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Eradicating polio in Pakistan: a systematic review of programs and policies

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ABSTRACT

Introduction: Established in 1994, Pakistan's polio program demonstrated early success. However, despite over 120 supplementary immunization activities in the last decade, polio eradication efforts in Pakistan have been unable to achieve their objective of halting polio transmission. Variable governance, and inconsistent leadership and accountability have hindered the success of the polio program and the quality of the campaigns. Insecurity and terrorism has interrupted polio activities, and community fears and misbeliefs about polio vaccinations continue to persist.

Areas covered: The article consists of a systematic review of the barriers and facilitators associated with the delivery of polio eradication activities in Pakistan. We also provide a comprehensive review of the policy and programmatic decisions made by the Pakistan Polio Programme since 1994. Searches were conducted on Embase and Medline databases and 25 gray literature sources.

Expert opinion: Polio eradication efforts must be integrated with other preventive health services, particularly immunization services. Addressing the underlying causes of polio refusals including underdevelopment and social exclusion will help counteract resistance to polio vaccination. Achieving polio eradication will require building health systems that provide comprehensive community-centered care, and improving governance and systems of accountability.

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Polio eradication; Pakistan; polio vaccination; policy analysis; service delivery

1. Introduction

The Global Polio Eradication Initiative (GPEI) was launched in 1988, with the goal of eradication and containment of all wild, vaccine-related and Sabin polioviruses worldwide [1]. Polio eradication efforts began in Pakistan in 1994, through the launch of the Pakistan Polio Eradication Programme [2]. The Pakistan Polio Eradication Programme is a public-private partnership led by the federal government, and supported by GPEI partners including WHO, UNICEF, BMFG, and CDC [3]. Despite national efforts to eradicate polio, the transmission of wild poliovirus is ongoing in Pakistan [4].

Presently, Pakistan and Afghanistan are the only countries where the transmission of endemic wild poliovirus has never stopped [5]. Given global interest in eradicating polio, polio eradication initiatives have been funded through a diverse range of donors made up of national governments, private organizations/non-governmental donors, and multisectoral partnerships. Since 1985, more than US\$ 17 billion has been donated to support the GPEI. Between 1985 and 2019, the Government of Pakistan contributed roughly US\$387 million and US\$121 million to the GPEI through loans provided by the Islamic Development Bank and Japan International Cooperation Agency, respectively, and roughly US\$ 58 million through assistance from other national governments [6].

Roughly 20,000 wild poliovirus cases were reported in Pakistan in the early 1990s, however the polio program has reduced this by up to 99% [2]. Today, Pakistan continues to be affected by wild poliovirus type 1 (WPV1) and circulating vaccine-derived poliovirus type 2 (cVDPV2) [7]. A record low of eight cases was reported in 2017; however, this was followed by an increase in subsequent years, with 12 cases in 2018, 147 cases in 2019, and 84 cases in 2020 (Figure 1). Polio transmission is highly active in certain core reservoir districts, including Karachi, Peshawar, and the Quetta block. Polio cases have also been identified in northern Sindh and Southern Punjab [4,8]. A large proportion of cases are among Pashto-speaking populations [9]. The polio program's success is highly dependent on vaccinating high-risk mobile populations (HRMP) and internally displaced persons (IDP), who often have inconsistent access to the health system [10]. The polio program implements numerous vaccination campaigns every year wherein roughly 260,000 health workers go door-to-door to ensure every child under five years of age is vaccinated against polio [2]. During vaccination campaigns, special attention is given to the core reservoir districts [4].

Despite efforts by the Pakistani polio program, vaccination bans, rumors, and conspiracy theories that polio eradication is enabling foreign bodies to destabilize the country

Article highlights

- Polio eradication requires the intervention of multiple stakeholders at different levels of the health system
- Variable governance and inconsistent leadership have compromised the functioning of polio eradication activities
- The morale of polio workers is low due to inconsistent pay, limited opportunities for promotion, and consistent threats of insecurity
- Improved field monitoring during polio campaigns and through polio surveillance systems are needed
- Misbeliefs and misperceptions about polio vaccination among community members continue to persist
- Integration of polio activities with other preventive health services especially child health, nutrition and routine immunizations may address community resistance and increase program reach
- Terrorism and insecurity are still a consistent concern for the polio program through blocking access to certain geographies and resulting in attacks on polio workers

continue to be a barrier to polio eradication [11–13]. Access to children in security-compromised areas, and attacks on healthcare workers have created an insecure environment where the safety of both the providers and recipients has been jeopardized [14]. In addition to these demand-related issues, governance and operational failures continue to persist as a barrier to polio vaccination [15,16].

The emergence of the coronavirus disease 2019 (COVID-19) has posed a new threat to polio eradication efforts [17]. In April 2020, polio vaccination campaigns and routine immunization programs across Pakistan were halted to mitigate the spread of COVID-19. Staff and resources from the

polio program were redirected in the fight against COVID-19, highlighting the strength of the program's infrastructure [18,19]. This strategy has unintentionally increased the susceptibility of already vulnerable children to vaccine-preventable diseases (VPD) such as polio [18]. Although the government's response to COVID-19 has been lauded, it begs the question why has polio not had received the same political commitment [19].

Understanding the barriers and facilitators to service delivery, and the operational factors that influence functioning of the polio program is essential to its success. This systematic review will present the following: i) a timeline highlighting distinct polio-related policies, programs, and activities implemented in Pakistan since 1994, and ii) barriers and facilitators associated with the delivery of polio eradication activities in Pakistan.

2. Methods

2.1. Search strategy

A systematic search of indexed peer-reviewed literature published between 1 January 2000 to 30 July 2020 was conducted in Embase and Medline databases using the OVID platform. We used the PICO methodology to develop a search strategy containing relevant key words and medical subject headings MeSH. Where possible, our search strategy utilized the 'explode' function for MeSH terms. We also hand-searched reference lists of studies included in full-text screening for any additional studies. The complete search strategy is presented in Appendix I.

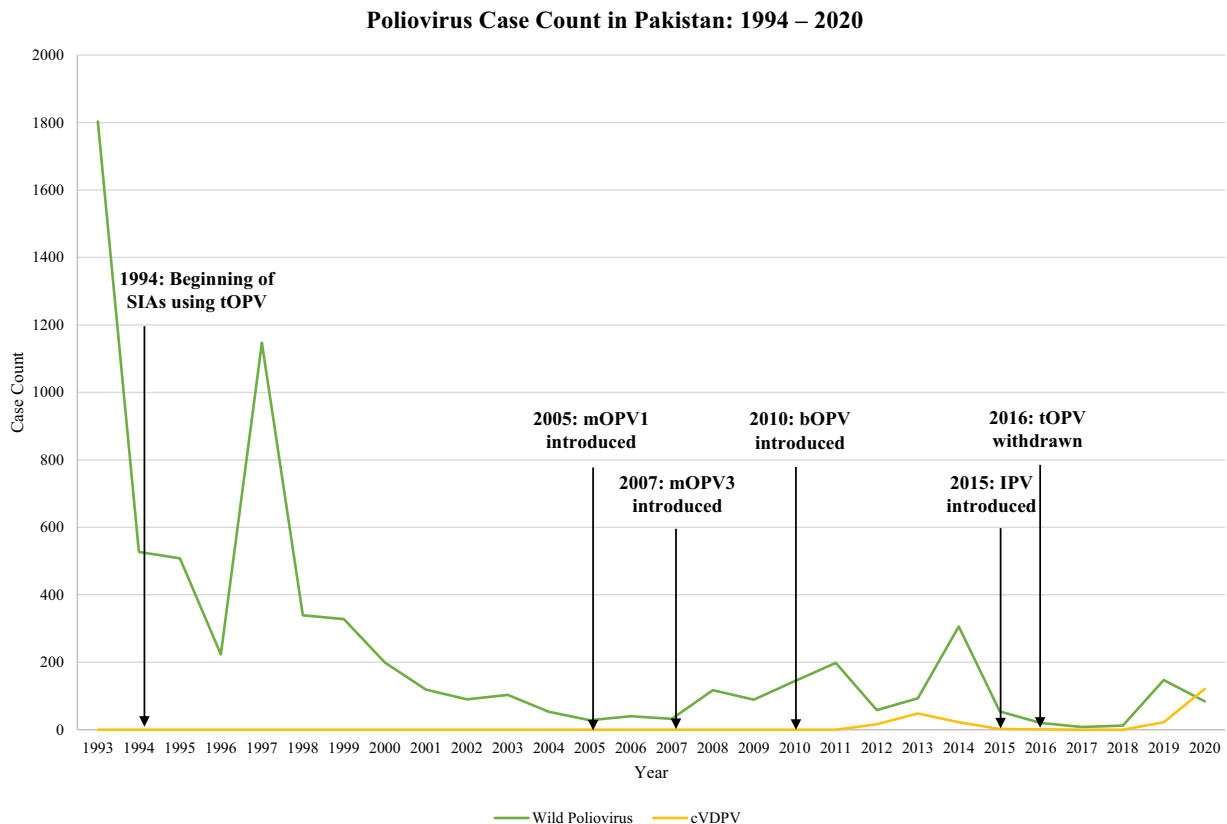


Figure 1. Poliovirus case count in Pakistan: 1994 – 2020 [20–24,118].

