



From Resurgence to Eradication: Reframing Pakistan's Polio Landscape, 2020–April 2025

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Abstract

Pakistan, together with Afghanistan, remains one of the final reservoirs of endemic Wild Poliovirus type 1 (WPV1). This review synthesizes Pakistan's polio trajectory from 2020 through April 2025, focusing on case trends, environmental surveillance, programmatic responses, and persistent barriers to eradication. The review used published and grey literature from WHO, the Global Polio Eradication Initiative (GPEI), CDC, UNICEF, Pakistan Polio Eradication Programme reports, and peer-reviewed articles. Pakistan experienced major fluctuation during the review period: 84 WPV1 cases in 2020 during COVID-19 disruptions, one case in 2021, a localized outbreak of 20 cases in 2022, six cases in 2023 with continuing environmental detections, and a resurgence to 74 cases across multiple districts in 2024. By April 2025, seven cases had been reported, while environmental surveillance continued to detect WPV1 in several districts. The evidence shows that low case counts can mask persistent transmission, especially when sewage surveillance remains positive. Key barriers include vaccine hesitancy, misinformation, insecurity affecting frontline workers, missed children, migration, cross-border transmission with Afghanistan, malnutrition, and poor sanitation. Pakistan's programmatic strengths include expanded environmental surveillance, repeated national and subnational immunization days, female frontline vaccinators, integrated health services, and adaptive hotspot targeting. Eradication will require uninterrupted vaccination, security for health workers, community trust-building, rapid response to environmental signals, and synchronized cross-border action until both paralytic cases and environmental detections reach zero.

Keywords: Polio; Pakistan; Wild Poliovirus Type 1; Environmental Surveillance; Vaccine Hesitancy; Eradication; Immunization

Introduction

Global polio eradication is one of the most ambitious infectious-disease control efforts in modern public health. Since the Global Polio Eradication Initiative was launched in 1988, wild poliovirus cases have declined by more than 99%, but complete eradication has remained elusive because of persistent transmission in Pakistan and Afghanistan and outbreaks of variant poliovirus in under-immunized settings [1, 2].

Pakistan is central to the final phase of eradication. The country has a large birth cohort, high internal mobility, areas of insecurity, variable routine immunization coverage, and porous cross-border movement with Afghanistan. GPEI identifies Pakistan as affected by ongoing endemic WPV transmission and emphasizes the need to reach every child, strengthen surveillance, and maintain political and financial commitment [1]. WHO also notes that polio activities in Pakistan require technical support for surveillance, cold-chain management, training, reporting, and communications at federal, provincial, and district levels [3].

The period from 2020 to April 2025 illustrates the fragility of eradication progress. Pakistan moved from pandemic-associated resurgence to near interruption, then to localized outbreaks, silent environmental transmission, and renewed nationwide resurgence. Understanding this trajectory is important because the final mile of eradication requires both epidemiological precision and community trust.

This review aims to synthesize Pakistan's epidemiological shifts from 2020 through April

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2025, describe persistent programmatic barriers, and identify policy pathways needed to interrupt WPV1 transmission.

Materials and Methods

Search strategy and source selection

We reviewed published and grey literature from January 2020 to April 2025. Sources included WHO, GPEI, CDC Morbidity and Mortality Weekly Report (MMWR), UNICEF, the Pakistan Polio Eradication Programme, End Polio Pakistan resources, peer-reviewed papers, and reputable news or surveillance summaries where official data were not available. Priority was given to official surveillance data, peer-reviewed reports, and national program documents.

Data extraction and synthesis

Information was extracted on annual WPV1 case counts, environmental surveillance signals, geographic spread, outbreak response, immunization campaigns, operational barriers, and policy lessons. Data were synthesized narratively because the review objective was to describe trends and programmatic interpretation rather than perform meta-analysis.

Results

Epidemiological trajectory from 2020 to April 2025

In 2020, Pakistan reported 84 WPV1 cases across multiple districts. COVID-19 disruptions temporarily interrupted vaccination activities and left large numbers of children unreached, while environmental surveillance showed extensive poliovirus circulation. The year demonstrated how quickly immunity gaps can widen when campaigns are suspended.

In 2021, Pakistan recorded only one WPV1 case, the lowest annual count in national history. Environmental positivity also fell sharply. This near-interruption reflected intensified campaigns, surveillance, and programmatic focus, but it did not represent eradication because environmental risk and cross-border transmission persisted.

In 2022, transmission re-emerged through a localized outbreak concentrated in southern Khyber Pakhtunkhwa, particularly North Waziristan. Many affected children were reported as zero-dose or

under-immunized, emphasizing the role of access barriers, refusals, and insecurity in maintaining susceptibility.

In 2023, only six WPV1 cases were reported, but environmental surveillance detected continued virus circulation. CDC reported that Pakistan experienced widespread WPV1 circulation during 2023–2024, especially in the historical reservoirs of Karachi, Peshawar, and Quetta, and that cases alone underestimated transmission risk [4].

