

# Public health, war and cross-border challenges: the recent cVDPV2 polio outbreak in Gaza

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## Summary

The recent vaccine-derived poliovirus type 2 (cVDPV2) outbreak in Gaza, linked to strains circulating in Egypt, highlights the challenges of maintaining vaccination efforts in conflict zones. Amid prolonged hostilities and a deteriorating healthcare system, vaccination coverage has significantly declined, leaving many children vulnerable to poliovirus and other preventable diseases. This report analysed the outbreak's context, vaccination strategies, and outcomes by reviewing vaccination coverage data, environmental surveillance reports, and public health interventions. It focused on the novel oral polio vaccine type 2 (nOPV2) campaigns and their effectiveness in mitigating transmission. The outbreak, detected in June 2024, included six environmental samples and one confirmed case of poliomyelitis in a 10-month-old child. Despite operational challenges, a vaccination campaign immunised 560,000 children under 10 years by September 2024. However, ongoing violence delayed subsequent rounds of vaccination, particularly in northern Gaza. Contributing factors included vaccine hesitancy, logistical hurdles, and the safety risks healthcare workers face. Regional collaboration remains limited despite cross-border transmission risks. The Gaza outbreak illustrates the critical need for robust vaccination programs, enhanced surveillance, and international cooperation to prevent poliovirus resurgence. Addressing vaccine hesitancy and logistical challenges is vital. Sustained funding and innovative strategies, including nOPV2 use, are essential to combat outbreaks in fragile settings and advance global eradication efforts.

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## Introduction

The global effort to eradicate polio faces a complex web of challenges as it enters its final stages. Despite considerable progress, wild virus transmission persists in Afghanistan and Pakistan, both experiencing security issues that limit accessibility in some regions and hinder vaccination efforts.<sup>1</sup> There and elsewhere, vaccination programmes face high levels of hesitancy fuelled by conspiracy theories that thrive on distrust.<sup>2,3</sup>

Compounding this problem is the emergence of circulating vaccine-derived poliovirus type 2 (cVDPV2) outbreaks in previously polio-free areas, including in Israel and Gaza.<sup>4</sup> The current conflicts in this region have produced a humanitarian crisis in several countries, with displacement of more than 1.9 million people in Gaza, 250,000 people in Israel, and 1.2 million in Lebanon. The situation in Gaza is especially severe, with reduced access to essential health services, including life-saving care and vaccines, including the polio

vaccine. These problems are compounded by a lack of clean water, food, and electricity, which exacerbates public health risks, including outbreaks of communicable and waterborne diseases.<sup>5–7</sup> As a result, polio vaccination coverage in the region has fallen.<sup>4,8</sup>

## Global epidemiology of cVDPV2

Unvaccinated groups in regions with poor water, sanitation, and hygiene conditions, fragile health systems, and, especially, those experiencing wars and conflicts are at increased risk for circulating vaccine-derived poliovirus (cVDPV). In recent years, cVDPV2 has become a major global public health concern, particularly among populations with low vaccination coverage.

The global success in eradicating wild poliovirus type 2 (WPV2) in 1999 led to the cessation of the type 2 component of the oral polio vaccine (OPV) in 2016. However, the continued circulation of cVDPV in countries with inadequate vaccination coverage of the enhanced potency inactivated poliovirus vaccine (eIPV) enables the attenuated vaccine-derived virus to circulate

