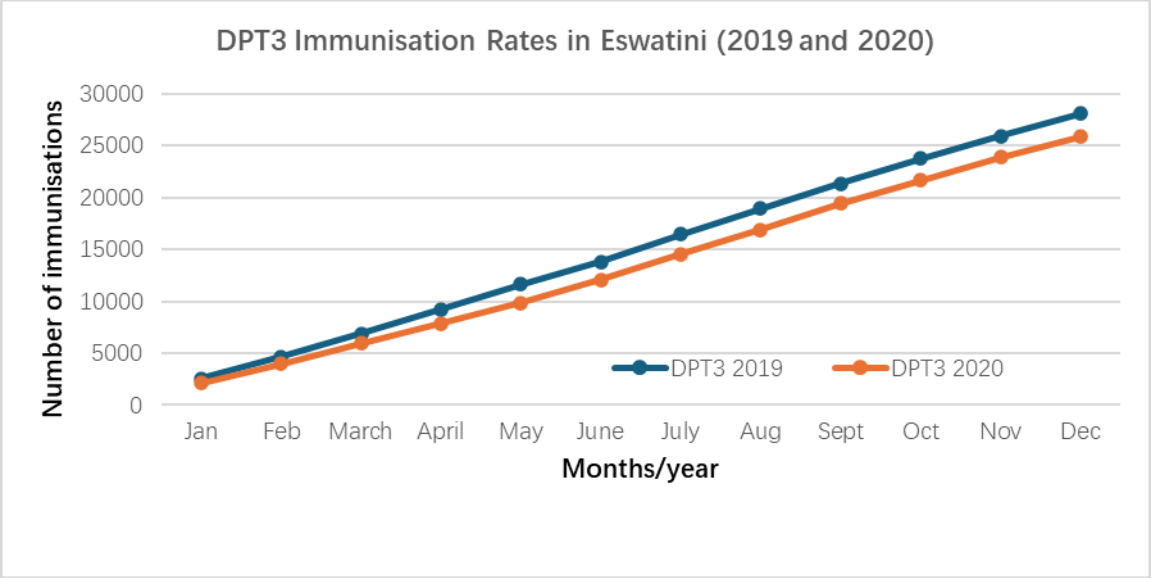
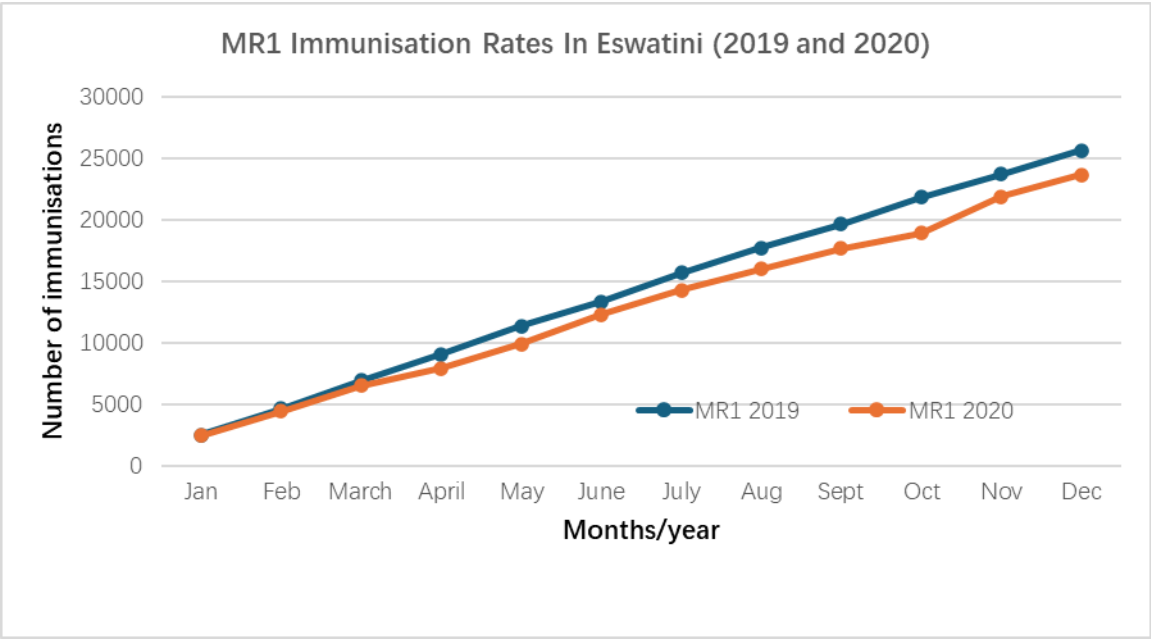


