



COMMENTARY

 OPEN ACCESS



# Implications of COVID-19 and “super floods” for routine vaccination in Pakistan: The reemergence of vaccine preventable-diseases such as polio and measles

Inayat Ali <sup>a,b</sup> and Saima Hamid <sup>c</sup>

<sup>a</sup>Department of Public Health and Allied Sciences, Fatima Jinnah Women University, Rawalpindi, Pakistan; <sup>b</sup>Department of Anthropology, Fatima Jinnah Women University, Rawalpindi, Pakistan; <sup>c</sup>Fatima Jinnah Women University, Rawalpindi, Pakistan

## ABSTRACT

With multiple waves and variants, the coronavirus disease 2019 (COVID-19) pandemic has affected routine vaccination programs globally. Its impact is also visible in Pakistan as routine health services continue to be disrupted. Consequently, thousands of children have emerged as vulnerable in the face of vaccine-preventable diseases (VPDs), which have already started causing outbreaks in the country. Infections with polio and measles have been significantly reported, especially during the last few years. This reemergence of both diseases is posing great challenges for the country at local, national, and global levels. These impacts are being multiplied by the 2022 flooding – called “super floods” – in the country. Hence, relevant stakeholders, such as the Pakistani government and the World Health Organization (WHO), need to revisit the entire vaccination program to address and resolve issues occurring at the management or local levels. It is highly important to pay attention to the context that provides a fertile ground to negatively affect vaccine uptake.

## ARTICLE HISTORY

Received 6 August 2022  
Revised 15 November 2022  
Accepted 28 November 2022

## KEYWORDS

COVID-19; pandemic; routine immunization; vaccination; polio; measles; Pakistan; flooding; climate change; resistance; global vaccination emergency

## Introduction

For more than two years, the 2020 coronavirus disease (COVID-19) pandemic has remained an evolving and unfolding phenomenon worldwide. With several waves and variants, it has also significantly affected healthcare systems, irrespective of their geographical location. Yet with distinguishable effects, its implications are critical for those who are located in low-income settings. On the one hand, these systems are overwhelmed due to a considerable number of people contracting COVID-19. On the other hand, it has also impacted vaccination programs, causing a situation that can be called a *global vaccination emergency* as an urgent response is required to vaccinate millions of children who missed their scheduled vaccines during the pandemic phase. The resultant decline in routine vaccine administration has contributed to situations that allow outbreaks of vaccine-preventable diseases (VPDs) such as measles and polio, specifically in low-income countries such as Pakistan.

The disruption of routine immunization owing to several reasons has posed a significant risk in this country, which has already been facing multiple public health challenges. It may confront adverse effects on its routine Expanded Program of Immunization (EPI) due to the pandemic. Commencing in 1976 as a pilot project and in 1978 launched across the country, the EPI protects children by immunizing them against various infectious diseases: childhood tuberculosis, poliomyelitis, diphtheria, pertussis, tetanus, measles, hepatitis B, Haemophilus influenzae type b (Hib), pneumococcal vaccine (PCV10), and polio vaccine (see Table 1).<sup>1</sup> The EPI aims to (i) “affirm the commitment of the Government of Pakistan to provide safe, effective and cost-effective vaccination against

vaccine-preventable diseases” and (ii) “set national standards and guidelines for immunization aligned with the global goals and evidence base, and encourage the generation of local evidence for vaccination against vaccine-preventable diseases.”<sup>1</sup> In this paper, we discuss how sociocultural, economic, and (geo-) political factors shape and influence local perceptions and practices around vaccination whilst significantly impacting routine immunization. We also briefly mention the potential effects of COVID-19 and flooding on the EPI with particular focus on polio and measles.

## Competing narratives around vaccination in Pakistan: an overview

Vaccination can prevent communicable diseases. This approach paved the way to the EPI, which was started in the 1970s in most of the countries around the world to vaccinate children against several infectious diseases. Among the foremost scientific advances of the 21st century, around 6 million deaths around the world are prevented from vaccine-preventable diseases (VPDs) annually.<sup>2</sup> Besides sanitation and clean drinking water, vaccination has emerged as one of the most effective public health interventions, as it substantially contributes to improving health outcomes globally.<sup>3</sup>

Despite its significant contribution to control morbidity and mortality, vaccination has appeared as a complex and contested phenomenon in several countries since multiple context-specific problems affect acceptance and uptake of vaccination.<sup>4–6</sup> These elements include sociocultural, economic, and (geo-)political factors, as well as natural disasters (e.g., floods) and health emergencies such as the COVID-19