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and further mutate, increasing the risk of cVDPV2 outbreaks. As of 2024, cVDPV1 has been reported in 22 countries, while cVDPV2 has been reported in 15 countries in multiple regions.<sup>9</sup> Africa is the worst affected due to poor vaccination coverage, wars and conflicts, displacement, poor water, sanitation, and hygiene, and barriers to accessing healthcare.<sup>10</sup> cVDPV2 can circulate for years in populations with low immunisation coverage and poor sanitation. Research from elsewhere has shown that vaccine-derived polioviruses can persist in settings similar to Gaza for up to 10 years or more.<sup>11</sup> In the World Health Organization (WHO) Eastern Mediterranean region, cVDPV2 has been detected in Afghanistan and Pakistan, where wild poliovirus type 1 (WPV1) remains endemic, complicating eradication efforts. Additionally, cVDPV2 has been detected in environmental samples in countries such as Iran and Somalia, indicating ongoing transmission, including importation from other countries, and highlighting the need for continued vigilance.<sup>12</sup> The WHO Western Pacific region has also reported cases of cVDPV2, particularly in Indonesia, where outbreaks in recent years have prompted emergency vaccination campaigns. In Asia, Tajikistan has experienced outbreaks linked to cVDPV2 strains originating in Pakistan, illustrating the potential of this virus for cross-border spread.<sup>12</sup>

The resurgence of cVDPV2 emphasises the need for sustained vaccination efforts, particularly in high-risk regions. The introduction of the novel oral polio vaccine type 2 (nOPV2), designed to be more genetically stable and less likely to revert to virulence than previous vaccine types, represents a critical tool in combating these outbreaks.<sup>12</sup> However, the ongoing challenge of ensuring high vaccination coverage, especially in conflict-affected and underserved areas, remains a major barrier to global polio eradication efforts.<sup>13</sup>

This is partly due to the obvious problems associated with violence and insecurity, although these are substantial. Thus, both the Fragile States Index and the Global Peace Index are highly correlated with cases of polio in the subsequent year, even after adjustment for a wide range of other variables.<sup>14</sup> As noted above, there is a specific association polio and situations in which Islamic insurgents hold territory.<sup>1</sup> A study from Afghanistan found an association between polio cases and recent improvised explosive device detonations.<sup>15</sup> However, these problems are exacerbated by the distrust that is encouraged by the growth of disinformation, especially online. This has been described in detail in a report from Pakistan, where a false rumour spread widely on YouTube, Facebook, and Twitter in 2019 is estimated to have led to over 2 million children going unvaccinated.<sup>16</sup> Acceptance of disinformation has, on occasion, been facilitated by exploitation of vaccination campaigns for other purposes.<sup>17</sup> Despite these major challenges, intensive global vaccination efforts

have reduced the number of polio cases originating from wild poliovirus from hundreds of thousands annually in the 1980s to 27 cases globally today. As of October 2024, 14 cases of WPV1 were reported in Afghanistan and 13 cases in Pakistan.<sup>18</sup> The world is close to making polio the second human disease to be eradicated. However, this “polio endgame” phase exposes the world to the challenges of the residuals of the cVDPVs. Therefore, there is a need to ensure that all children are immunised against all strains of the virus using eIPV 1, 2, 3, combined with simultaneous administration of bivalent oral polio vaccine (bOPV) 1, 3 in areas with poor sanitation and hygiene. In cases of cVDPV2 outbreaks, nOPV2 is recommended as the first-line vaccine, used in conjunction with eIPV, aiming to rapidly and widely stop the circulation of the virus. Regional polio vaccination strategies should be tailored to address a whole-of-community approach that prevents the spread of polio, as borders do not confine hazards or microorganisms. The current polio situation in Israel and Gaza is a clear illustration of this need.