Figure 3. Cumulative Immunised Children against DPT1 and DPT3 between 2019 and 2020 in Eswatini

Between 2019 and 2020, a cumulative total of 2 771 (9.33%) DPT1 immunisations were missed and 2280 (8.11%) missed their third dose (DPT3) (Figure 3). Actually, this number could be more because our calculations did not consider increase in birth rate between the two years. Nonetheless, these children could develop symptoms of diphtheria, pertussis or tetanus as a result of the missed vaccinations against these diseases which has increased their susceptibility.



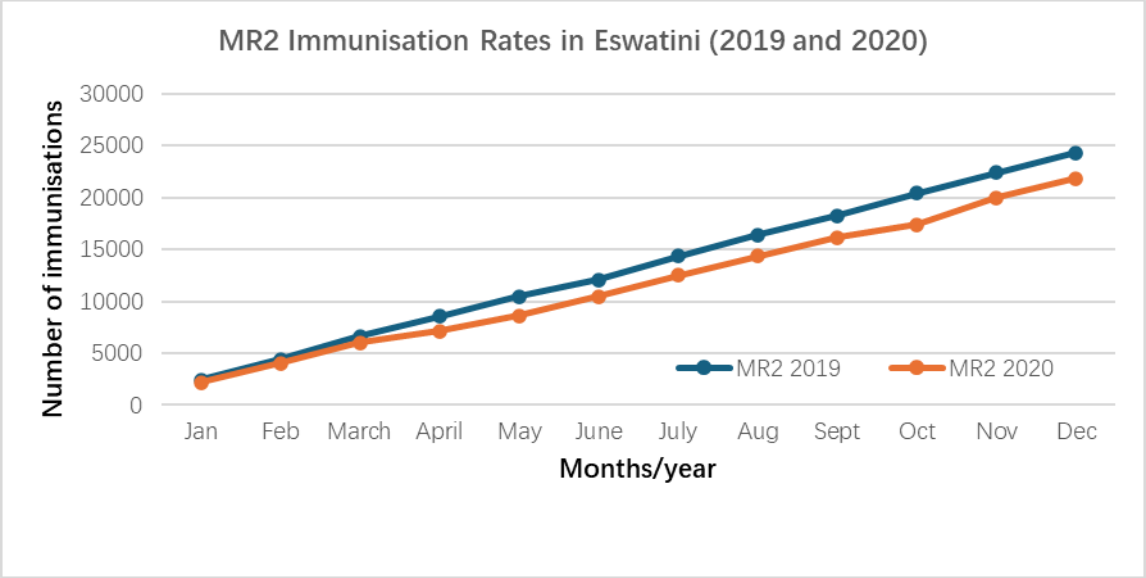


Figure 4. Cumulative Immunisation Rates against MR1 and MR2 between 2019 and 2020 in Eswatini

The cumulative number of children that missed (measles and rubella) MR1 immunisation in 2020 was 1 995 (7.70%) (Figure 5), suggesting that these children were not protected from measles and rubella. The cumulative number of children unimmunised against MR1 shows an exponential increase in 2020 following implementations of strategies to reduce spread of COVID-19 (Figure 5). A total of 2 428 children missed their second dose (MR2), representing 9.99%. Reports suggest that Eswatini measles cases was at level of 64 in 2022, up from 29 the previous year (2021), which represents a change of 120.69%. Such a huge increase could partly be explained by the missed immunisations during COVID-19 partial lockdown. The figure below (Figure 5), shows the number of cumulative unimmunised children against MR1 in 2020 against the cumulative unimmunised target. From this figure, we can see that from January, the cumulative number of unimmunised children continued to increase way above the cumulative target of unimmunised children in 2020.