**Table 1.** Pakistan's EPI vaccination schedule<sup>1</sup>.

Disease	Causative agent	Vaccine	Doses	Age of administration
Childhood TB	Bacteria	BCG [BCG = bacille Calmette – Guérin]	1	Soon after birth
Poliomyelitis	Virus	OPV [oral polio vaccine]	4	OPV0: soon after birth OPV1: 6 weeks OPV2: 10 weeks OPV3: 14 weeks
Diphtheria	Bacteria	IPV	1	IPV-I: 14 weeks
Tetanus	Bacteria	Pentavalent vaccine	3	Penta1: 6 weeks
Pertussis	Bacteria	(DTP+Hep B + Hib)		Penta2: 10 weeks
Hepatitis B	Virus	[diphtheria, tetanus, pertussis, hepatitis B, Haemophilus influenza B]		Penta3: 14 weeks
Hib pneumonia and meningitis	Bacteria			
Measles	Virus	Measles	2	Measles1: 9 months Measles2: 15 months
Diarrhoea due to rotavirus	Virus	*Rotavirus	2	Rota 1: 6 weeks Rota 2: 10 weeks

pandemic. In the case of later two factors, the underlying reasons may include a shift of allocated resources to deal with new challenges related to human mobility. Evidence shows that when routine vaccinations are halted, VPDs cause severe outbreaks, as was observed during the 2013–16 Ebola outbreak in West Africa.<sup>7</sup>

Similarly, VPDs have started re-occurring in Pakistan due to disruptions in vaccination drives caused by COVID-19. The country was already lagging behind in terms of meeting WHO's target of around a 95% vaccination rate, as 2012–2016 data for all types of EPI vaccines revealed a cumulative vaccination coverage of 60.60%.<sup>8</sup> The underlying reasons are multifaceted since routine vaccination in Pakistan faces multidimensional issues, which are related to the supply side, and several pertain to its demand side.<sup>9</sup> For instance, the staff is not well trained, or maintaining the cold chain is difficult especially in some areas due to a lack or low voltage of electricity.<sup>10</sup> Sociocultural, economic, and (geo-)political factors significantly shape the local perceptions and practices around vaccination as well as its administration.<sup>10</sup> Studies now substantiate how various narratives such as rumors and conspiracy theories negatively affect vaccination programs leading people suspect vaccines that they can cause many harmful side effects, illnesses, and even death.<sup>10,11</sup> For instance, it is perceived that simultaneous and multiple vaccines for different diseases to a child may overload the immune system, increasing the risk of harmful side effects.<sup>11</sup> Media in Pakistan have been broadcasting such reports time and again, especially during (supplementary) vaccination drives. Many such reports emerged when a nationwide vaccination campaign against measles was carried out in 2014. A Pakistani English newspaper *Express Tribune*<sup>12,13</sup> produced two reports revealing vaccine reactions – (i) *A normal reaction?: Six more children faint during measles drive* and (ii) *30 children fall sick in Swat upon receiving measles vaccinations* – which generated a debate demonstrating different competing narratives. Precisely, issues surrounding vaccination are multifaceted: they can be related to availability, affordability, acceptability, and accessibility, all of which seem to be affecting vaccination uptake.<sup>5</sup> In the following section, we highlight (i) the impacts of COVID-19 on vaccination and (ii) the expected effects of the recent “super floods” on vaccination.

### COVID-19 affects routine vaccination in Pakistan

The pandemic's effects on routine vaccination were predictable. As soon as the pandemic occurred and started unfolding its significant impacts, it was assumed that the pandemic would challenge routine vaccination. Since COVID-19 appeared overwhelming in nature, demanding high attention and many resources, every country shifted resources to minimize the spread and impact of the new viral disease. As among other measures to deal with the pandemic, limited outdoor movement and lockdown policies started impacting routine vaccination programs, leading to a significant decline in the vaccination rate.<sup>4</sup> Additionally, fear of people's physical interactions might have appeared as a compelling factor for the vaccinator to accomplish daily routine immunization activities.<sup>14</sup> Likewise, parental concerns about potentially exposing their children to COVID-19 during receiving a vaccine might also have contributed to the decline in routine vaccination visits. All these mentioned factors and measures during COVID-19 greatly affected the routine immunization coverage in Pakistan, which has resulted in an increased vaccine hesitancy and a decreased vaccination rate at local and national levels.

