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Impact of COVID-19 lockdown on routine immunisation in Karachi, Pakistan

The swift spread of COVID-19 has upended health systems and affected all health services. The disruption of routine immunisation services could start secondary outbreaks of vaccine-preventable diseases and also worsen the longstanding inequity in immunisation coverage, especially in rapidly urbanising cities. Karachi, the capital of Sindh province and the largest megacity in Pakistan, is home to more than 16 million people.¹ Despite the city's status as the industrial hub of the country, Karachi has seen a decline in the delivery of health-care services over the past decade. The city has numerous informal settlements, ranging from dense, urban slums near the city centre to less dense, urban sprawl fading into periurban areas. An estimated 7 million people live in these informal settlements.² These vast aggregations of underserved urban poor are the most susceptible to debilitating diseases, given that they live in densely packed areas with poor access to health services and low rates of immunisation coverage.^{3,4}

Against this backdrop, Karachi has the highest number of under-vaccinated children when compared with other megacities in Pakistan and globally (where subnational data are available) and is one of the last reservoirs of wild-type poliovirus.⁵ Immunisation services in Karachi are provided through the Expanded Programme on Immunization (EPI) and are mainly based in clinics (ie, fixed-centre), with the private sector having a broader role in vaccination delivery in the urban areas of Karachi than in the rural areas of the province.

The first case of COVID-19 in Pakistan was reported from Karachi on Feb 26, 2020,⁶ and, to contain and curb further spread of the disease, a

provincial lockdown was instituted on March 23, 2020. The lockdown restricted all non-essential movement, affecting the provision of health services, including immunisations.

To understand the impact of COVID-19 restrictions on routine immunisation coverage in Karachi, we used the data from the provincial Electronic Immunization Registry (the Zindagi Mehfooz [Safe Life] Program; ZM EIR). The ZM EIR is an Android-based application that allows vaccinators to enrol and track the vaccination status, geographical location, and biodata (eg, name, sex, and date of birth) of children using smartphones, which has enabled the collection of real-time data for the monitoring and evaluation of service delivery.⁷ The Government of Sindh scaled up ZM EIR in 2017 to bolster efforts to achieve universal, timely, and equitable immunisation coverage in the province. From October, 2017, to May, 2020, more than 2.9 million children (aged 0–23 months) and more than 1 million women (aged 15–49 years) were enrolled, and more than 22 million immunisation events have been recorded. More than 790 vaccinators use ZM EIR across 242 public and 86 private immunisation clinics in Karachi. In 2019, 429 447 (91.6%) of the 469 078 children (aged 0–11 months) born alive in Karachi in 2019 were enrolled in ZM EIR, as estimated by the EPI.

We compared the ZM EIR data from Karachi in the 6 months before the COVID-19 lockdown (Sept 23, 2019–March 22, 2020) with those from the first 6 weeks of the lockdown period (March 23–May 9, 2020). Of a total of 701 324 records, 608 832 children (aged 0–23 months) were immunised during the baseline period and 92 492 were immunised during the lockdown period. The mean number of daily immunisation visits (accounting for all antigens) decreased by 52.8% (from 5184 to 2450 visits) during the lockdown compared with

baseline. The decrease in the mean number of daily immunisation visits was steeper in the earlier weeks of the lockdown (appendix p 1). On average, 2734 children per day missed routine immunisation during the lockdown in Karachi. Further analysis of data from after the lockdown was lifted on May 10, 2020, showed a steady recovery in coverage rates (appendix p 1). From May 10, 2020, to June 6, 2020, the mean number of daily immunisation visits was reduced by 27.2% compared with baseline (from 5184 to 3772 visits).

Outreach services were affected more than fixed-centre services, with a reduction in immunisation doses given of 88.6% for outreach and 38.7% for fixed (appendix p 2) between the baseline period and the lockdown period. This decline can be attributed to a combination of demand and supply factors. Restrictions on movement and concerns around COVID-19 transmission might have prevented caregivers from accessing immunisation services. Of all the 321 operational immunisation centres, 50 (16%) had no client flow. The supply side was also adversely affected, as 48 (18%) of all 271 immunisation centres were closed. We postulate that fear of infection because of a lack of preparedness contributed to a decrease in the mean proportion of vaccinators who attended work during the lockdown compared with baseline (25 931 [78.7%] of 32 960 person-days vs 112 131 [91.6%] of 122 461 person-days).