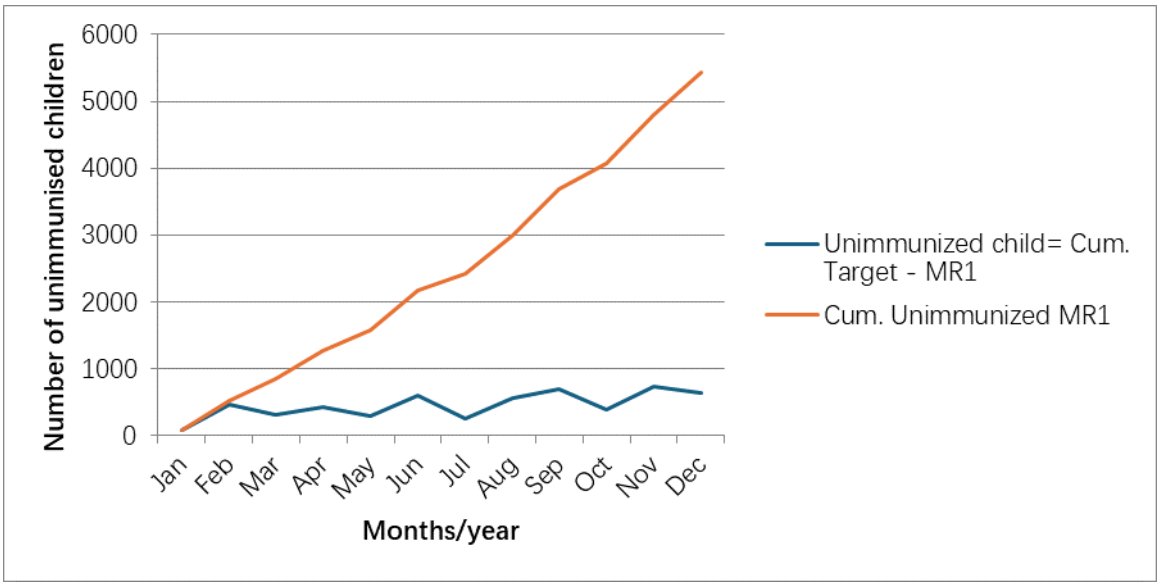


Figure 5. Cumulative Unimmunised Children against MR1 in Eswatini, 2020

A total of 2 464 (8.96%) immunisations of inactivated polio vaccine (IPV) could not be conducted in 2010 (Figure 6). Fortunately, wild polio virus has been eliminated from the continent of Africa, but reports of circulating vaccine derived polio virus disease continue to be received. Also, because of the ease of travel, visits between Eswatini and Pakistan or Afghanistan have increased in recent years, suggesting that importation of wild polio viruses still remain a global and national threat. Therefore, 2 464 (8.96%) unimmunised children were at risk of acquiring poliomyelitis and initiate local transmission if it happened that viruses were imported.