Because of halted EPI activities during the COVID-19 lockdown, in only one city, Karachi, approximately 2,750 children missed their routine immunization per day.<sup>15</sup> Moreover, since all daily numbers of vaccine doses included in the scheduled EPI program have been affected, around a 53% decline has occurred in daily vaccination coverage at fixed sites, including Bacillus Calmette–Guérin (BCG) (40.6%).<sup>16</sup> A significant decline in BCG immunization can result either from reduced hospital visits due to fear of COVID-19, fear of vaccination, and/or the implementation of a national lockdown by the government.<sup>17</sup>

COVID-19 lockdown measures unintentionally affected routine healthcare as public transport was suspended, which negatively affected people's accessibility to particular health-care centers. The other plausible reason for a decline in both hepatitis B and BCG immunizations is the low number of first postnatal hospital visits, as both these vaccines are often administered after birth. It is well established that coverage of routine immunization of less than 90–95% puts herd immunity at risk in a population and may lead to the outbreak of VPDs. In Pakistan, the measles and polio immunization campaigns

face numerous challenges, including inadequate health facilities, inaccessibility of people, administrative and organizational deficiencies, and missed vaccinations due to refusals.

### **Polio reemerges**

Polio in Pakistan has become a great challenge, and also in Afghanistan. Being both as polio-endemic countries, these have collectively contributed 85% of the polio cases at the global level by 2020.<sup>18</sup> In Pakistan, polio has been one of the major public health issues for decades and has gathered various competing narratives. Various stakeholders such parents, religious leaders, the government, and WHO interpret and negotiate it differently. Several (geo-)political and sociocultural factors, especially emerging after the launching of the population control program, have contributed to negatively influence the successful elimination of polio from the country.<sup>19,20</sup> Competing narratives, in the form of rumors and conspiracy theories, prevail in Pakistan; they constitute one among the major hindrances in polio eradication in this country.<sup>18</sup> In addition, vaccine hesitancy or resistance, insecurity, and life threats to polio workers, inducing mass migration and displacement, poor access to remote areas, and vulnerable populations have widely affected the polio eradication program.<sup>18</sup>

COVID-19 further contributed to adverse effects on the polio vaccination. It was noted that due to the pandemic, outreach vaccination activities were disrupted in 58% of 65 surveyed countries in May 2020.<sup>21</sup> Consequently, the Global Polio Eradication Initiative (GPEI) estimated that almost 80 million children missed the vaccine in the Eastern Mediterranean Region.<sup>21</sup> The disruption in polio campaigns due to COVID-19 has put many children at risk of contracting this virus.

Pakistan resumed a limited-scale polio vaccination campaign on 20 July 2020 after a four-month suspension of all polio vaccination activities due to the COVID-19 pandemic.<sup>21</sup> However, as a result of the pandemic, parents were still unsure and were scared about whether they could leave their homes and take their children to the basic health facility for vaccination. Some people refused the polio vaccine whilst believing that it would do no good to their children: Ali and colleagues describe the views of one respondent as follows: “As soon as the vaccination team arrived here, we promptly asked them not to vaccinate our children and return because they have been vaccinating our children for a long time. Yet, the health of our children does not improve. Many of them remain sick. Given that, what is the purpose of having our children vaccinated?”<sup>6</sup> In the same village, laypersons also perceived the coronavirus spread to be a “Western production” or a government plot to gain more foreign aid, and the vaccine as a product of the *Angraiz* (British), thus, “Who knows what types are these vaccines, and what if we allow vaccinators to vaccinate our children and then our children die?”<sup>6</sup> Hence, rumors, fears, misconceptions as well as socio-cultural (geo) political, and religious factors have simultaneously contributed to vaccine hesitancy and refusal among various communities of Pakistan.<sup>6</sup>

Consequently, the inactivated polio vaccine (IPV) drop-off was a 26% average decrease throughout the lockdown period, especially in March 2020 compared to the pre-lockdown

period.<sup>21</sup> According to the Pakistan Polio Eradication Program, the poliovirus was detected in 60% of sewage environmental samples in August 2020, whereas it was 43% in August 2019. This marked increase between the pre-pandemic year of 2019 and the pandemic year of 2020 might be a future concern. In 2020, there were 84 wild polio virus (WPV) reported cases across the country and the cVDPV2 polio cases were 135.<sup>21</sup> Cases have also been reported in 2021 (8 WPV and 1 cVDPV2) and 2022 (11 WPV and 0 cVDPV2). This reemergence of polio raises serious concerns as the virus is still causing challenges despite many efforts at various levels. Although effective global vaccination has eradicated polio serotypes 2 and 3 around the world, type 1 serotype (WPV 1) polio infection is still prevailing in Pakistan and Afghanistan.