Geospatial analysis showed that the worst hit areas were the slums and squatter settlements of Orangi, Baldia, Gadap, and other poor suburbs in Karachi. Among the 188 union councils of Karachi, the decline in the mean number of daily immunisation visits was worse in the eight union councils that are identified as being super high-risk for poliovirus transmission (69.3% [range 53.2–90.2]), followed by the broader category of slum union councils (54.0% [17.0–93.0]). In



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Gujro, a super high-risk union council with historically low immunisation coverage, the decrease in the mean number of daily immunisation visits during the lockdown was 90.0%. These results illustrate considerable spatial heterogeneity in the city, revealing hotspots with a rapid accumulation of unvaccinated children. These hotspots in metropolitan areas are ticking time bombs for vaccine-preventable diseases, such as measles and poliomyelitis, and should be prioritised for an immediate intervention following the easing of the lockdown. The sharp decrease of immunisation coverage in super high-risk union councils further highlights the potential negative impact of lockdown measures on efforts to eradicate poliomyelitis in Karachi. This level of decrease in routine immunisation in areas affected by poliovirus might increase the odds of a resurgence of the wild-type poliovirus and put the hard-won gains made in the eradication of poliomyelitis at immense risk.⁸

Our analysis depicts the widening schism in the proportion of immunisation coverage between the different wealth quintiles as the more affluent neighbourhoods of the city have been less affected by the restrictions. Previous surveys have shown existing inequities in the proportion of full immunisation coverage between the lowest and the highest wealth quintiles in the country, which are now being exacerbated.⁹

At fixed sites, the largest percentage decrease in the mean daily number of vaccine doses administered to children was seen for the antigens administered at the immunisation visit at 6 weeks of age (ie, the first dose of pentavalent vaccine, oral polio vaccine, pneumococcal conjugate vaccine, and rotavirus vaccine), pointing to a substantial decline in coverage for the antigens given earlier in the schedule (appendix p 2). This decline would lead to an increase in the number of zero-dose children,

who, in the absence of a standardised birth registry in Pakistan, could remain unregistered and unaccounted for, contributing to the cohort of unvaccinated children. The ZM EIR shows a slight reduction in the proportion of female children enrolled during the lockdown (11 970 [48.4%] of 24 720 children) versus the baseline (120 508 [49.2%] of 245 131 children).

Our analysis shows the declining trend of routine immunisations in Karachi, with a distinct geographical pattern, brought about by the COVID-19 lockdown. The gains made in improving immunisation coverage in Karachi as part of the roadmap for universal immunisation made by the EPI must not be lost as a consequence of the COVID-19 pandemic.¹⁰ Preventing this loss requires an immediate response by the government to cover all the children who missed their vaccine doses because of the lockdown measures.

ZM EIR provides a unique opportunity for Karachi (and Sindh province) to track every child's service use and location, and engage and inform caregivers regarding the resumption of EPI services through the embedded text message reminder system. In the context of COVID-19 and the continuation of physical distancing measures, ZM EIR can help to rationalise resources by identifying crowded health facilities with longer queues and refer caregivers to the less crowded facilities within their vicinity. Having children's vaccination history digitally recorded in the system and connected through a unique identifier makes these kinds of interventions feasible. The system can track the availability of personal protective equipment in the facilities and inform caregivers of this availability to allay their concerns regarding COVID-19 transmission during their visit to the EPI site. Additionally, with ZM EIR providing data on individual children and their immunisation status, the application can generate defaulter lists of children to prioritise efforts in the hard hit areas as outreach

immunisation services are resumed. With updates being incorporated in the ZM EIR system concerning birth registration and the triangulation of data with polio zero-dose registries, the children who have never received a single dose of vaccine can be traced and enrolled for routine immunisation.

Lockdown is painfully exposing and exacerbating existing immunisation inequities. Enforcing stringent monitoring and cultivating data-driven accountability is more important than ever as we move towards a post-pandemic resumption of immunisation services. Digital systems, like the ZM EIR, are valuable in the response to disruptions to immunisation programmes created by the pandemic. Concerted trace and immunise strategies can help to cover every single child that has missed a vaccine dose because of restrictions related to COVID-19.

We declare no competing interests. We alone are responsible for the views expressed in this Correspondence, and these views do not represent the views, decisions, or policies of our institutions.

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