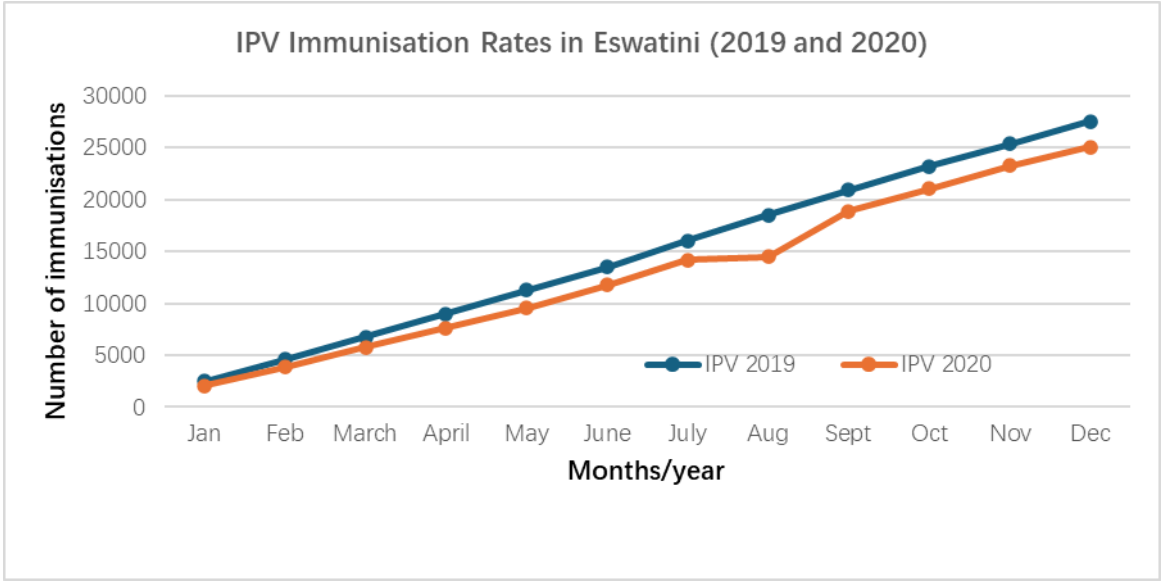


Figure 6. Cumulative Immunisation Rates against IPV between 2019 and 2020 in Eswatini

The table below (Table 1) shows the total number of immunisations that were missed in 2020, based on the total number in 2019. These estimates assume that all the children in 2019 remained at immunisable ages in 2020 and does not take into consideration children born between 2019 and 2020 who added to the immunisable number.

Table 1. Number of Immunisations Conducted for DPT1, DPT3, IPV, MR1 and MR2 in 2019 and 2020 in Eswatini

Immunization type	2019 Total Immunised	2020 Total Immunised	Difference	Proportion
DPT1	29686	26915	2771	9.33%
DPT3	28106	25828	2280	8.11%
IPV	27507	25043	2464	8.96%
MR1	25634	23659	1995	7.70%
MR2	24298	21870	2428	9.99%
TOTAL			11 938	

A total of 11 938 immunisations for the different vaccine preventable diseases considered in this analysis among children in Eswatini did not receive their routine immunisations, suggesting that they remained susceptible to infection by each of these vaccine preventable diseases. The differences between immunisation numbers between 2019 and 2020 were found to be non-statistically significant, probably because the decline was only beginning during the same year of implementation of the partial lockdown. Nevertheless, though not significant, the consistent decline on immunisation levels for all immunisable diseases is good reason to believe that this was due to the implementation of the response to the COVID-19 outbreak.

Public transportation services

A common constraint was the inability of health workers in some settings to reach health facilities because of disruption to the public transport systems caused by lockdown. This was likely to be more prominent in underserved and poor communities where alternative options might be limited. To address this, a special transportation scheme could have been introduced to improve the mobility of health workers. To ease caregiver movement through roadblocks and promote adherence to the immunisation schedule, the child home-based record could have been regarded as a ‘pass’ at police mounted road blocks aimed at ensuring adherence to travel restrictions. Public transportation services are vital in ensuring that parents and children access immunisation points when required to do so. The partial lockdown in Eswatini also resulted in halting of public transportation services throughout the country. The UNICEF Country Office Annual Report for Eswatini (2022) suggested that 59 per cent of the population lived below the national poverty line and that 20.1 per cent were in extreme poverty. This statistic suggests that more than half of the households probably do not have any mode of transport and

rely on public transport to access healthcare, including immunisation centres. An estimated 60% of the population do not have any form of employment and the country is actually listed as one of those with the highest poverty rates in Southern Africa. With all public transportation modes adhering to the partial lockdown in the country, access to health facilities was hindered. In addition to unavailability of transport, many countries, including the Kingdom of Eswatini, reported frequent stock-outs of fuel that could have been used to fuel the cars if transport was available. The frequent stock-outs of fuel prevented even those with private modes of transport to reach health facilities even when they experienced emergencies or to access routine health services such as those related to immunisation. Fuel depots (stations) were allowed limited operation times resulting in many motorists remaining at home for the period of the partial lockdown.