### **Reemergence of measles**

Measles continually reemerges globally. Annually, it causes thousands of infections and hundreds of deaths worldwide. The Eastern Mediterranean region accounts for around 65% of the total measles burden among 22 countries.<sup>22</sup> The same is the case with Pakistan, which reports several outbreaks every-year. In terms of numbers, the greatest outbreak of measles occurred in 1988 when over 50 thousand cases were reported in the country.<sup>23</sup> Later on, there was a significant decline until the disease reemerged significantly in 2013–14 when it caused two critical outbreaks causing around 30,000 infections and over 300 deaths, especially in Sindh province of the country.<sup>23</sup>

As previously mentioned, there are several important factors that are affecting efforts to deal successfully with measles. In addition, the coronavirus pandemic greatly affected routine vaccination, which has made a great number of children vulnerable to contracting measles across the world. Low immunization rates during COVID-19 have already caused a surge in the number of measles cases in Pakistan.<sup>22</sup> In 2020, 23 million children did not receive all basic childhood vaccines, which is considered the highest number seen since 2009 and 3.7 million more than in 2019.<sup>24</sup> According to the United Nations, during the first two months of 2022, there has been a 79% increase in the cases of measles globally.<sup>24</sup> It is anticipated that this increased risk for the spread of measles will lead to large measles outbreaks globally.<sup>24</sup>

Pakistan is no exception, as the country has reported several outbreaks during the pandemic period, i.e., 2020 to 2022. Being among the top five countries due to the number of unvaccinated children with measles in 2021, the country reported the highest measles cases, along with Yemen, Tanzania, India, and Nigeria.<sup>22</sup> In 2021, there were around 20,000 reported measles cases around the world.<sup>25</sup> Thus far, in 2022, Pakistan stands at the fifth position in terms of the highest number of reported cases of measles: around 2,700.<sup>26</sup> Such cases put the country at a different scale in terms of controlling this vaccine-preventable disease.

### **The 2022 “super floods” and the expected impacts on vaccination in Pakistan**

Since children are also critically vulnerable during every emergency, in the 2022 “super floods” out of 33 million people

affected, 16 million are children.<sup>27</sup> Approximately 530 children have died, particularly in Sindh province, and around 3.4 million required immediate lifesaving support.<sup>27</sup> Child morbidity and mortality may further increase as routine vaccination has been affected during the floods, mainly due to two main reasons: shifting of resources at the government level and the dislocation of children due to flooding. It has been well studied how extraordinary events, such as pandemics and natural/human-made disasters, affect vaccination programs and create a conducive environment for vaccine-preventable diseases to occur.<sup>4</sup>

Infectious diseases follow natural disasters, due to interrupted public health measures.<sup>28</sup> During previous flooding, healthcare services were affected in Pakistan,<sup>29</sup> including interruptions in supply chain medicine and vaccination of women and children.<sup>29</sup> Issues were also related to reporting routine cases of refusal as well as the vaccinated population, as in Punjab province, a health official stated, “Disruption of communication systems during active floods makes it hard to coordinate and impossible to report.”<sup>29</sup> And in Sindh province, the officials had a different response while sharing the loss of records, “We did not have records of vaccination and pregnant women as they were drowned in water, as our homes also got submerged.”<sup>29</sup>

Similar effects can be anticipated during the ongoing 2022 flash and riverine flooding in Pakistan. Flooding can have direct effects in the form of suspending routine vaccination drives, difficulty to travel to a healthcare facility, and the immobility of vaccination teams to reach their targeted populations. It can also create difficulties in maintaining the cold chain, which is essential for maintaining the temperatures of vaccines. Failures in maintaining the cold chain can make a vaccine ineffective. Other effects encompass overcrowding of people in the flood camps, which increases the risk of various infections as the immune system weakens owing to disturbed food patterns, unhygienic conditions, and polluted water.<sup>30</sup>