For the gray literature search, we searched the websites of 25 stakeholders which are involved in delivering polio eradication or public health activities across Pakistan, including governmental agencies, national organizations, and international organizations. These websites included the Ministry of National Health Services, Regulations, and Coordination, the health departments of each province and territory, Asian Development Bank, Bill & Melinda Gates Foundation, Centers for Disease Control, GAVI, Global Polio Eradication Initiative, Japan International Cooperation Agency, Pakistan Health Knowledge Hub, Pakistan Polio Eradication Programme, Relief Web, United Nations UNDP, UNFPA, UNICEF, UNICEF Innocenti, World Health Organization (WHO EMRO, WHO Iris, WHO Pakistan), and World Bank (Open Knowledge Repository, Projects Database). When searching each website, we used search terms which captured polio, immunization, and general health programs and policies in Pakistan. Grey literature documents published from 2000 onwards were reviewed.

2.2. Eligibility criteria

Eligible peer-reviewed studies included those reporting primary data on polio eradication activities in Pakistan. The publication must have been available in English, and must have described barriers and facilitators related to polio eradication.

Exclusion criteria included editorials, commentary pieces, opinion pieces, serological studies, systematic reviews, guidelines, and non-English publications.

Eligible gray literature documents included any policy or program-related proposal, evaluation, or report, which reported on polio eradication activities in Pakistan. Grey literature documents were included if they reported on: i) barriers or facilitators related to polio eradication activities, or ii) any polio-related policies, programs, political events, partnerships, religious advocacy events, milestones, or external events which impacted polio eradication efforts.

2.3. Data extraction and analysis

Peer-reviewed studies were managed on Covidence, an online software used to streamline the systematic review process. Records identified from both databases were imported into Covidence for screening, and duplicates were removed. Titles and abstracts were screened in duplicate, full-text screening was done by a single reviewer, and data extraction was done in duplicate, followed by data matching. A single reviewer downloaded, screened and extracted every gray literature document (see Figure 2). A total of 32 articles from the peer reviewed literature [25–56] and 13 from the gray literature [57–69] were included.

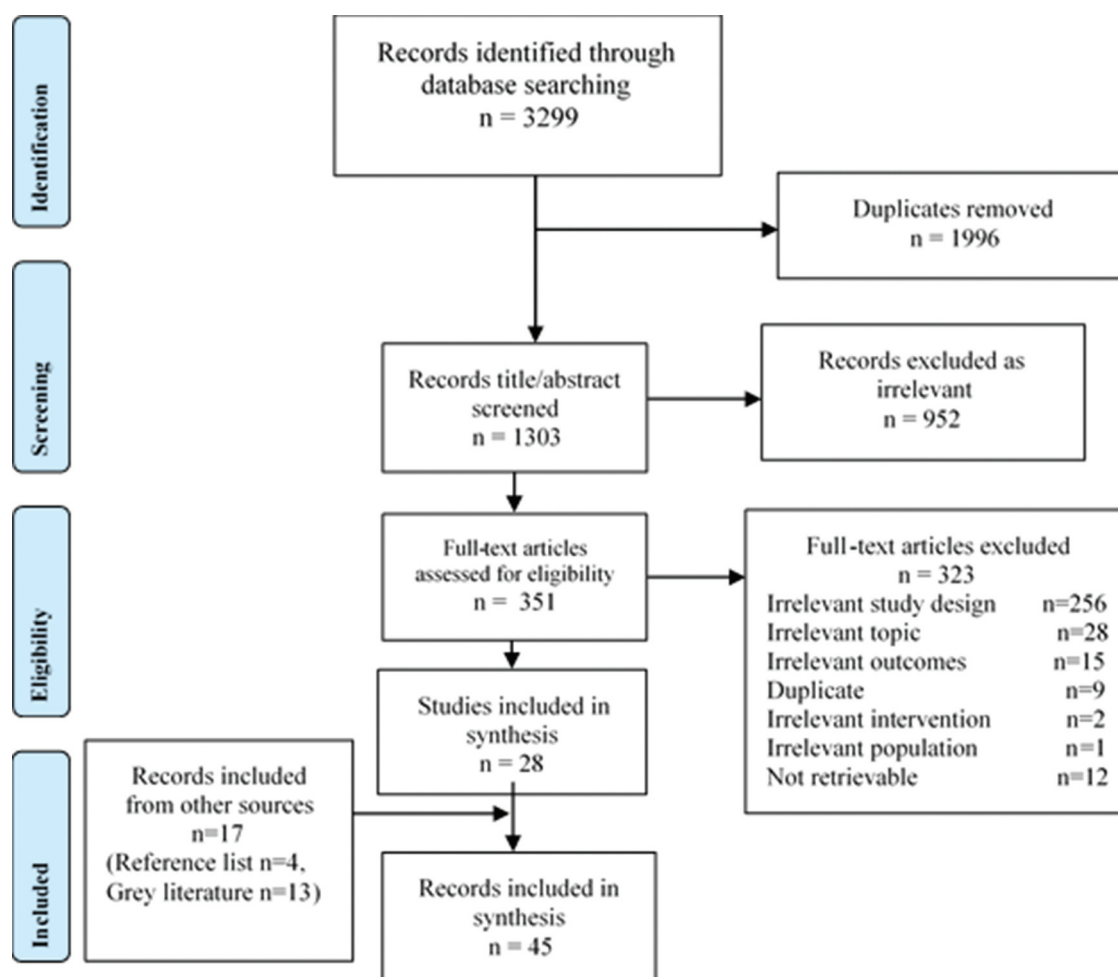


Figure 2. Prisma.

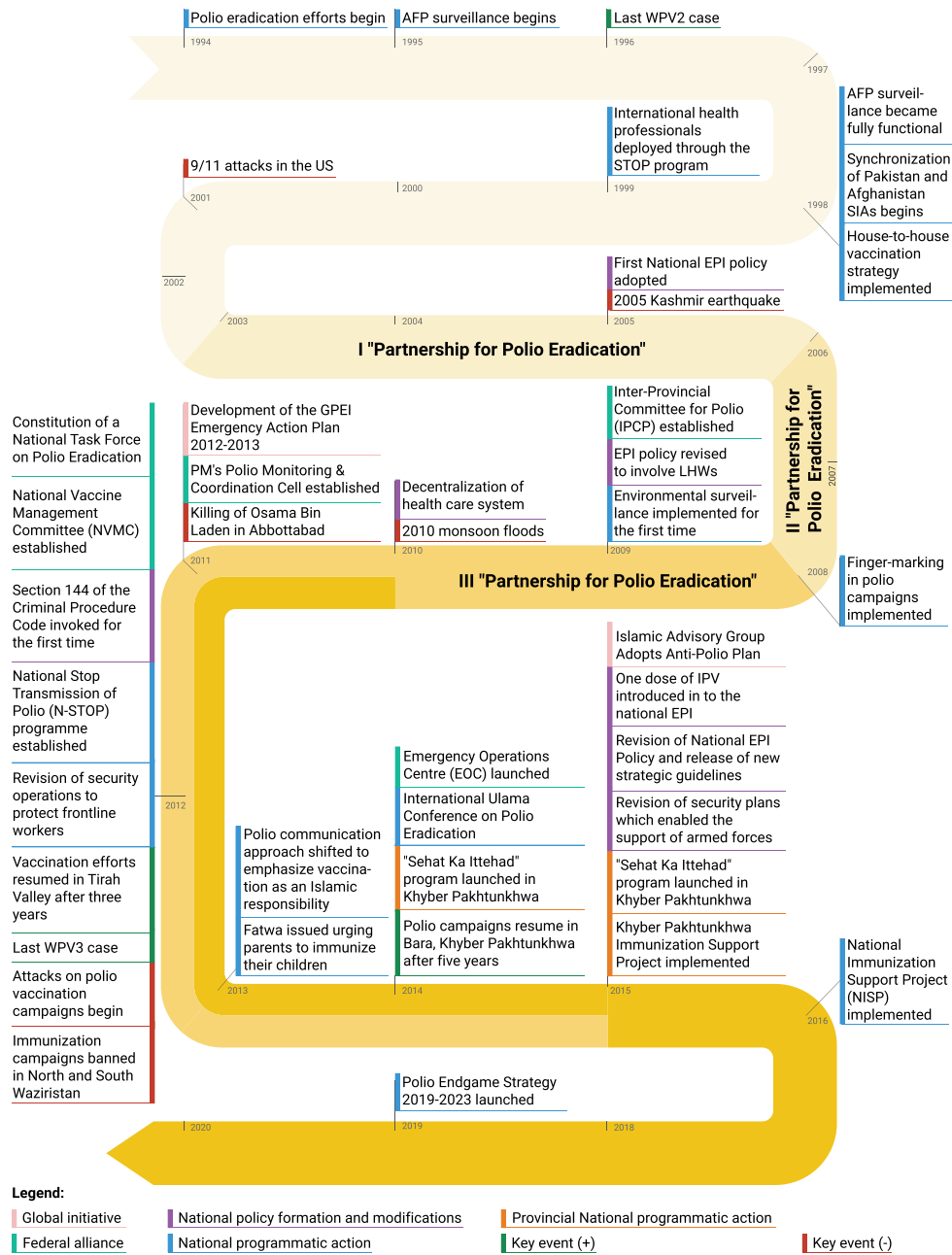


Figure 3. Overview of polio policies and programs in Pakistan.