Community mobilisation activities

Social mobilization remains a key health promotion strategy used by low- and middle-income countries (LMICs) to promote adherence to immunisation requirements. Implementation science also emphasizes the need to tailor information needs to the demand of different stakeholders. Some caregivers delay or refuse to immunise their children even when immunisation services are available for various reasons that can be contextual (e.g. historical influences, religious and cultural beliefs), individually-driven (e.g. lack of awareness, knowledge gaps, negative vaccination experience, lack of perceived benefits), and vaccine- or vaccination-specific (e.g. adverse events following immunisation, administration of multiple vaccines at a single visit, concerns about new vaccine introduction, distrust in vaccine manufacturer). In 2019, the WHO declared vaccination delays and refusals linked to vaccine hesitancy among the top-ten global health threats (WHO, 2019c). The importance of infant immunisation requires continued emphasis to motivate caregivers to continue scheduled immunisation visits according to plans made with health facilities. Health facility nurses and staff from the the Expanded Programme on Immunisation (EPI) engage in community mobilisation activities to sensitize parents to bring their children for immunisation. Commonly, mobilisation processes take an inter-sectoral approach with other sectors providing health promotion activities and transportation to health facilities in support of supplementary immunisation initiatives. During the partial lockdown, healthcare staff could not travel to areas where community mobilisation activities are required to be held (such as in hard to reach areas), either because of restricted movement or lack of transport. Persons that would attend such activities were forced to remain at their homes and those seen travelling were arrested or fined by the police.

Human resources

The need to provide COVID-19-related services, including immunisation, on top of the burden of maintaining routine and essential service provision resulted in the overburdening of the health workforce in Eswatini. Healthcare staff involved in the provision of immunisation services were re-deployed to combat the spread of COVID-19, which was largely viewed by the government of the Kingdom of Eswatini as a severely emergent situation. Re-deployment of health workers responsible

for immunisation services during periods of crisis should be minimized or avoided if possible, as it can lead to long-term negative consequences (WHO, 2020e). The emergence of epidemics such as COVID-19 and similar disruptive emergencies suggest that governments should respond by expanding the healthcare staff in order to cope with the additional requirements of protecting citizens of the country. New health workforce networks developed for the COVID-19 response play a critical role in the equitable delivery of vaccines and strengthening of primary health care services in a post-pandemic world. As the country moves past the emergency period of the COVID-19 pandemic, there may be opportunities to maintain this expanded workforce to support routine and life-course immunisation, mobile teams, new vaccination sites, multi-antigen vaccination campaigns, and routine health screenings. However, in the absence of funds reserved to pay for such additional staff requirements, healthcare staff was re-deployed while leaving essential services such as the provision of immunisation activities at deplorable states. Sustaining and building on progress for health workforce development also requires an understanding of workforce needs and capacities to better support health facilities during health emergencies and with routine health services. Health workforce information systems contain data on the number of health workers in specific geographic areas, helping to identify shortages and gaps in workforce capacity and training, availability of services, and personal protective equipment (PPE) and infection prevention and control equipment needs. In Indonesia, the Ministry of Health utilized the *System Informatasi Sumber Daya Manusia Kesehatan* (SI-SDMK), a human resource for health information system, to strategically deploy health workers and maintain essential services with access to data on staffing, workload, incentives, and PPE needs. The data also helped health leaders in Indonesia develop daily situational reports during the COVID-19 pandemic, allowing districts and local health teams to make data-driven decisions based on how health workers were distributed across the country relative to the epidemiologic situation and availability of infection prevention and control resources.

Financial support

The introduction of SARS-CoV-2 resulted in the country requiring substantial amounts of funding to fight COVID-19. In the absence of adequate funds reserved for such emergent situations, the Ministry of Health only had to rely on funds reserved for other disease control programmes including immunisation activities. Understandably, countries such as the Kingdom of Eswatini, with a low GDP per capita income, sustained low immunisation coverage because of having no supplementary budget to address the huge financial requirements to cope with COVID-19 challenges. As part of the planning process, there is a need to understand what financial resources may be available from external sources, and the extent to which these can be aligned with the zero-dose agenda of the country, with the main aim to regain vaccination loses during the COVID-19 pandemic. However, a challenge in donor coordination is that different stakeholders control various financing mechanisms. For the Gavi and Global Fund, the Ministry of Health decides what is included in funding applications, whereas for the World Bank, Asian Development Bank, and IMF, the Ministry of Finance plays this role. In contrast,