In 2024, Pakistan experienced a major resurgence, with 74 reported WPV1 cases across multiple districts. WHO's International Health Regulations Emergency Committee reported that Pakistan accounted for 74 of the 99 WPV1 cases reported globally in 2024 and that 628 WPV1-positive environmental samples were reported from Pakistan during the year [5]. By April 2025, seven cases had been reported in the source review period, while environmental detections continued in multiple districts. These data reinforce that environmental surveillance can foreshadow outbreaks even when acute flaccid paralysis case counts remain low.

Persistent barriers

The main barriers to eradication include vaccine hesitancy, misinformation, security threats, population movement, operationally missed children, and weak health-system conditions. In several high-risk districts, refusals are linked to religious, political, or trust-related narratives. Insecurity and attacks on vaccinators disrupt campaigns and reduce reach. Cross-border movement with Afghanistan sustains transmission between epidemiologically connected reservoirs.

Operational gaps are also critical. Children may be missed because of refusal, absence during campaigns, migration, nomadic movement, inaccurate microplanning, or inaccessibility. Poor sanitation, malnutrition, and low routine immunization can increase susceptibility and environmental persistence of enteric viruses. These barriers interact, creating pockets where repeated supplementary immunization activities still fail to reach every child.

Programmatic responses and policy lessons

Pakistan's eradication program has responded with repeated National Immunization Days, subnational rounds in hotspots,

Table 1: Summary of Pakistan WPV1 trajectory, 2020–April 2025.

Period	Reported WPV1 cases	Main epidemiological interpretation
2020	84	COVID-19 disruption, campaign suspension, broad resurgence
2021	1	Near interruption, but continued risk
2022	20	Localized outbreak concentrated in southern Khyber Pakhtunkhwa
2023	6	Low case count with environmental evidence of silent transmission
2024	74	Nationwide resurgence across multiple districts
2025 Jan-Apr	7	Continued circulation despite intensified campaigns

WPV1: Wild Poliovirus type 1

Table 2: Persistent barriers and eradication-oriented responses.

Barrier	Operational implication	Priority response
Vaccine hesitancy and misinformation	Refusals and under-immunized clusters	Local trust-building, religious/community engagement, female health workers
Security and access	Interrupted campaigns and missed children	Protection plans, local recruitment, negotiated access
Cross-border mobility	Reintroduction and shared reservoirs	Synchronized Pakistan-Afghanistan campaigns and border vaccination
Operationally missed children	Repeated immunity gaps	Improved microplanning, tracking of refusals and mobile populations
Sanitation and malnutrition	Higher susceptibility and environmental persistence	Integrated health, nutrition and WASH services

WASH: Water, Sanitation and Hygiene

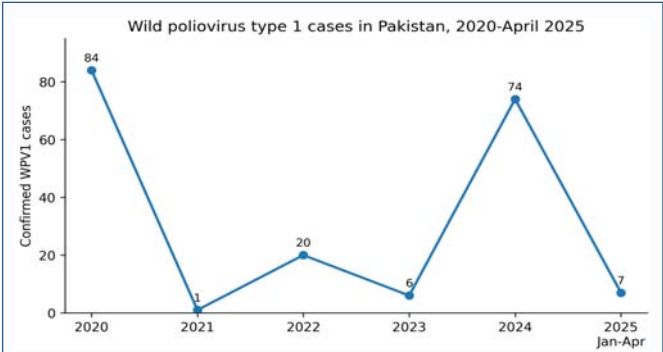


Figure 1: Annual WPV1 case trajectory in Pakistan from 2020 to April 2025.

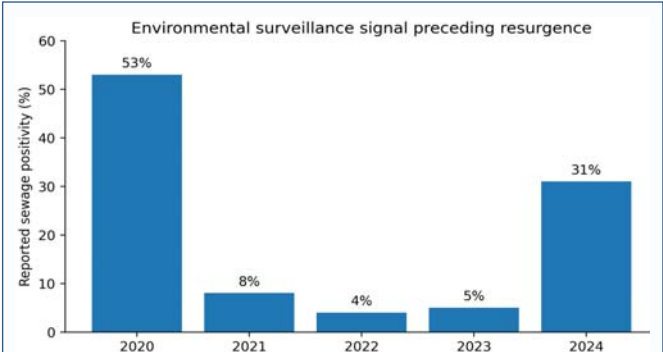


Figure 2: Environmental surveillance positivity showing that sewage signals can precede or accompany resurgence.

environmental surveillance expansion, community mobilization, and integrated health services. WHO notes that technical support has included surveillance, cold-chain management, training of more than 300,000 frontline workers and health managers, reporting, data management, operations, and communications [3].

The most important policy lesson is that low case counts do not equal interruption of transmission. Rising environmental positivity can provide an early warning of resurgence and should trigger rapid microplanning, vaccination rounds, and community engagement. A second lesson is that trust-building must accompany vaccine delivery. Female frontline workers, local social mobilizers, and integrated service delivery can improve acceptance by linking polio vaccination

to broader health needs.