Barriers and facilitators were extracted from the peer-reviewed and gray literature in Microsoft Excel. Key data extracted included study design, study characteristics, type of data, and barriers and facilitators which had an impact on polio eradication activities. The data were then imported in to NVivo 12, a qualitative data analysis software, and a thematic analysis of the barriers and facilitators was conducted through an inductive process. Barriers and facilitators were categorized in to reviewer-generated codes, followed by broader categories, and ultimately broad themes.

Polio-related policies, programs, and activities were extracted from the gray literature using a separate extraction form in Microsoft Excel. Key data extracted included activity

name and description, impact, implementation level, and stakeholders involved. The extracted data was used to form a timeline of events, as depicted in Figure 3.

3. Results

3.1. Policy & program overview

Since 1994, a variety of programs and policies have been implemented as part of polio eradication efforts (Figure 3). In this section, we will provide an overview of the polio-related policy and programmatic decisions organized by major polio project timelines (Table 1).

Table 1. Polio program and policy analysis table.

Policies/Programs/Strategies/Plans		
GLOBAL		
GPEI Emergency Action Plan 2012–2013 (2011)	Description	The GPEI developed the GPEI Emergency Action Plan 2012–2013 for Nigeria, Pakistan, and Afghanistan. The goal of this plan was to help get the GPEI back on track in the endemic regions through an emergency approach. The plan builds upon the strategies highlighted in the GPEI Strategic Plan 2012–2012, and was focused on developing appropriate leadership, oversight, accountability and surge capacity at global, national and sub-national level to support a transformational change.
National Stop Transmission of Polio (N-STOP) programme (2012)	Classification	Global initiative
	Description	Piloted in Nigeria, N-STOP is a CDC-WHO collaborative program which supports eradication efforts in polio priority countries, by strengthening local surveillance, training local health professionals, and deploying public health professionals accordingly. The National Stop Transmission of Polio (N-STOP) program was established in Pakistan in 2012; 16 public health professionals were deployed as part of Pakistan's N-STOP program.
Islamic Advisory Group Adopts Anti-Polio Plan (2015)	Classification	Global initiative
	Description	The Islamic Advisory Group for Polio Eradication (IAG) adopted a new action plan that sought to help eradicate polio in the remaining Muslim nations. The meeting was hosted by Al Azhar in Cairo and was attended by Islamic scholars and experts of the IAG. Specific to Pakistan, the IAG aimed to enhance the work of the National Islamic Advisory Group for Polio Eradication in Pakistan, through increased advocacy and communication activities, and also planned to organize for members of the IAG to visit and interact with religious institutions in priority areas of Pakistan.
	Classification	Global initiative
NATIONAL		
Pakistan Polio Eradication Programme (1994)	Description	The Pakistan Polio Eradication Program, a public–private partnership between the Government of Pakistan and partners from the GPEI (WHO, UNICEF, BMGF, Rotary International, and CDC), was launched in 1994. The initiation of polio eradication efforts was signified by the first set of supplementary immunization activities (SIAs) through National Immunization Days (NIDs).
Trivalent OPV (1994–2016)	Classification	National programmatic action
	Description	Trivalent OPV (tOPV) was the only vaccine used in SIAs between 1994–2004, after which a combination of monovalent and bivalent vaccines were used. The trivalent vaccine was withdrawn globally in 2016.
Acute Flaccid Paralysis (AFP) surveillance begins (1995)	Classification	National programmatic action
	Description	The program began conducting acute flaccid paralysis (AFP) surveillance in 1995. As part of the AFP surveillance, AFP cases in children aged less than 15 years were reported to surveillance bodies and further investigated as possible polio cases
AFP surveillance becomes fully functional (1998)	Description	AFP surveillance was fully functional by 1998, after provincial staff were provided training and computerized case listings were introduced.
	Classification	National programmatic action
Synchronization of Pakistan and Afghanistan SIAs (1998)	Description	To ensure comprehensive coverage of border regions and children in transit, immunization activities in Pakistan and Afghanistan were synchronized.
	Classification	National programmatic action
Stop Transmission of Polio (STOP) program (1999)	Description	The STOP program is a collaborative program run by the CDC, WHO, and UNICEF. In 1999, the Stop Transmission of Polio (STOP) program was launched; international health professionals were sent to Pakistan on 3 to 5 months assignments to assist with polio eradication activities and improve the quality of surveillance activities.
	Classification	National programmatic action
House-to-house vaccination strategy implemented (1998–1999)	Description	During the implementation of the 1998–1999 subnational immunization days (SNIDs) in Pakistan, a house-to-house vaccination approach was introduced. The house-to-house vaccination approach was expanded further in 2000, and became a core aspect of Pakistan's polio eradication strategy.
	Classification	National programmatic action
First 'Partnership for Polio Eradication' project (2003–2006)	Description	In 2003, the First Partnership for Polio Eradication project was implemented by the Government of Pakistan. [24] This project was funded by the World Bank, and the objective of this project was to support the supply to the Government of Pakistan (GoP) of 50% of the Oral Polio Vaccine (OPV) needed for Supplemental Immunization Activities during 2003–2005. Project funds were transferred to UNICEF, who was responsible for vaccine procurement and delivery, as per an agreement between the Government of Pakistan and UNICEF. The project financed the procurement of 371 million oral polio vaccines (OPV) for SIAs held between 2003 to 2006, and roughly 30 million children were immunized in each round.
	Classification	National programmatic action
First National EPI policy (2005)	Description	In 2004, the National EPI Advisory Group (NEAG) developed the first National EPI policy, which was adopted by the former Ministry of Health in 2005. The new EPI policy introduced new vaccines and technologies, and aligned its goals with priorities set at the global and regional level. Specific to vaccinations, the policy introduced new strategies for immunizations and vaccine preventable disease (VPD) surveillance.
	Classification	National policy formation and modifications
Monovalent OPV (2005–2010)	Description	Monovalent OPV (mOPV) was introduced in Pakistan in 2005 (mOPV1) and 2007 (mOPV3), and were used until the introduction of bivalent OPV in 2010.
	Classification	National programmatic action
Second 'Partnership for Polio Eradication' project (2006–2008)	Description	In 2006, the Second Partnership for Polio Eradication project was implemented by the Government of Pakistan, an extension of the initial project implemented in 2003. The second project was also financed by the World Bank, and vaccine procurement and delivery was also handled by UNICEF. The second project financed the procurement of approximately 590 million doses of OPV to children between 2006 to 2008. Approximately 30 million children were immunized in each round of SIAs.
	Classification	National programmatic action
Finger-marking in polio campaigns (2008)	Description	Finger-marking was introduced into polio campaigns in 2008 to objectively measure polio quality. This measure was intended to complement parental recall and other methods used to identify previously vaccinated children.
	Classification	National programmatic action

(Continued)

Table 1. (Continued).