the bilateral (e.g., USAID) and private (e.g., Bill and Melinda Gates Foundation) donors have a more direct position in deciding how funds are used. This means that many different stakeholders would need to be engaged to ensure that funding is directed towards reaching zero-dose children. Information on funding disbursement and utilization is crucial for greater transparency, facilitating more substantive operational discussions between governments and donors. This transparency not only enables clear and coherent planning throughout the project and grant period but also fosters accountability for both donor organizations and country governments. By ensuring that funds are used in alignment with agreed-upon priorities, transparency supports the pursuit of renewed national objectives, particularly in identifying and reaching zero-dose children. Ideally, organizations should publicly disclose comprehensive details about the funds available to countries, including the channels through which they are provided and the implementing agents responsible for administering the funds within each country. Whilst organizations, such as the World Bank and Asian Development Bank, publicly provide this information on their project documentation, other organizations provide limited information. Greater transparency in this sense helps alleviate the burden on country governments, especially in low- and middle-income countries, such as the Kingdom of Eswatini, with limited capacity for donor coordination, while also promoting greater donor–donor harmonization.

Supply chain for vaccines

The COVID-19 pandemic affected over 200 countries and territories across all regions, including countries from which UNICEF procures essential commodities for children. Vaccine suppliers to UNICEF indicated that they were experiencing some disruption in production due to lockdown measures in countries where staff were not able to travel to work to support production. In week 13 (week of March 22, 2020), there was a collapse in the airline industry, where shipments of vaccines were significantly impacted as a result. The dramatic decline in available flights, compounded by lockdowns of receiving countries where airports were closed impeded UNICEF's ability to ship vaccines as per country and supplier shipment plans. Many destinations remained difficult to access with limited flight and charter options, in addition to country lockdown and airport closures. Land-transit options were used to ensure vaccines are delivered to countries, in addition to coordination with other aid agencies to consolidate shipments where feasible. However, these options resulted in increasing costs significantly above the budgeted estimates funded by donors and countries for shipments, although they later became more predictable to increase options to secure financing. As a consequence of the supply disruptions, countries across West and Central Africa (WCARO), East and southern Africa (ESARO) (including Eswatini), East Asia (EAPRO), and South Asia (ROSA) indicated vaccine stocks reaching critical levels, including for measles; Bacillus Calmette-Guérin (BCG); pentavalent (diphtheria, tetanus, pertussis (whooping cough), hepatitis B and haemophilus influenzae type B); human papillomavirus (HPV); hepatitis B; oral polio vaccine (OPV), rotavirus and pneumococcal conjugate vaccine (PCV). However, the situation was reported to be changing daily as cargo or charter flight options were arranged to mitigate the risk of stockouts in countries. As a result of

slowdown of consumption/demand, countries started experiencing a risk of vaccines reaching expiry before they can be used, and delayed shipments of some vaccines, further putting stress on suppliers that have produced vaccine in accordance with planned forecasts.

Discussion

Vaccine-preventable disease (VPD) remains an important public health issue that requires adherence to recommendations to prevent severe illness or death among children (Bianchini et al., 2019). According to the World Health Organisation (WHO), VPD is a threat to 80 million children worldwide because of the disruption of healthcare systems during the COVID-19 pandemic (Burton et al., 2009). In July 2022, WHO and UNICEF published updated vaccination coverage estimates, which revealed the largest sustained decline in childhood vaccination coverage in 30 years (UNICEF, 2022). It is estimated that 25 million children missed out on one or more doses of diphtheria–tetanus–pertussis (DTP) in 2021; of these, 18 million children did not receive even one dose of the DTP vaccine. This population group, known as zero-dose children, represents those who did not receive a single vaccine. On March 26, 2020, the World Health organisation issued guidance on the operation of immunisation programmes during the COVID-19 pandemic (WHO, 2020c). The guidance called for temporary suspension of mass vaccination campaigns; routine immunisation programmes were advised to be sustained in places where essential health services had operational capacity of adequate human resources and vaccine supply, while maintaining physical distancing and other infection control measures. Unfortunately, low- and middle-income countries such as Eswatini operational capacity was a challenge even before the emergence of COVID-19. The World Health Organisation issued Regional Strategic Plan for Immunization (2014 – 2020) (WHO, 2015). This strategic plan was intended to help shape national strategic plans so as to improve (i) harmonization in eliminating inequities in access to immunization services both within countries and across the Region, (ii) equity in access to human and financial resources needed to achieve this goal, and (iii) mutual accountability between governments and their domestic and international partners. The monitoring and evaluation framework appended to this strategic plan provides national, regional and global standards for accountability goals (WHO, 2015). Countries were still in the process of operationalizing this strategy when COVID-19 restrictions hit hard on their plans and WHO herself advised for halting of immunization activities in order to combat the spread of COVID-19. A modelling study conducted by the World Health Organization (WHO) predicted that with widespread community transmission, an estimated 223 281 401 (representing 22% of the Africa's population) will become infected within a year following introduction of coronavirus disease in 2019 (Cabore et al., 2020). These modelling results suggest that the impact of COVID-19 were still going to affect routine immunization plans for many African countries.