A third lesson is that regional synchronization with Afghanistan is indispensable. Pakistan and Afghanistan form a single epidemiological block; therefore, vaccination timing, border vaccination, genomic surveillance, and rapid information exchange must be coordinated. Finally, vaccinator security is not optional but central to programme continuity.

Discussion

Pakistan's experience from 2020 to April 2025 demonstrates both the progress and fragility of the eradication effort. The country moved from 84 cases in 2020 to a single case in 2021, proving that intense campaigns can sharply reduce transmission. However, the subsequent outbreaks and 2024 resurgence show that eradication cannot be declared until transmission is interrupted in all reservoirs and environmental detections cease.

The 2024 resurgence is particularly instructive. Environmental surveillance and genomic sequencing indicated that poliovirus continued to circulate even when case counts were low. This observation aligns with CDC reports that widespread WPV1 circulation in Pakistan during 2023-2024 was concentrated in historical reservoirs and detected through environmental surveillance [4]. Eradication strategies must therefore treat environmental detections as actionable signals, not secondary indicators.

Community trust remains as important as vaccine supply. Vaccine hesitancy, misinformation, and attacks on health workers undermine the final mile. Programs that integrate polio vaccination with nutrition, maternal-child health, sanitation messaging, and basic services may be more acceptable in underserved communities. Such approaches can reframe polio teams from single-purpose vaccinators to trusted health partners.

Pakistan's polio future also depends on sustaining funding and political commitment. GPEI and WHO emphasize that Pakistan remains affected by endemic WPV1 transmission and requires sustained surveillance, technical support, and immunization reach [1, 3]. Short-term campaign fatigue or reduced financing could allow rapid re-expansion of immunity gaps.

This review is limited by reliance on summary program data and published reports, which may be updated as case classification,

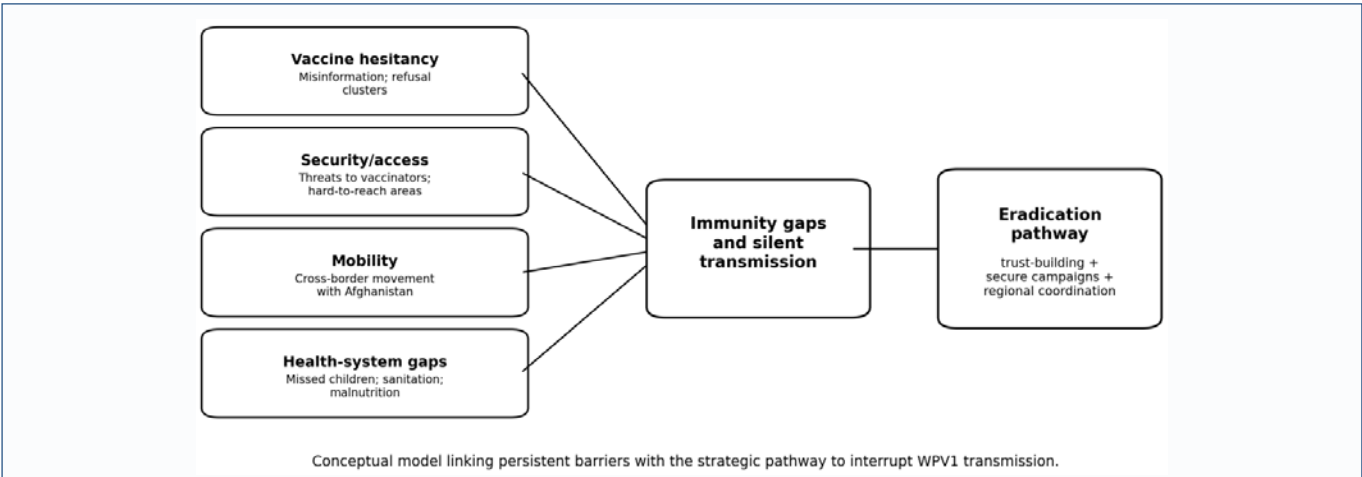


Figure 3: Conceptual model of barriers and eradication pathways for Pakistan.

genomic analysis, and environmental surveillance results evolve. The review period ends in April 2025 for the primary synthesis; readers should consult GPEI and national program dashboards for the most current case counts.

Conclusion

Pakistan remains in the final but most difficult phase of polio eradication. From 2020 to April 2025, the country alternated between resurgence, near interruption, localized outbreaks, silent transmission, and renewed spread. Eradication is achievable, but only if vaccination remains uninterrupted, environmental signals trigger rapid response, frontline workers are protected, communities are engaged with trust and broader services, and cross-border coordination with Afghanistan continues until both cases and environmental detections reach zero.

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Ethics Approval and Consent to Participate

Ethical approval was obtained from the relevant institutional review board/ethics committee before data analysis. Because this manuscript was prepared from de-identified routine clinical or programmatic data, the requirement for written informed consent should be confirmed and inserted according to the approving committee policy.

Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request and subject to institutional permission.

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Competing Interests

The authors declare no competing interests. Authors should update this statement if any competing interest applies.

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