## Conclusions

After two years of the overwhelming COVID-19 pandemic, its impacts on healthcare systems and vaccination programs are visible around the world, which have caused the global vaccination emergency. These effects have increased the risk for VPDs to cause outbreaks and epidemics, especially in low-income countries such as Pakistan. At the parental level, measures to contain the coronavirus such as physical distancing, lockdowns, and concern about contagion affected their choice to get their children vaccinated with the routine childhood vaccinations, as did the rampant rumors and conspiracy theories. At the government level, overstretch of health services to shift the resources and to implement the “rituals of containment” required for appropriately dealing with the extraordinary COVID-19 pandemic had critical implications for entire vaccination programs, including supplementary immunization activities (SIAs). Consequently, VPDs have started causing outbreaks, as there is a reemergence of polio, even in previously polio-free countries such as Mozambique, DR Congo, and Yemen.<sup>31</sup>

Unsurprisingly, Pakistan has also started reporting infections of polio and measles from 2020 to 2022 (during the pandemic period). And since the pandemic is ongoing, there are chances of more outbreaks and cases, which will further be increased while interplaying with the already prevailing vaccine hesitancy and resistance. This interplay may aggravate the related risks. At the time of revising this paper, Pakistan is facing one of the greatest monsoon floods – called “super floods” – that have affected 33 million people, of whom 16 million are children. These floods, which are related to the ongoing climate change, will significantly affect the lives of children, and it may not be possible for the government to run the routine vaccination programs, thereby multiplying the chances of outbreaks of VPDs. Moreover, a comprehensive approach to deal with this global pandemic and a deep understanding of vaccine hesitancy are required to improve the vaccination programs. The government needs to equally deal with contextual factors affecting vaccination uptake in Pakistan, such as super floods. And since climate change has become a reality, laypeople located in rural areas need to count on the positive effects of vaccines and utilize their folk wisdom to make contingency plans for super floods, rather than being caught by surprise and having to run for their lives.

## Acknowledgments

We are grateful to Robbie Davis-Floyd for reading the manuscript and providing invaluable comments. Also, we are thankful to various colleagues and students for their provoking questions and comments that shaped the current article.

## Disclosure statement

No potential conflict of interest was reported by the authors.

## Funding

Inayat Ali acknowledges the Higher Education Commission (HEC) of Pakistan’s grant [PD/OSS-II/Batch-IV/Austria/2012/9903] to support his doctorate, which has shaped this article.

## ORCID

Inayat Ali  <http://orcid.org/0000-0003-1659-8492>  
Saima Hamid  <http://orcid.org/0000-0003-1772-2061>

## References

1. World Health Organization. Expanded programme on immunization. Geneva: World Health Organization; 2022.
2. Ehreth J. The global value of vaccination. *Vaccine*. 2003;21:596–5. doi:10.1016/S0264-410X(02)00623-0.
3. Rodrigues CM, Plotkin SA. Impact of vaccines; health, economic and social perspectives. *Front Microbiol*. 2020;11:1526. doi:10.3389/fmicb.2020.01526.
4. Ali I. Impact of COVID-19 on vaccination programs: adverse or positive? *Hum Vaccin Immunother*. 2020;16:2594–600. doi:10.1080/21645515.2020.1787065.
5. Ali I, Ali S, Iqbal S. COVID-19 vaccination: concerns about its accessibility, affordability, and acceptability. *Front Med*. 2021;8. doi:10.3389/fmed.2021.647294.