In addition to facility-based immunisation, the Expanded Programme on Immunisation (EPI) in Eswatini utilises schools and public health centres to reach out to children and facilitate immunization especially during supplementary immunisation days. Because of the partial lockdown implemented by

the Kingdom of Eswatini in response to SARS-CoV-2, children could not go to school or were not allowed to leave their homes. School closure was a vital intervention strategy implemented by the Government of Eswatini to partially curb community transmission of coronaviruses during the pandemic in the country. As such, supplementary immunisation days (SIDs) were not possible to conduct during the partial lockdown period since such initiatives utilised schools to access child immunisation age groups.. Our findings in Eswatini are in line with reports of postponed or unknown status of supplementary immunisation activities for 17 African countries in 2020 (WHO, 2020d). Operational regulations enforced by the Government of the country emphasised that both parents and children had to stay at home during a four month partial lockdown period (17 March – July, 2020).

Our study identified that the implementation of routine immunisation suffered logistical constraints such as: the supply of vaccines, delivery cold chain problems, staff shortage due to reallocation of nurses and doctors to work on COVID-19 and some healthcare workers testing positive to SARS-CoV-2 infection and having to go into quarantine and isolation and some even passing on. Healthcare staff with underlying conditions were at increased risk of COVID-19 and hence, were allowed to stay away from their work stations. Earlier findings reported five occupational groups with the most cases being healthcare workers (HCWs) (22%), drivers and transport workers (18%), services and sales workers (18%), cleaning and domestic workers (9%) and public safety workers (7%). This statistic suggests that healthcare staff were a majority among those who died or were severely ill during the COVID-19 pandemic. Possible work-related transmission played a substantial role in early outbreak (47.7% of early cases). Occupations at risk varied from early outbreak (predominantly services and sales workers, drivers, construction labourers, and religious professionals) to late outbreak (predominantly HCWs, drivers, cleaning and domestic workers, police officers, and religious professionals) (Lan et al., 2020).This information is in agreement with our findings that personnel supporting immunisation e.g. HCWs, drivers and transport workers, services and sales workers were at higher risk of infection with COVID-19, hence some were affected, reducing access to supply and discharge of immunisation services. Most of the studies to date focus on occupational exposure among healthcare workers (HCWs). Work-related transmission among HCWs constituted a large proportion in previous coronavirus outbreaks. HCWs comprised 37–63% of suspected severe acute respiratory syndrome (SARS) cases in highly affected Asian countries, and around 43.5% of Middle East Respiratory Syndrome (MERS) cases (Chowell et al., 2015; Twu et al., 2003; Peck et al., 2004).

Currently, there is no evidence suggesting that transmission of SARS-CoV-2 will not continue or re-emerge and cause epidemic waves in the future in many countries as has been observed among countries in the northern hemisphere who go through very cold winter seasons. As such, in order to safeguard against losing the gains from routine child immunisation, there was a need to quickly implement mitigation measures to ensure that routine immunisation targets are maintained or regained. Without such mitigation measures during COVID-19, the World Health Organisation targets of eliminating vaccine preventable diseases by 2030 will not be achieved. In fact, with a large cohort of