## Polio in Israel and Gaza

In 1977 and 1978, Gaza experienced a severe polio outbreak, with more than 70 cases occurring each year, even among partially vaccinated children. Simultaneous outbreaks of enteric diseases and measles exacerbated this crisis. In a remarkable display of collaboration, Israeli and Palestinian health officials, WHO, and the United Nations Relief and Works Agency for Palestine Refugees in the Near East (UNRWA) took decisive action. They implemented a new polio control strategy based on advice from a WHO consultant, Dr. Joseph Melnick, which involved combining the OPV with two doses of inactivated polio vaccine (IPV). This collaboration amidst conflict exemplifies “health for peace”. Health authorities on both sides prioritised public health over political differences, showcasing an extraordinary commitment to health. Such coordinated efforts require transparency, joint planning and trust between the health professionals involved. The impact of this partnership was not only a significant reduction in polio cases in Gaza but also the establishment of a model that other countries can adopt. Actually, this strategic approach, coined the “Gaza system”, received full support from the Israeli Civil Administration, responsible for overseeing the healthcare system in Gaza and the West Bank, marking an important milestone in the fight against polio.<sup>19</sup> Following this success, the “Gaza system” was adopted by other countries in the Mediterranean region. A summary of the characteristics of the different polio vaccine types and its application beyond Gaza is presented in [Table 1](#).

**Fig. 1** illustrates the polio vaccination timeline in Israel and Gaza since 1988, along with key polio-related events up to the recent cVDPV2 outbreak in Gaza.

Vaccine type	Characteristics	Evolution/modifications	Application beyond Gaza
Oral polio vaccine (OPV)	<ul style="list-style-type: none"> <li>Live attenuated vaccine.</li> <li>Administered orally.</li> <li>Effective at inducing intestinal immunity.</li> </ul>	<ul style="list-style-type: none"> <li>Early forms included trivalent OPV (tOPV).</li> <li>In 1999, after the eradication of the wild poliovirus type 2, it was modified to bivalent OPV (bOPV).</li> </ul>	<ul style="list-style-type: none"> <li>Previously used worldwide but now being phased out in many countries.</li> <li>Still plays a critical role in areas with poor sanitation and ongoing transmission (e.g., parts of Africa, South Asia).</li> </ul>
Inactivated polio vaccine (IPV)	<ul style="list-style-type: none"> <li>Killed virus.</li> <li>Administered intramuscularly.</li> <li>Induces individual immunity.</li> </ul>	<ul style="list-style-type: none"> <li>Enhanced Potency IPV (eIPV) developed for higher effectiveness.</li> <li>In some countries it is administered with OPV.</li> </ul>	<ul style="list-style-type: none"> <li>Widely used in high-income countries.</li> <li>Adopted globally in 2016 as part of the Polio Endgame Strategy.</li> </ul>
Novel oral polio vaccine type 2 (nOPV2)	<ul style="list-style-type: none"> <li>Genetically stabilised OPV2 designed to reduce the risk of vaccine-derived outbreaks.</li> </ul>	<ul style="list-style-type: none"> <li>Deployed under emergency use in response to cVDPV2 outbreaks since 2021.</li> </ul>	<ul style="list-style-type: none"> <li>Applied in settings with cVDPV2 outbreaks.</li> </ul>
Combination vaccines (e.g., Gaza system)	<ul style="list-style-type: none"> <li>Combines OPV with IPV to enhance immunity and coverage.</li> </ul>	<ul style="list-style-type: none"> <li>Introduced in Gaza in the 1980s.</li> <li>Adopted by other countries, including Israel in the Mediterranean region.</li> </ul>	<ul style="list-style-type: none"> <li>Adopted by Israel, Jordan, Lebanon, and other Mediterranean countries to address local health challenges.</li> </ul>

**Table 1: The characteristics of the different polio vaccine types, their evolution and modifications and application beyond Gaza.**

In 1988, Israel experienced a major poliomyelitis outbreak, marking the most extensive occurrence of paralytic poliomyelitis in the country since 1979. This outbreak, caused by WPV1, resulted in 15 confirmed cases of paralytic poliomyelitis between July and October of that same year. The outbreak also saw the co-identification of a clinical case in the West Bank, alongside the detection of WPV1 in sewage samples from Gaza. Most cases (12 of the 15) were concentrated in Israel's Hadera subdistrict, an area where, since 1982, eIPV had been exclusively used for infant vaccination.<sup>20</sup> In response to the outbreak, the Israeli Ministry of Health launched a mass vaccination campaign, targeting all individuals under 40 years old for vaccination with OPV, which led to the elimination of the virus. The outbreak precipitated the implementation of the combined eIPV and OPV vaccination schedule in Israel.<sup>21</sup>