6. Ali I, Sadique S, Ali S. COVID-19 and vaccination campaigns as “western plots” in Pakistan: government policies, (geo-) politics, local perceptions, and beliefs. *Front Sociol.* 2021;6:608979. doi:10.3389/fsoc.2021.608979.
7. Walldorf JA, Date KA, Sreenivasan N, Harris JB, Hyde TB. Lessons learned from emergency response vaccination efforts for cholera, typhoid, yellow fever, and ebola. *Emerg Infect Dis.* 2017;23:S210. doi:10.3201/eid2313.170550.
8. Umer MF, Zofeen S, Hu W, Qi X, Zhuang G. Spatiotemporal clustering analysis of expanded program on immunization (EPI) vaccination coverage in Pakistan. *Sci Rep.* 2020;10:1–11. doi:10.1038/s41598-020-67839-0.
9. Aslam F, Ali I, Babar Z, Yang Y. Building evidence for improving vaccine adoption and uptake of childhood vaccinations in low-and middle-income countries: a systematic review. *Drugs Therapy Perspect.* 2022;38:1–13. doi:10.1007/s40267-021-00890-7.
10. Ali I. The COVID-19 pandemic: making sense of rumor and fear: op-ed. *Med Anthropol.* 2020;39:376–79. doi:10.1080/01459740.2020.1745481.
11. Clift K, Rizzolo D. Vaccine myths and misconceptions. *J Am Acad Physic Assist.* 2014;27:21–25. doi:10.1097/01.JAA.0000451873.94189.56.
12. The Express Tribune. 30 children fall sick in swat upon receiving measles vaccinations. Karachi: The Express Tribune; 2014.
13. The Express Tribune. Alarming situation: four children reportedly die from measles vaccine. Islamabad: The Express Tribune; 2014.
14. Ota MO, Badur S, Romano-Mazzotti L, Friedland LR. Impact of COVID-19 pandemic on routine immunization. *Ann Med.* 2021;53:2286–97. doi:10.1080/07853890.2021.2009128.
15. Chandir S, Siddiqi DA, Setayesh H, Khan AJ. Impact of COVID-19 lockdown on routine immunisation in Karachi, Pakistan. *Lancet Glob Health.* 2020;8:e1118–20. doi:10.1016/S2214-109X(20)30290-4.
16. Chandir S, Siddiqi DA, Mehmood M, Setayesh H, Siddique M, Mirza A, Soundardjee R, Dharma VK, Shah MT, Abdullah S, et al. Impact of COVID-19 pandemic response on uptake of routine immunizations in Sindh, Pakistan: an analysis of provincial electronic immunization registry data. *Vaccine.* 2020;38:7146–55. doi:10.1016/j.vaccine.2020.08.019.
17. Rahman SU, Haq FU, Imran M, Shah A, Bibi N, Khurshid R, Romman M, Gaffar F, Khan MI. Impact of the COVID-19 lockdown on routine vaccination in Pakistan: a hospital-based study. *Hum Vaccin Immunother.* 2021;17:4934–40. doi:10.1080/21645515.2021.1979380.
18. Ahmad T, Khan M, Musa TH, Hui J. Polio vaccination campaign in Pakistan: a step towards eradication or still a challenge in hand? *Hum Vaccin Immunother.* 2020;16:1444–45. doi:10.1080/21645515.2020.1717152.
19. Andrade GE, Hussain A. Polio in Pakistan: political, sociological, and epidemiological factors. *Cureus.* 2018;10. doi:10.7759/cureus.3502.
20. Rahim S, Ahmad Z, Abdul-Ghafar J. The polio vaccination story of Pakistan. *Vaccine.* 2022;40:397–402. doi:10.1016/j.vaccine.2021.11.095.
21. Pakistan Polio Eradication Programme. Polio cases in provinces. Pakistan: Pakistan Polio Eradication Programme; 2022.
22. Rana MS, Alam MM, Ikram A, Salman M, Mere MO, Usman M, Umair M, Zaidi SSZ, Arshad Y. Emergence of measles during the COVID-19 pandemic threatens Pakistan’s children and the wider region. *Nat Med.* 2021;27:1127–28. doi:10.1038/s41591-021-01430-6.
23. Ali I. Constructing and negotiating measles: the case of Sindh province of Pakistan. Vienna: University of Vienna; 2020.
24. UNICEF. Measles cases are spiking globally. Geneva: UNICEF; 2022.
25. Rana MS, Usman M, Alam MM, Ikram A, Salman M, Umair M. The world’s largest measles-rubella vaccination campaign in Pakistan: time to invest in routine immunization. *Hum Vaccin Immunother.* 2022;18:2080444. doi:10.1080/21645515.2022.2080444.
26. Centers for Disease Control and Prevention. Global measles outbreaks. Atlanta (GA): Centers for Disease Control and Prevention; 2022.
27. UNICEF. Devastating floods in Pakistan. Geneva: UNICEF; 2022.
28. Murthy S, Christian MD. Infectious diseases following disasters. *Disaster Med Public Health Prep.* 2010;4:232–38. doi:10.1001/dmp.2010.hcn10005.
29. Pradhan NA, Najmi R, Fatmi Z. District health systems capacity to maintain healthcare service delivery in Pakistan during floods: a qualitative study. *Int J Disaster Risk Reduct.* 2022;78:103092. doi:10.1016/j.ijdrr.2022.103092.
30. Hasan Q, Bosan A, Bile K. A review of EPI progress in Pakistan towards achieving coverage targets: present situation and the way forward. *EMHJ-East Mediterr Health J.* 2010;16(Supp):31–38. doi:10.26719/2010.16.Supp.31.
31. World Health Organization. Global WPV1 & cVDPV cases, previous 12 months. Geneva: World Health Organization; 2022.