Policies/Programs/Strategies/Plans		
Inter-Provincial Committee for Polio (ICPC) (2009)	Description	In 2009, the Federal Ministry of Health established the Inter-Provincial Committee for Polio (IPCP), which was chaired by the Federal Minister of Health. The ICPC was responsible for managing inter-sectoral coordination, monitoring the engagement of officials working at district and union council levels, and bringing together all provincial health ministers in order to collectively address challenges experienced when implementing polio eradication strategies.
	Classification	Federal alliance
EPI Policy revised to involve LHWs (2009)	Description	In 2009, the EPI policy was revised and provided guidelines highlighting greater involvement of lady health workers (LHWs) in immunization programs. The revised EPI policy specified that LHWs who are trained in EPI will deliver vaccination services, and LHWs who are not trained in EPI will assist the vaccinator by organizing vaccination services and mobilizing community members.
	Classification	National policy formation and modifications
Third 'Partnership for Polio Eradication' project (2009–2014)	Description	In 2009, the third 'Partnership for Polio Eradication' project was implemented by the Government of Pakistan, the final extension of the initial project implemented in 2003. The third project was also financed by the World Bank, and UNICEF continued to be responsible for vaccine procurement and delivery. The third project ensured timely supply and procurement of OPV for polio campaigns conducted between 2009–2014, and approximately 32 million children were immunized in each round of SIAs.
	Classification	National programmatic action
Environmental surveillance (2009)	Description	Surveillance activities were expanded in 2009, when environmental surveillance was implemented. Sewage testing began in Lahore and Karachi, and enabled virus transmission to be monitored so that poliovirus reservoirs could be identified.
	Classification	National programmatic action
Bivalent OPV (2010–present)	Description	Bivalent OPV (bOPV) containing wild polioviruses 1 and 3 was introduced in 2010. bOPV replaced tOPV in 2016, and continues to be used today.
	Classification	National programmatic action
Decentralization of Pakistan's health care system (2010)	Description	The passing of the 18th Amendment to the Constitution by the National Assembly of Pakistan in 2010 resulted in the decentralization of Pakistan's federal health care system. As a consequence, the Federal Ministry of Health was devolved, and health care responsibilities were transferred from federal to provincial authorities.
	Classification	National policy formation and modifications
National Emergency Action Plan (NEAP) (2011–2020)	Description	The National Emergency Action Plan (NEAP) was developed and launched in 2011. After limited success of the NEAP 2011, and Augmented NEAP was launched in 2012, with the goal of stopping poliovirus transmission by the end of 2012. The goal of ending transmission was not achieved, thus followed the implementation of a yearly NEAP in 2013. This is an annual strategic plan which has been released every year to date, and outlines the program's eradication strategy, priorities, and innovations. The NEAP includes coordination with and support from GPEI partners.
	Classification	National programmatic action
PM's Polio Monitoring & Coordination Cell (2011)	Description	The Prime Minister's Polio Monitoring & Coordination Cell was established in 2011. The purpose of this new Cell was to monitor and coordinate polio-eradication activities nationwide. The specific duties of the Cell included the following: 1) To liaise on a regular basis with the Provincial Monitoring Cells, Provincial health departments, National and Provincial EPI teams, Chief Secretaries office, DCOs, EDOs Health and other relevant departments and organizations to regularly monitor the progress of the Polio Eradication Initiative and provide feedback to the Prime Minister. 2) To facilitate and ensure the establishing of Polio Monitoring Cells at the Provincial level in line with announcement made by the Prime Minister on 14 January 2011. 3) To provide guidance, technical input and situation analysis to the National Task Force on Polio Eradication led by the Prime Minister.
	Classification	Federal alliance
National Task Force on Polio Eradication (2012)	Description	The President of Pakistan declared polio eradication a national emergency, and established the National Task Force on Polio Eradication in 2012. The Task Force was to be chaired by the Prime Minister, and constituted of provincial chief ministers and chief secretaries.
	Classification	Federal alliance
National Vaccine Management Committee (NVMC) (2012)	Description	In 2012, a National Vaccine Management Committee (NVMC) was established at the federal level, with representation from EPI, WHO, and UNICEF. The Committee was responsible for supporting vaccine management and reporting, including vaccine storage, transport, and utilization. The Committee was developed in response to the recommendations made by UNICEF, after they conducted a vaccine management review which highlighted issues with vaccine storage and wastage, and cold chain maintenance.
	Classification	Federal alliance
Revision of security operations (2012)	Description	After a series of attacks on polio workers and vaccination campaigns in 2012, the program adapted and began to operate under a new security framework, with intensified security operations in place for frontline health workers.
	Classification	National programmatic action
Section 144 of the Criminal Procedure Code invoked (2012)	Description	Section 144 of the Criminal Procedure Code was invoked for the first time during a polio campaign in Pakistan in 2012, by the District Coordination Officer (DCO) of Faisalabad. Section 144 was implemented to counteract vaccine refusals, and made it a criminal offense for parents to refuse vaccinating their children during polio campaigns. Furthermore, under Section 188 of the Pakistan Penal Code, action could be taken against parents who refused to let health teams vaccinate their children against polio during the anti-polio campaigns. According to press releases, this seems to be the first time that the law held non-compliant caregivers accountable, however Section 144 was also implemented in other cities such as Peshawar (2014), Charsadda (2015), and Mardan (2020).
	Classification	National policy formation and modifications
Polio communication approach shifted as an Islamic responsibility (2013)	Description	The polio communication approach saw a shift in 2013; with support from UNICEF, the Government of Pakistan began to emphasize polio vaccination as an Islamic responsibility.
	Classification	National programmatic action
Fatwa issued urging parents to immunize their children (2013)	Description	A prominent Pakistani religious scholar, Maulana Sami Ul Haq, issued a Fatwa (Islamic ruling) urging parents to immunize their children against poliovirus.
	Classification	National programmatic action

(Continued)

Table 1. (Continued).

Policies/Programs/Strategies/Plans		
Emergency Operations Center (EOC) (2014)	Description	The Government of Pakistan launched the Emergency Operations Centers (EOC), at both the federal and provincial levels. These centers were to be supported by Polio Eradication Committees at the district and union-council levels, and were responsible for timely monitoring of activities, and responding to the needs of local areas in a prompt and effective manner.
	Classification	Federal alliance
International Ulama Conference on Polio Eradication (2014)	Description	The International Ulama Conference on Polio Eradication was held in 2014, and had representation from Pakistan, Saudi Arabia, Egypt, and other Islamic nations. At this conference, the Ulama of Pakistan issued a Fatwa declaring the use of polio vaccine completely permissible under Islamic Sharia, and they also reassured the community that the polio vaccine does not contain any harmful ingredients, further endorsing its use.
	Classification	National programmatic action
Revision of National EPI Policy (2015)	Description	The revised EPI policy was released in 2015, and outlined the following objectives: 1) To affirm the commitment of the Government of Pakistan (GOP) to provide safe, effective and cost-effective vaccination against Vaccine Preventable Diseases (VPDs). 2) To set national standards and guidelines for immunization aligned with the global goals and evidence base, and encourage the program for generation of local evidence for vaccination against VPDs.
	Classification	National policy formation and modifications
IPV introduced into the national EPI (2015)	Description	According to the revised national EPI policy, one dose of IPV was introduced into the routine immunization schedule.
	Classification	National policy formation and modifications
Revision of security plans to include armed forces (2015)	Description	Ongoing attacks against polio workers led to the revision of the program's security plan in 2015. Minister for National Health Services Saira Afzal Tarar chaired an emergency high level polio security meeting, which was attended by representative of Armed Forces, Ministry of Interior. Secretary, and Ministry of National Health Services. The outcomes of this meeting were as following: 1) A post incident inquiry be conducted in the event of any polio-related attack. These inquiries will be conducted by a team consisting of a Ministry of Interior representative, an official from the intelligence agencies, a District Police Officer representative, and an expert representing the polio program. This inquiry should determine the case, fix responsibilities if a lapse in security arrangements was identified, and make recommendations to avoid recurrence of such events. 2) Provinces will be allowed to seek help from civil armed forces or armed forces to ensure security cordoning of campaign areas.
	Classification	National policy formation and modifications
National Immunization Support Project (NISP) (2016)	Description	In 2016, the National Immunization Support Program (NISP) was implemented, with the goal of providing the Government of Pakistan with additional funding to strengthen the national EPI program. The NISP has the following objectives: 1) Increase the equitable coverage of services for immunization against vaccine preventable diseases (VPD), including poliomyelitis, for children between 0 and 23 months in Pakistan, 2) Improve immunization services through strengthening Routine Immunization and introduce Systems Strengthening approach, 3) Interruption of transmission of indigenous wild Poliovirus by the end of 2015 and certification of a Polio Free Pakistan by the end of 2018.
	Classification	National programmatic action
Polio Endgame Strategy 2019–2023 (2019)	Description	The GPEI launched the Polio Endgame Strategy 2019–2023 in 2019. The Endgame Strategy outlines the strategic plan for eradicating polio globally, with a particular focus on the polio-endemic countries. The plan highlights that complete polio eradication will require prompt detection and interruption of polio transmission, strong immunizations systems and integration of polio surveillance with other VPD surveillance systems, and the ultimate containment of all polioviruses.
	Classification	National programmatic action
PROVINCIAL		
'Sehat ka Insaf' (health justice) campaign – Khyber Pakhtunkhwa (2014)	Description	The Pakistan Tehreek-e-Insaf (PTI) political party launched the 'Sehat ka Insaf' campaign in Khyber Pakhtunkhwa in 2014, with the goal of protecting children against nine vaccine-preventable diseases, including polio. The campaign was initially launched in Peshawar and reached approximately 30,000 families, costing the PTI government roughly 20 billion rupees.
	Classification	Provincial action
'Sehat Ka Ittehad' (health unity) program – Khyber Pakhtunkhwa (2015)	Description	The 'Sehat Ka Ittehad' program was launched in Khyber Pakhtunkhwa in 2015. The 'Sehat Ka Ittehad' program was aimed at providing polio vaccination, and vaccinations against other diseases such as measles and diarrhea, to children in FATA and other regions of Khyber Pakhtunkhwa, who had not been vaccinated due to inaccessibility or security reasons.
	Classification	Provincial action
Khyber Pakhtunkhwa Immunization Support Project (2015)	Description	The Khyber Pakhtunkhwa Immunization Support Project (KPISP) was launched in Khyber Pakhtunkhwa in 2015. KPISP was aimed at providing additional funding to support the province's existing EPI program, and increasing coverage of VPD, including polio, among children.
	Classification	Provincial action

3.1.1. 1994 – 2001: Early days of polio eradication

The Expanded Program on Immunization (EPI) was launched in Pakistan in 1978 and included immunization against several diseases including polio. However, through support from the GPEI, the Pakistan Polio Eradication Programme was launched as an independent program in 1994 [2,3,70]. The initiation of polio eradication efforts was signified by the first set of supplementary immunization activities (SIAs) through National Immunization Days (NIDs) [71]. In 1995, the program began conducting acute flaccid paralysis (AFP) surveillance, and AFP surveillance

was fully functional by 1998 [14,72,73]. The last case of wild poliovirus type 2 (WPV2) in Pakistan was reported in 1997 [74]. This positive milestone so early in the program supported the belief that polio eradication in Pakistan was possible.