Following the 1988 outbreak, a collaborative early warning system was established. This included the

routine monitoring of sewage from Israel, the West Bank, and Gaza at the Central Virus Laboratory of Israel's Ministry of Health.<sup>22</sup>

WHO declared Israel, and subsequently the West Bank and Gaza, polio-free in 2002 and 2010, respectively.<sup>22,23</sup> In 2004, Israel discontinued the use of OPV in line with the WHO European Region, which had declared the region polio-free the previous year (while Israel is in WHO's European Region, Palestine is in the Eastern Mediterranean Region). However, Gaza has continued to employ the Melnick plan.

In May 2013, a "silent outbreak" of WPV1 in southern Israel, so-called because it was spreading without being detected through case identification, was identified via sewage monitoring.<sup>24</sup> The same virus had previously been detected in sewage samples in Cairo, Egypt. Genetic analyses linked it to strains circulating in Pakistan, indicating its spread from South Asia to the Middle East.<sup>25</sup> Later in 2013, the virus spread silently

Area	Israel & Gaza		Israel		Gaza		Israel and Gaza		Israel	Gaza
Poliomyelitis cases	WPV1 outbreak						None		Paralytic cVDPV2 case	Paralytic cVDPV2 case
Polio in Swage	WPV1 in Gaza						WPV1 in Israel and Gaza		cVDPV2 in Israel	cVDPV2 in Gaza
	↓		Israel declared as polio free		Gaza declared as polio free		↓		↓	↓
vaccination schedule	1988	1989	2002	2005	2010	2013	2014	2022	2024	
	tOPV	eIPV+tOPV		Change to eIPV only		bOPV		eIPV+bOPV		
Israel	national SIA					national SIA				
Gaza	national SIA	eIPV+tOPV		eIPV+tOPV		national SIA		eIPV+bOPV		nOPV2 campaign

**Fig. 1:** Timeline of polio vaccination, cases, and detection of poliovirus in sewage in Israel and Gaza since 1988. tOPV – trivalent oral polio vaccine (1, 2, 3); bOPV – bivalent oral polio vaccine (1, 3); nOPV2 – novel oral polio vaccine 2; eIPV – enhanced potency inactivated poliovirus vaccine; SIA – supplementary immunisation activity.

across Israel, as evidenced by environmental surveillance results but with no clinical cases.<sup>26</sup> The outbreak extended further, with WPV1 identified in sewage samples from both the West Bank and Gaza.<sup>27</sup> In response to the widespread detection of WPV1, authorities in Israel, in collaboration with their counterparts in the Palestinian territories, initiated a coordinated public health response that included a mass vaccination campaign using bOPV. Moreover, due to the ongoing threat posed by the virus, Israel made the strategic decision to re-include bOPV in its national vaccination schedule, a move aimed at ensuring sustained immunity and preventing future outbreaks.<sup>28</sup> The epidemiological rationale was that without the deployment of the OPV, it is doubtful that the polio outbreak could have been effectively contained and, in due course, eradicated.<sup>28</sup>

## Latest epidemiology of cVDPV2 in Israel

In 2022, Israel reported a case of vaccine-associated paralytic poliomyelitis (VAPP) linked to cVDPV2. At the same time, cVDPV2 was detected in environmental samples, specifically in sewage, underscoring the silent circulation of the virus within the population. This was part of a broader pattern observed globally, as during the same period, cVDPV2 was also identified in sewage in the United Kingdom and the United States, highlighting the potential for the re-emergence of this virus even in polio-free regions.<sup>29</sup> The Israeli Ministry of Health responded by intensifying surveillance and reassessing vaccination strategies to increase vaccination coverage with eIPV. The situation underscored the importance of continuous vigilance and adaptability in public health strategies to prevent the re-emergence of poliovirus in any form.