unvaccinated children, herd immunity would be lost resulting in increased number of vulnerable children (CDC, 2020). Besides, failure to prevent illness from vaccine preventable childhood diseases could result in catastrophic consequences that are worse than those resulting from COVID-19 among children. For example, if measles vaccination coverage of 90%-95% (the level needed to establish herd immunity) is not achieved, measles outbreaks can occur. Also, SARS-CoV-2 and MERS-CoV seem to less commonly infect children and to cause milder symptoms, and are associated with much lower case-fatality rates and most children recover quicker than adults from the infection (Ludvigsson, 2020; Mansourian et al., 2021). The mysterious lower global symptomatic illness and rate of fatality among children could be advocated to the global active immunisation of children from birth to six years. Vaccinations against varicella, Hepatitis B, MMR, Poliomyelitis and rotavirus could build immunity against SARS-CoV-2 providing protection of lung cells from invasion (Steinglass, 2013). The occurrence of cross reactivity between vaccination and other viral genera including serum antibodies of HIV that emerged after measles vaccination have been reported (Baskar et al., 1998). Most routine viral vaccines have the ability to stimulate T Helper 1 cells (CD4+) to secrete many different types of cytokines such as interferon-gamma, interleukin-2 (IL-2), and interleukin-12 (Baskar et al., 1998). Some of these cytokines provoke maturation of the killer T cells and improve cytotoxicity of natural killer cells which recognise and destroy virally infected cells. For these reasons, measures to promote child immunisation during COVID-19 remain important and could further protect children from infection with SARS-CoV-2 or even death. Children are potential asymptomatic carriers of COVID-19 and, like adults, can transmit the infection among the population, suggesting that reducing child infections through maintenance of high routine immunisation rates could also lower transmission of COVID-19 to adults.

In 2020, the World Health organisation issued guiding principles during COVID-19 and other times of severe disruptions (WHO, 2020e). The guidelines emphasized that immunisation activities should be prioritized and safeguarded for continuity to the greatest extent possible during times of severe disruption to service delivery or utilization. The document suggests that healthcare staff involved in immunisation activities should be prioritised in the provision of personal protective equipment in order to ensure that their safety from COVID-19 or other similar threats while carrying out the essential responsibility of immunising children is guaranteed. The guidelines continue to emphasize the importance of making sure health care staff involved in immunisation activities is trained, supervised, properly remunerated, protected and empowered to ensure adherence to infection prevention and control measures for their safety and that of their communities. Unfortunately, while some of the recommendations of the WHO make scientific sense, countries such as the Kingdom of Eswatini, lack the financial abilities to undertake the provisions of these guidelines, hence the recovery of immunisation services is expected to take a while before prior gains are recovered.

Conclusion

Physical distancing measures and partial lockdown implemented to reduce transmission of coronavirus disease (COVID-19) has had a very negative impact on routine childhood immunisations in the Kingdom of Eswatini. The COVID-19 pandemic has precipitated large declines in childhood vaccination coverage and, consequently, substantial increases in the number of zero-dose children. Our results are consistent with previous reports from findings in several developed countries such as in the United States of America (Bremmer et al., 2020), in England (McDonald et al., 2020); and in Saudi Arabia (Alsuhaibani and Alaqeel, 2020). The country will require development and implementation of immunisation recovery plans with innovative approaches to delivery that maintain physical distancing requirements to protect infection of both children, parents and healthcare staff who assembly at national immunisation points. Continuous and timely assessment of immunisation coverage in the country will be required to respond to potentially volatile changes during and after the COVID-19 pandemic or any other pandemic thereof. To effectively respond to these declines, it is necessary to promptly direct resources to recovery processes of immunisation services. Even brief disruption or postponement of an immunisation service could lead to increases in individuals susceptible to outbreak-prone vaccine preventable diseases (VPDs) in the short term, such as measles; and, in the longer term, increased risk for chronic diseases such as hepatocellular carcinoma due to hepatitis B virus, and cervical cancer due to human papilloma virus. The critical importance of preserving immunisation activities is supported by modelling, which estimates that routine vaccines prevent at least 80 deaths in children in Africa for each death in an older household member due to infection with SARS-CoV-2 acquired during a routine immunization clinic visit. Strengthening infection prevention and control measures (IPC), training health workers on IPC and ensuring adequate supplies of personal protective equipment (PPE) can further reduce health facility-acquired COVID-19. Integrating systems thinking and implementation science in health planning and decision-making could help African countries and the Kingdom of Eswatini to gain a better understanding of the influence of COVID-19, or any other epidemic on health programmes, such as childhood immunisation, and facilitate the implementation of multifaceted evidence-based strategies in complex practice settings. As African countries re-strategize for the post-2020 era, these emerging fields could contribute significantly in accelerating progress towards universal access to vaccines for all children on the continent despite COVID-19 and improve on loses experienced during partial lockdown.

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