Starting in 1998, immunization activities in Pakistan and Afghanistan were planned in synchronization to ensure border regions and children in transit were covered comprehensively [14]. In 1999, the Stop Transmission of Polio (STOP) program was launched, which deployed international health professionals to Pakistan to assist with polio eradication and

surveillance activities [14]. Between 1998 and 1999, Pakistan implemented subnational immunization days (SNIDs) which introduced the use of a house-to-house vaccination strategy [14].

The start of the new millennium was marked by the September 11 attacks against the United States (US), which led to the US invading Afghanistan [75]. The start of this war increased insecurity and conflict in Afghanistan and bordering regions of Pakistan, and posed a threat to polio workers' safety. Displacement and the disruption of Afghanistan's surveillance system limited polio eradication efforts [76]. In an effort to address terrorism in Pakistan, drone strikes began in the newly merged districts of Khyber Pakhtunkhwa (known at that time as the Federally Administered Tribal Area), which intensified the belief that vaccination programs had an underlying ulterior motive [77].

3.1.2. 2003 – 2006: First partnership for polio eradication

In 2003, the First Partnership for Polio Eradication project was implemented by the Government of Pakistan [57]. This project was funded by the World Bank, and financed the procurement of 371 million oral polio vaccines (OPV) for SIAs between 2003 and 2006 [57]. In 2005, the Government of Pakistan adopted its' first national EPI policy, which introduced new strategies for immunizations and VPD surveillance which would be relevant to polio [70]. In October 2005, the Kashmir Earthquake struck; this environmental disaster impacted the delivery of polio vaccination campaigns in affected regions, and more than 50 medical officers from the polio eradication program were critical first responders to the earthquake [78].

3.1.3. 2006-2008: Second partnership for polio eradication

In 2006, the Second Partnership for Polio Eradication project was implemented by the Government of Pakistan and financed by the World Bank [58]. As an extension to the initial project implemented in 2003, the second project financed the procurement of approximately 590 million doses of OPV for SIAs held between 2006 and 2008 [58]. In 2008, finger-marking was introduced in to polio campaigns to objectively measure the quality and reach of campaigns [79].

3.1.4. 2009 – 2012: Third partnership for polio eradication

In 2009, the third, and final, Partnership for Polio Eradication project was implemented [59]. The third project, also financed by the World Bank, ensured timely supply and procurement of OPV for polio campaigns conducted between 2009-2014 [59]. In 2009, an Inter-Provincial Committee for Polio (IPCP) was established by the Federal Ministry of Health [80,81]. The ICPC was chaired by the Federal Minister of Health, and brought together health officials working at the provincial district, and union council level [80,81]. The existing EPI policy was revised in 2009, and provided guidelines which promoted greater involvement of lady health workers (LHWs) in immunization delivery [70]. These adjustments hoped to leverage the already established cadre of workers embedded in communities. Polio surveillance activities in Pakistan were expanded in 2009, through the pilot implementation of environmental surveillance [80].

Pakistan's federal health-care system was decentralized in 2010, after the passing of the 18th Amendment to the Constitution [82]. The devolution of health care to provinces resulted in staffing shortages in the EPI, and issues related to the quality, supply, storage and management of GPEI vaccines by provinces [68]. During the 2010 monsoon season, devastating floods ravaged the country and affected the lives of millions of people [83]. The risk of poliovirus transmission was heightened as the monsoon floods resulted in a large displacement of populations, damaged health infrastructure, and lack of access to water and sanitation supplies, particularly in the hardest-hit regions of Central Pakistan [83].

In 2011, the GPEI Emergency Action Plan 2012-2013 was developed for Pakistan, Nigeria and Afghanistan (the remaining polio-endemic countries) [84]. The plan builds upon the GPEI Strategic Plan 2010-2012, and was aimed at getting the GPEI back on track to reach its milestones through an emergency approach [84].

With increasing polio case rates in Pakistan, the 2011 National Emergency Action Plan (NEAP) was created [85]. At the federal level, 2011 also saw the establishment of the Prime Minister's Polio Monitoring & Coordination Cell [85]. By working in close liaison with health agencies at every level, the Cell aimed to improve oversight and coordination of polio-eradication activities nationwide [86]. The politicization of the polio program was heightened in 2011, when Osama Bin Laden was killed in Abbottabad [87]. Osama Bin Laden was located through a fake hepatitis vaccine program conducted by the American CIA, in collaboration with a local Pakistani physician [87]. This incident deepened community mistrust toward vaccine programs, including polio vaccination programs, and, for many, confirmed their belief that polio eradication campaigns were a ploy by the CIA [88].

2012 was characterized by a series of positive and negative events. On the positive side, the last case of wild poliovirus type 3 (WPV3) in Pakistan was reported in 2012, signifying the eradication of two types of wild polioviruses [86]. In addition, negotiation efforts led to roughly 30,000 children living in Tirah Valley, Khyber Pakhtunkhwa, being vaccinated for the first time in three years [89]. Children in Tirah Valley had not received polio vaccinations since September 2009 due to insecurity which made certain parts of the region inaccessible to polio teams [90]. At the same time, the opposite situation was unfolding in North and South Waziristan in Federally Administered Tribal Area FATA, where local leaders issued a complete ban on immunization campaigns [89]. The ban was imposed in July 2012 and continued in to 2013, making roughly 200,000 children at high risk of contracting polio as they could not be accessed by vaccination teams [89]. The ban was initiated by Hafiz Gul Bahadur who stated that vaccinations would be halted until the drone strikes stopped [91]. That year also marked the beginning of a series of violent attacks against polio workers across Pakistan, beginning in July 2012 and continuing today [89,92]. The victims of these attacks include frontline workers, international consultants/staff, program staff, and even policemen providing security [89]. In light of the 2012 attacks, the program's security was

revised, and the program began to operate under a new security framework [89].

In response to increasing case rates and brewing vaccine hesitancy, 2012 saw the establishment of various new initiatives. The President of Pakistan declared polio eradication a national emergency, and established the National Task Force on Polio Eradication [86]. The 2011 NEAP, which had been implemented with limited success, was revised to create the 2012 Augmented NEAP [60]. The National Stop Transmission of Polio (N-STOP) program, which consisted of local and international partners, was implemented in Pakistan [89]. Amidst critique of vaccine storage and wastage, and cold chain maintenance, the National Vaccine Management Committee (NVMC) was also established [68,93]. The NVMC included representation from EPI, WHO, and UNICEF [68].

Section 144 of the Criminal Procedure Code was invoked for the first time in the context of polio eradication in Pakistan, by the District Coordination Officer (DCO) of Faisalabad in 2012 (according to press releases) [94]. Section 144 was imposed in the district, and under Section 188 of the Pakistan Penal Code, action could be taken against parents who refused to let health teams vaccinate their children during polio vaccination campaigns [94]. Despite this being the first time that the law held non-compliant caregivers accountable, Section 144 has since been implemented in other cities such as Peshawar (2014), Charsadda (2015), and Mardan (2020) [95–97].

3.1.5. 2013 – present: yearly national emergency action plans (NEAP)

As the partnerships for polio eradication wrapped up in 2014, and with limited success of NEAP 2011 and 2012, the implementation of a yearly NEAP began [60]. The NEAP is a yearly plan that outline the program's eradication strategy, priorities, and innovations [98]. In 2013, in response to growing religious opposition to polio vaccination, the polio communication strategy began to emphasize polio vaccination as an Islamic responsibility [99]. That same year, a prominent Pakistani religious scholar issued a Fatwa (Islamic ruling) urging parents to immunize their children against poliovirus [100]. Religious advocacy remained a priority in 2014, with the Ulema (prominent Muslim scholars) of Pakistan issuing a Fatwa declaring the use of polio vaccine completely permissible under Islamic Sharia [101,102].

In 2014, the Government of Pakistan launched the Emergency Operations Centers (EOC), at both the federal and provincial levels [64,103]. This decision was in response to the disjointed management of the polio eradication activities, EOCs created a centralized hub and a strong platform for the program [64,103]. Despite these coordination efforts, many coordination and management issues continued to persist [61].

Sehat ka Insaf (justice for health) campaign was launched in Khyber Pakhtunkhwa in 2014, with the goal of protecting children against nine vaccine-preventable diseases, including polio [104]. Other positive developments in Khyber Pakhtunkhwa included the resumption of polio campaigns in Bara, after five years of inaccessibility [103].