## Current polio outbreak in Gaza

The routine vaccination schedule in Gaza and the West Bank includes five dosages of OPV 1, 3 and two of eIPV1, 2, 3. Until mid-2023, vaccination coverage was as high as 99.6%.<sup>30</sup> However, the Israeli response to the attacks by Hamas on 7th October, 2023, caused widespread destruction. By June, 2024, it was estimated that 1.7 million of Gaza's 2.1 million people had been displaced.<sup>31</sup> Prior to the conflict, an estimated 98% of waste was managed by the disposal system but this had fallen to 20%, with landfill sites overflowing and garbage uncollected.<sup>32</sup> Safe water supply had diminished by an estimated 95%.<sup>33</sup> The situation was exacerbated by restrictions on the flow of aid into Gaza.<sup>34</sup>

Nearly three months into the escalation of hostilities, an estimated 16,854 children had missed their routine vaccinations, leaving their immunity compromised at a time of significant vulnerability. Before October 7, substantial progress has been made to improve children's health and wellbeing in Palestine, with

vaccination coverage of critical vaccines as high as 99%. Despite continuing efforts to maintain vaccination coverage, Gaza's relentless socioeconomic decline, exacerbated by the conflict and the weakness of Gaza's already fragile healthcare infrastructure, intensified by prolonged conflict and interruptions to services, all posed significant challenges, disrupting vaccinations and disease surveillance and increasing the risk of deadly but preventable diseases, such as measles and polio.<sup>35</sup>

In June 2024, Gaza faced a new polio threat following the detection of cVDPV2 in six environmental samples, followed by a verified case of cVDPV2 in a 10-month-old girl with poliomyelitis. This outbreak represents a significant public health emergency in Gaza and the wider region. The virus is genetically linked to cVDPV2 strains circulating in Egypt during the second half of 2023, reflecting the regional interconnectedness of poliovirus transmission. The last detection of the related variant polioviruses in Egypt was in samples collected in December 2023. Based on the analysis of genetic changes in the isolates, the variant poliovirus could have been introduced in Gaza as early as September 2023.<sup>36</sup>

In response to this outbreak, a critical polio vaccination campaign using nOPV2 was launched on September 1, 2024,<sup>37</sup> targeting more than 640,000 children under 10. This campaign was successful, with 560,000 children vaccinated between September 1 and 12, 2024. The next round of the vaccination campaign in Gaza began on October 14, 2024,<sup>38</sup> using a scheme similar to that used in the first round, with local "tactical pauses" in fighting during the hours the campaign operates.<sup>37</sup> Unfortunately the final phase of the campaign, aiming to vaccinate about 120,000 children across northern Gaza, has been delayed due to escalating violence and the lack of assured humanitarian pauses. Fortunately, at the time of writing, a ceasefire has been agreed and, if it holds, the prospects for continuation of vaccination efforts are improved.<sup>37</sup> At this point it is important to reflect on what could have happened had the vaccination campaign not been mounted. A detailed report, published in February 2024, produced a central estimate (with wide confidence intervals), of 639 deaths from vaccine-derived poliovirus and 506 from wild poliovirus over the following six months, had there been ceasefire at that point, with the corresponding estimates in a scenario where there was an escalation of violence increasing to 194 and 1050 deaths.<sup>39</sup> The recent situation involving the spread of polio in the Middle East is an example of how local context must be considered within the current global effort to eradicate polio and highlights the importance of involving all health actors at local, regional, and global levels in implementing sustainable vaccination programmes. In the years ahead, we must also consider the legacy of the COVID-19 pandemic: misinformation and

vaccine hesitancy pose serious obstacles, particularly in areas with low literacy where conspiracy theories can spread rapidly.<sup>40</sup> Surveys in Gaza in 2021 and 2023 found hesitancy to receive COVID-19 vaccines was over 30%,<sup>41</sup> while a qualitative study identified a range of conspiracy theories, some related to the political situation in the region.<sup>42</sup> Such scepticism undermines efforts to achieve high vaccination coverage. Logistical challenges, such as maintaining a cold chain, further complicate the eradication campaign.

The Gaza situation presents some specific challenges. While not unique to Gaza,<sup>43</sup> the safety of healthcare workers remains a grave concern, with targeted attacks on polio vaccination teams threatening their lives and the success of vaccination campaigns. Ensuring local ceasefires is crucial. Population movement also increases the risk of viruses spreading across borders. Weak routine vaccination programmes in high-risk environments and among populations at risk leave children vulnerable to infection while competing for health priorities and disease outbreaks strain resources and distract attention from polio eradication efforts.

Funding gaps remain a major challenge, as sustained financial support is crucial for maintaining eradication efforts yet financial flows have been compromised by political considerations by donors.<sup>44</sup> Additionally, the increased detection of poliovirus in environmental samples, such as sewage, indicates ongoing transmission risks that must be addressed to achieve global eradication.

The Gaza outbreak, combined with the discovery of previously detected cVDPV2 in Israel, underscores the need for coordinated regional efforts and sustained vaccination campaigns to prevent further virus spread. Recent events, both in Israel and Gaza, have highlighted new challenges, not only for the region but also for the global eradication campaign. These events have shown the importance of CVDV and revealed the best ways to deal with this using currently available vaccines, given the differences in health system capacity and ongoing military and political conflicts.

The complex situation in the Middle East could fuel the emergence and re-emergence of infectious diseases across the region, making it essential for countries to collaborate and implement cross-border responses. Successful precedents for such cooperation exist, even in conflict areas or where frontiers are disputed.<sup>45</sup> Examples in this region include the establishment of the Middle East Consortium on Infectious Disease Surveillance (MECIDS),<sup>46</sup> as well as joint efforts during the 2009 H1N1 pandemic<sup>47</sup> and the silent 2013 outbreak of WPV1.<sup>26</sup> The current crisis has also encouraged WHO's regional offices to create mechanisms to coordinate efforts when threats transcend their borders.<sup>48</sup>

The current situation involving cVDPV2 in the area may require an expanded vaccination campaign with nOPV2.<sup>49</sup> Similar initiatives, in partnership with

international bodies and organisations, are urgently needed to coordinate responses to the current polio outbreak in Gaza and address other infectious disease threats that may arise from conflict in the Middle East.

## Conclusions

Polio outbreaks require immediate action, but effective response depends on timely detection. This underscores the need for enhanced surveillance, particularly during disasters and conflicts, which often disrupt healthcare systems and vaccination programmes and displace populations. The recent cVDPV2 outbreak in Gaza highlights the vulnerability of global polio eradication efforts and the critical need to sustain high vaccination coverage in conflict-affected areas. It also demonstrates the interconnected nature of public health, emphasising the importance of collaboration among local, regional, and global partners to implement coordinated regional responses.

The successful implementation of vaccination campaigns amidst conflict reveals both the challenges and opportunities in crisis settings. Advances such as targeted campaigns using the novel oral polio vaccine type 2 (nOPV2), alongside comprehensive coverage with inactivated polio vaccine (eIPV), provide hope for preventing future outbreaks. However, eradication will depend on sustained political commitment, addressing cross-border health determinants, enhancing coordinated emergency responses, fostering international cooperation, advancing research, and employing innovative strategies to reach every child with life-saving vaccines.

As the world navigates the complexities of the “polio endgame”, lessons from the Gaza outbreak will be instrumental in shaping global health policies and improving preparedness for future infectious disease challenges. These insights reaffirm the need for resilient health systems and robust monitoring and information-sharing mechanisms to safeguard progress in eradication efforts.

## Contributors

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## Declaration of interests

None.

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