Two other health programs were launched in Khyber Pakhtunkhwa in 2015; the *Sehat Ka Ittehad* (unity for health) program and the Khyber Pakhtunkhwa Immunization Support Project (KPISP) [105,106]. The *Sehat Ka Ittehad* program was aimed at providing vaccinations against diseases, including polio and measles, to children in Khyber Pakhtunkhwa, who had not been vaccinated due to inaccessibility or security reasons [106,107]. KPISP was aimed at providing additional funding to support the province's existing EPI program, and increasing coverage of vaccines for VPD, including polio, among children [105]. Peshawar has previously been declared the 'world's largest reservoir' of poliovirus by the World Health Organization, which had concerned local authorities as it is the main urban center of northwest Pakistan [108]. The mass movement of populations through Peshawar, coupled with insecurity and rumors about the polio vaccine poses continued threats to polio eradication, thus in 2014 the WHO called for immediate action to boost vaccination among children residing in Peshawar [108]. In response to misconceptions about vaccines being incompatible with the Islamic Shariah Law, the Islamic Advisory Group (IAG) adopted a new anti-polio action plan which incorporated advocacy and communication activities in 2015 [109]. The national EPI policy was revised in 2015; additionally, one dose of IPV was introduced in to the routine immunization schedule [70]. In light of ongoing attacks against polio workers, the security plan for polio workers was revised in 2015, and included the program's utilization of civil armed forces for heightened security protection [110].

In 2016, the National Immunization Support Program (NISP) was implemented, which provided the Government of Pakistan with additional funding to strengthen the national EPI program [111,112]. Between 2016 and 2019, a series of partnerships were formed between the polio program and public and private organizations such as Zong (mobile network operator company), K-Electric (energy company), Coca-Cola Pakistan and Survey of Pakistan (public government agency) to support program efforts [85,113,114]. Similarly, program partnerships with celebrities, such as Wasim Akram and Shahid Afridi (well-known cricketers), have been used to promote and highlight the importance of polio [115]. In 2019, with only two polio endemic countries remaining, the GPEI launched the Polio Endgame Strategy 2019–2023 [69]. This strategy outlines the plan for eradicating polio globally, and focuses on strategies which need to be implemented in Pakistan and Afghanistan [69].

3.2. Barriers and facilitators

The following sections will outline the barriers and facilitators to the delivery and uptake of polio vaccination. These factors have been divided into sections that focus on the beliefs and experiences of caregivers, the Pakistani Polio program, and threats to Pakistan's polio eradication activities.

3.2.1. Caregiver beliefs, knowledge, and experiences

Caregiver's beliefs and knowledge about polio vaccination were identified by our literature review as an important barrier and facilitator to polio vaccination. Several articles cited

misbeliefs and misperceptions about polio vaccination as a barrier to increasing vaccination rates. The beliefs were of two different types; demographic, geopolitical, and religious concerns, and misbeliefs about when a child could be vaccinated [26,27,31–33,36,38–42,44,49,53,54,56,65]. Misbeliefs about when a child could be vaccinated were less common, and included caregivers who believed that they could not vaccinate their child if the child was unwell [33,42]. Fear of side effects was highlighted by multiple studies as one of the key reasons for refusing vaccination [25,30–,30–32,35,36,41,42,45,47,48,52,54]. The majority of these studies did not describe specifically the type or nature of side effects that caregivers feared.

Demographic, geopolitical, and religious concerns, which were more commonly cited in the literature, were often characterized in the literature as rumors about polio vaccination. Demographic concerns were focused on the potential fertility impacts of the polio vaccine on increasing sterility [27,31,35,36,38–41,44,47–49]. Closely related to demographic concerns were geopolitical anxieties about the true motive underlying the vaccine [26,40,44,49]. Several studies described community fears that the polio campaign was part of a US, specifically CIA, agenda [40], while others highlighted community concerns about the involvement of foreign NGOs [44]. At the core of geopolitical anxieties were demographic concerns about shrinking the Muslim population as part of a foreign agenda [49]. Questions about the religious permissibility of the polio vaccine were also common [27,31,32,36,38–32,36,38–41,44,49,53,54,56,65]. In some contexts, these understandings were related to the belief that haram (impermissible) ingredients such as pig by-products were used in the polio vaccine [40,44,49].

Limited knowledge of immunization schedules and the need for multiple polio vaccinations was highlighted by several studies as leading to incomplete polio vaccination [32,33,42,45,52,54]. Conversely, caregiver's awareness of the benefits of polio vaccination for their children was a strong facilitator of vaccination [32,35,42,47,48,56].

The type of information caregivers received, and the source was also cited as an essential factor to polio vaccination. Tailored messages specific to the needs of the local community were described as an important strategy to encourage polio vaccination [46]. However, exposure to messaging about the benefits of polio vaccination is not sufficient, as several studies highlighted community members who did not trust the messaging about the vaccines effectiveness, utility, or necessity [25,27,41,42,45,47,48,54]. Trust in government institutions and foreign agencies involved in polio campaigns affected receptivity to vaccination. Repeated polio campaigns had contributed to community fatigue and fostered vaccine hesitancy [27,50,66]. Frustrations with the lack of essential services such as poor water and sanitation also fostered mistrust in the Pakistani government and contributed to polio vaccine refusal [26,66]. Conversely, the literature highlighted how positive experiences through community outreach activities facilitated polio vaccinations [32,63,64]. The importance of communication strategies such as *Sehat Muhafiz* (health security) was highlighted by one study as shifting beliefs about polio activities and healthcare workers [63]. Several

documents highlighted how trust in the healthcare workers delivering vaccination could also foster trust and acceptance of the services provided by these workers, particularly polio vaccines [32,64,65]. A few studies highlighted how caregivers only partially or entirely refused vaccinating their children because they had experienced negative treatment by healthcare workers [42,54].

3.2.2. Polio program: governance and oversight

Governance and oversight of the polio program experienced significant challenges that hindered program delivery. Staff morale and job satisfaction was highlighted as an issue in polio eradication efforts. Several studies highlighted complaints among polio workers related to insufficient remuneration [26,43,46–48] and inefficient and delayed payment mechanisms [26,50,65]. Several studies argued that low pay with limited incentives such as promotions and raises [26,43,46] coupled with intense pressure and job insecurity of temporary posts had led to exhaustion and dissatisfaction [26,46]. Attacks on healthcare workers and increased insecurity exacerbated their dissatisfaction with their job [26]. Transportation was also an issue for many vaccinators [32,43,47,67]. Although they were expected to reach areas that were far off, they did not have access to vehicles [47,48], or at times funds for fuel or vehicle repairs [67]; thus, many of these far-flung areas remained unvaccinated [43].

Critiques persisted about the poor selection and training of polio workers [50,62,63]. The hiring of locals as healthcare workers has proven to be a successful strategy as it allows the leveraging of local knowledge, related to the local context and the specific households of missed children, both of which are key to eradication [60,65]. However, nepotism often played a role in how polio workers were identified. Insufficient training of vaccinators and other health workers [29,32] resulted in issues with both their technical skills [32,45,46] and their knowledge about the virus [32,46]. Limited training and knowledge of polio has been seen to be a particular concern with LHWs [37]. Concerns related to the training of vaccinators have also been highlighted by caregivers and community members. One study also highlighted how caregivers themselves were unsatisfied with the training of vaccinators who they saw as not providing sufficient instructions on how to position a child's head during vaccination [32]. The need for further training also extended to management, with managers not having the requisite skills related to resource allocation and HR management [46].

Limited preparation and accountability were best evidenced during campaigns. Pre-campaign trainings have been critiqued for being ineffective and having low engagement from staff, particularly area-in-charge (AIC) and medical officers [50]. Preparation meetings were not conducted, even though they were reported as having been completed. Many of the trainings that did occur were seen as formalities [50]. During campaigns, vaccinator absences were also a key issue [42,45,67]. Ineffective use of teams to wrong areas, or for insufficient periods was also an issue [50]. AICs are tasked with monitoring the field activities of vaccinators, however, many of them do not provide this feedback [50]. Vaccine ledgers and tally sheets were also highlighted as having errors

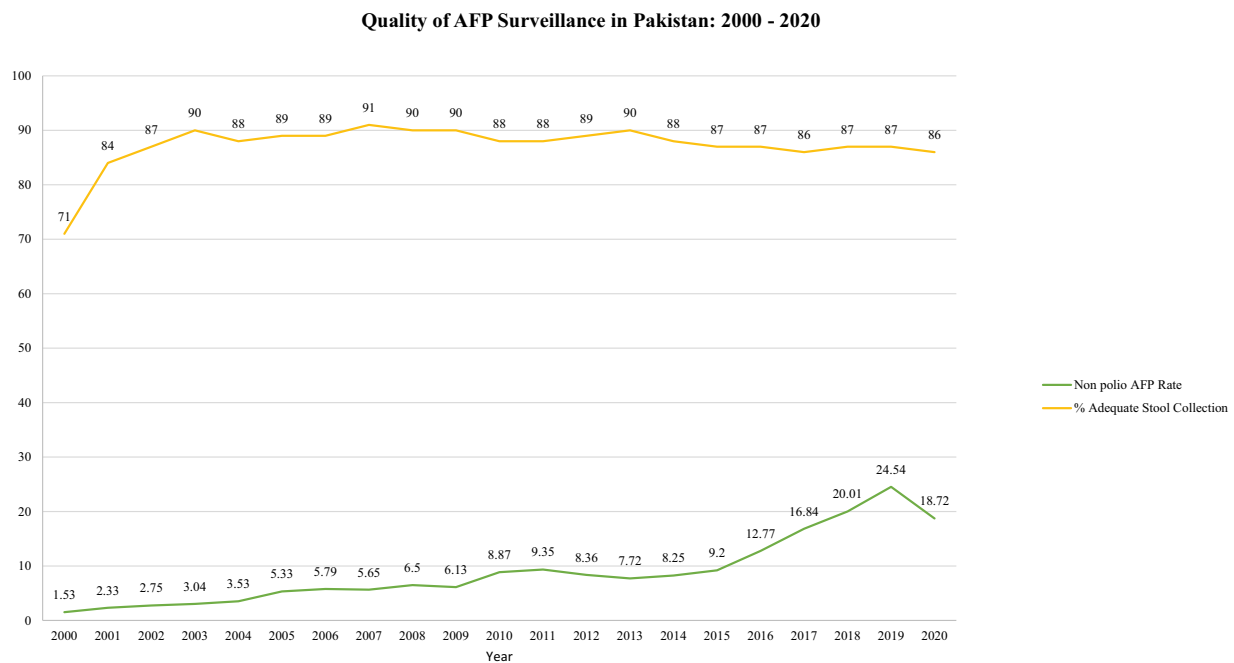


Figure 4. Quality of AFP surveillance in Pakistan: 2000-2020 [118]

[68] Many vaccinators doubted that they would be held accountable for their performance [26,50]. Microplans were also not utilized to their best of their ability. Although these documents were developed, they were not used effectively during campaign preparation and many of these had significant gaps [50,63,64]. Moreover, many implementing partners did not enforce the use of microplans during campaign activities [50]. Field monitoring systems are an area which requires concerted improvement [50].

Reliable surveillance systems are also key to polio eradication strategy and planning [57]. Some of these probable surveillance gaps have been highlighted as contributing to outbreaks such as the cVDPV2 outbreak in Jaffarabad and Mastung Districts. Better integration between AFP, VPD, disease early warning system (DEWS), and health management information systems (HMIS) reporting systems would allow more sensitive monitoring of field activities [50]. The current AFP surveillance systems have been critiqued for its limited sensitivity to capture the circulation of polio virus [50,62]. Efforts to improve the sensitivity of the AFP surveillance system have however been implemented in the past. In 2004, the collection of stool samples was expanded to include the direct contacts of AFP patients for whom stool-specimen collection, storage, or shipment, to the laboratory was inadequate or questionable [116]. Between 2000 and 2004, the non-polio-associated AFP rate (NFAFP) increased from 1.53 to 3.53 cases per 100,000, and the percentage of AFP cases for which adequate stool specimens were collected increased from 71% to 88% (Figure 4). Targeted surveys have led to accurate assessments of missed populations, particularly HRMP, and development of focused vaccination strategies [63,65].

A lack of adherence to and enforcement of protocols related to vaccine supply and storage were also highlighted. Many studies described concerns related to cold chain maintenance [28,29,34,41,45–48,58,67,68] due to noncompliance

[45,58], maintenance of cooling units [45,46,67,68], and load-shedding [46–48]. Insufficient vaccine supplies and delays in receiving vaccines hindered the effectiveness of polio eradication activities [29,32,33,35,68].

Government ownership of polio eradication through providing sustained oversight to activities and establishing strong partnerships with donors and experts is an important aspect of polio eradication activities [58,60,61,63,64]. However, coordination between different levels of government including central, provincial and district managers is limited and inconsistent [29,46].

The 18th amendment and devolution of powers is believed to have contributed to the confusion of responsibilities at different levels of government [46]. Leadership transitions and political interference have exacerbated the effectiveness of polio eradication activities [43,46,66]. In order to improve coordination, EOCs and polio control rooms have been established as part of the NEAP to ensure oversight and accountability of the NEAP [62,63]. Regular meetings between the Prime Minister's Polio Monitoring and Coordination Cell, Chief secretaries, and other provincial and district level officials have also been used as a strategy to improve engagement and in turn, campaign effectiveness [60].

Integration of polio with broader health services has also come to the forefront as an important strategy to facilitate polio vaccination [28,63]. As the 2018-2019 NEAP highlighted multi-level, interdisciplinary, and multi-agency collaboration is an important strategy to support polio eradication [65]. Polio activities, such as SIA, have been critiqued for being disjointed from routine EPI services [50]. Moreover, there is still a pressing need for engagement with other preventive health programs [46], supportive government agencies [66], and the private sector [43].

Structural issues related to health infrastructure development were an obstacle for parents seeking routine

immunization services. Physical proximity and access to health facility was highlighted as a key facilitator of polio vaccination [40,42]. Families that live far away from EPI centers often cited that this was one of their reasons for refusing immunization [25,30,31,35,36,42,45,47,48,52,54,67]. Constraints to caregivers time and schedules also acted as a barrier to vaccinating their children [25,28,30,32,35,42,45,47,48,54].

3.2.3. *Pakistani context: climate and insecurity threats*

Pakistan faces significant challenges related to environmental factors and insecurity. Climate shocks such as the floods in 2010 have proved to be a challenge for polio vaccination as displaced populations moved into crowded and unsanitary temporary living situations where polio spread easily [59]. Pakistan's high population density and warm climate are also conditions conducive to the spread of polio [30].

Insecurity and terrorism have been a persistent barrier to polio eradication efforts [26–29,36,39,40,47,48,50,54,55,58,59,61,67]. Vaccination bans, such as those in North and South Waziristan in 2012, limited access to pockets of populations [59]. While attacks on healthcare workers have cultivated fear among healthcare workers. For instance, the targeted killing of a healthcare worker in UC-4 Gadap Town Karachi led to healthcare workers avoiding those areas [61]. Healthcare workers frequently experienced verbal abuse when delivering polio vaccinations [40,44]. At times, they also experienced physical abuse, as one study described a health worker who was hit in the face by a father angrily refusing polio vaccination [26]. As discussed above, working in this difficult environment had a negative impact on worker motivation [26]. Improvements in the security situation in Shangla and Swat, and the subsequent increase of polio vaccination, demonstrate the role of insecurity in polio vaccination rate [36].

4. Conclusion

As our review has demonstrated, Pakistan's failure to eradicate polio cannot be traced to one underlying cause. Instead, it is essential that one considers the web of factors that have thwarted Pakistan's polio eradication efforts [117]. Although consistently present throughout the polio program, these factors have emerged more strongly at different periods in response to different conditions and events. Programs and policies have attempted to respond to these concerns but at times, these delays have also led to an increase in polio cases.

At its onset, Pakistan's eradication efforts experienced significant success. Eradication of polio seemed feasible with case rates of 1803 in 1994 falling to 28 cases in 2006 [118]. However, the optimism associated with the program soon dwindled as the country started to experience steady increases in polio cases. By 2008, there were a documented 118 cases of polio in Pakistan. The early success of the polio program demonstrated that Pakistan had the technical capacity to implement polio eradication efforts [119]. Yet, the increase in polio cases in the 2000s indicated that there were underlying issues with the polio vaccination activities. Underlying increasing polio cases in the late 2000s was inconsistent governance and limited oversight [120,121]. The

creation and launch of the 2011 NEAP led to little progress on the ground [120,121]. Dysfunctional governance including fragmented responsibility and limited accountability continued to drive polio cases [120,121]. As cases steadily increased from 89 in 2009 to 198 in 2011, re-strategization of polio eradication plans became necessary [118]. Through the augmented 2012 NEAP, the polio eradication program was able to improve management issues and increase accountability [9,122].

However, as governance and management issues started to improve in 2012, terrorism and insecurity increased across Pakistan. Threats of violence against polio workers began to increase, ultimately culminating in to violent attacks against polio teams. In 2012, 22 polio workers were killed [122]. Security and access emerged as one of the most important barriers to polio vaccinations. The increase of polio refusals and propagation of rumors reflected fractured community trust. Insufficient community-based strategies and unmet needs in maternal and child health services only exacerbated the situation. Pakistan's increasing polio case count made it the key obstacle to global polio eradication. In June 2014, military intervention in Waziristan improved access to populations where the majority of polio cases were concentrated [123]. This includes improving vaccination among high-risk mobile populations where there are often larger clusters of cases [12]. Many of these individuals travel within Pakistan but also cross the border between Afghanistan and Pakistan [124]. Initiatives such as all age vaccination points in Torkham Gate (Khyber Pakhtunkhwa) and Friendship Gate (Balochistan), and improved tracking and surveillance of polio in this group is an important priority for government officials, although some of these activities have been disrupted due to COVID-19 [66,125].

More recently, governance and oversight challenges have again emerged as a key challenge for the polio program. Political interference has hindered polio eradication activities [15,16] Inconsistent leadership has only worsened after the 2018 elections. Leading into these elections, the international community expressed concern that polio eradication activities may be disrupted by any political transitions. Despite assurance that Senator Ayesha Raza Farooq, the Prime Minister's Focal Person for Polio Eradication, would continue in her position to give continuity to program activities, she resigned after the election [124]. The government did not announce anyone to take her place, leaving the polio program with a leadership vacuum for several months [124]. The subsequent appointee, Babar Bin Atta, has since resigned and been accused of corruption [126].

5. Expert opinion

5.1. *Reframing resistance*

Among the many reasons contributing to the failure of Pakistan's polio eradication effort, the Pakistan polio program has maintained a vertical strategy that narrowly focuses on the eradication of one disease without supporting primary health care or other preventive healthcare services [117]. Not only has the use of such a strategy diverted attention and resources from key primary healthcare

services, it has also played a role in cultivating suspicion of polio vaccination. As our findings have demonstrated, community concerns related to limited health infrastructure and services played a role in the receptivity to polio vaccination. Pakistan's polio eradication activities, which are relatively well funded, occur against the backdrop of an underfunded and under-resourced health system [91,127]. The exorbitant attention given to polio by the policymakers fuels skepticism of the true reasons underlying the program especially with other health services being severely underfunded [117]. As Closser and Coburn argue, for many children, a polio visit is the only health service they obtain [91]. Repeated polio campaigns have only contributed to concerns about the agenda underlying polio campaigns and resulted in community, and health worker, fatigue [27,50,66,128]. As part of the GPEI Endgame strategy, the government has committed to integrating EPI activities, such as routine immunization, with polio vaccination [69]. Such a strategy will be essential to engaging communities that are marginalized and disenfranchised [128]. Moreover, the integration of polio activities within other preventive health services may present an opportunity for the generation of trust [129].

As our review has demonstrated, rumors and mistrust of the polio vaccine are common in Pakistan. Situating this resistance to polio vaccination within its larger backdrop is essential to understanding and shifting beliefs. Geopolitics, military intervention, and ethnic tensions are key elements of the landscape within which polio vaccination occurs. Most recent estimates suggest that 26% of WPV cases in 2020 and 63% of WPV cases in 2019 were in Khyber Pakhtunkhwa [2], with cases in cities such as Karachi concentrated in areas populated by Pakhtuns [19]. It is unsurprising that polio refusals have been mainly from Pakhtun populations, many of whom live in or are from geographies that have been the most affected by drone attacks, foreign military intervention, and terrorism. The belief of polio rumors has been closely linked to feelings of marginalization and disenfranchisement [130]. Analysis of polio resistance among Pakhtuns has illustrated that misperceptions and belief in rumors mirror larger political debates in Pakistan [125]. Within the context of extended low-grade conflict, community fears related to foreign involvement in polio vaccine could be anticipated [91]. Emerging research has demonstrated that military action such as drone attacks further fragment community trust in polio activities [77,91]. In fact, the 2012 vaccination ban in North and South Waziristan was a direct response to these activities, and a desire for these attacks to be halted [91]. The political nature of refusals to polio asks us to reconsider some of our strategies to ensure the uptake of polio vaccination. For instance, the use of section 144 of the Criminal Procedure Code and section 188 of the Pakistan Penal Code to arrest refusal parents may deepen distrust of the state and vaccination [130–132]. Also, the involvement of security forces to assist with polio efforts may confirm community's fears that there is an ulterior motive underlying these activities [133].

The connection between disenfranchisement and polio is perhaps best evident in the way that polio vaccination has been used as a bargaining chip to obtain government services [16]. This practice speaks to self-perceived powerlessness of the community, and their belief that exploiting the government's commitment to eradicate polio is the best strategy to obtain a desired social service. It is clear that resistance to polio vaccination often signals deeper inequities rooted in underdevelopment, a lack of critical public health services, disenfranchisement, and marginalization. Integrating polio vaccination into comprehensive primary care services, as part of a larger strategy to provide development and infrastructure needs, is essential.

5.2. Research gaps and opportunities

The current literature on polio in Pakistan has been dominated by a focus on user perspectives. This literature has primarily focused on the beliefs and knowledge of caregivers. Literature focusing on the perspectives of program workers, partner organizations, and government representatives is limited. The few studies that include these perspectives have still focused on their perspectives on caregiver views of polio vaccination. There is a key gap in our understanding of how to improve coordination and collaboration between different levels of government agencies and partner organizations. Focused in-depth research in this area could generate key recommendations for policymakers. Moreover, despite mistrust of polio eradication efforts being cited in the literature for over a decade, there is limited research on how this trust can be cultivated by the polio program. Further research on how to develop trust between communities, particularly HRMP, and government agencies could have important impacts on polio activities. One of the limitations of our study is that we did not include serological research that investigated the appropriateness of vaccine variants given their differing efficacy on virus variants. Evidence from India demonstrates that the success of their program was highly contingent on responsive and modified approaches to distributing tOPV, bOPV, and mOPV to geographic hotspots during different outbreaks [134]. In Pakistan, many of these policy changes are relatively recent (see Figure 1); however, further research is still needed to understand the role of these vaccine transitions on polio eradication efforts.

There is also the opportunity to nuance our current understanding of perceived barriers to polio vaccination. The focus on the religious opposition to polio vaccination has been reductive. Moreover, the current engagement of religious leaders to encourage polio vaccination has not been able to entirely convince the public. Literature on Islam and health practices has demonstrated that religious beliefs are consistently negotiated and contested [135,136]. The question remains how then can that be leveraged to address vaccine hesitancy in Pakistan. Understanding the nature of these beliefs is essential to ensuring that policy and programmatic activities fully address these concerns.

Finally, the engagement of local partners in future research is essential, particularly in areas of clinical research and disease modeling. This is an understudied area, with the first study on seroprevalence in Pakistan published in 2013 [137]. Moreover, the genetic studies and disease modeling that has occurred has been largely led by foreign institutions which obscure local academic voices. It is essential that local experts with important contextual details are funded and supported in these research activities and centered in the academic discourse. Engagement of local institutions must also include universities and academic centers that are in the areas most affected by polio including Balochistan and Khyber Pakhtunkhwa.

The goal of global polio eradication is ambitious and requires the buy-in from multiple stakeholders at different levels of the health system. Pakistan has continuously fallen behind on its milestones and optimism has begun to wane [138]. If Pakistan is to make progress toward this goal in the next five years, it will require concerted and targeted efforts. As we have described, the Pakistan Polio Programme has experienced large amounts of variability due to variable governance, and weak management. Poor governance has thwarted Pakistan's polio eradication efforts [128]. Creating systems of accountability to address corruption, and variable governance will be fundamental to its success. Ensuring continuity after election cycles will ensure that any progress made will not be undone. Moreover, as one epidemiologic zone, eradication in Pakistan is contingent upon eradication in Afghanistan and vice versa [15]. Improved collaboration toward the common goal of polio eradication and cross-country learnings can help improve vaccination uptake.

As the COVID-19 pandemic continues, it is unclear the extent of the impacts it has had on polio vaccination rates. The disruption of polio vaccination programs to control the spread of COVID-19, continued social distancing, and supply issues may have serious long-term impacts on the progress made by the polio program [139]. Now, more than ever, it is essential that Pakistan scale up its polio efforts to vaccinate missed children during the disrupted vaccines campaigns. Any gains made by the Pakistan polio program are precarious given the latent potential for polio outbreaks [117]. As we have seen with incidents such as in Cairo, polio in Pakistan is a risk to the efforts of other countries globally [117].

Ultimately, for as long as EPI coverage continues to be low and there is limited coordination between EPI and the polio program, increasing polio vaccination rates will continue to be a problem. As our review demonstrates, the current approach of a vertical polio eradication strategy has limitations [140,141]. Unless polio eradication is sufficiently integrated into other health and preventive services including child health, nutrition, and routine immunization, a vertical program is likely to fail. Furthermore, if current polio eradication efforts do not adequately address the community's underlying concerns related to polio vaccination, there is little chance that the eradication efforts will be unable to achieve their goal [141]. Pakistan has the potential to make large gains toward polio eradication in the next five years; however, this will

require consistent leadership and political support of the program.

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Appendix I: Search strategy

1. Pakistan.mp. or exp Pakistan/
2. Balochistan.mp.
3. Khyber Pakhtunkhwa.mp.
4. Punjab.mp.
5. Sindh.mp.
6. Azad Jammu and Kashmir.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
7. exp 'Azad Jammu and Kashmir'/
8. gilgit-baltistan.mp. or exp Gilgit-Baltistan/
9. Islamabad.mp.
10. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9
11. exp poliomyelitis vaccine/or exp poliomyelitis/or exp Poliomyelitis virus/or exp oral poliomyelitis vaccine/
12. polio*.mp.
13. exp inactivated vaccine/or inactivated polio vaccine.mp.
14. eradicat*.mp.
15. eradication.mp. or exp disease eradication/
16. exp virus transmission/
17. exp communicable disease/
18. exp infection control/
19. exp disease transmission/
20. exp capacity building/
21. outreach.mp.
22. 'integrated service delivery'.mp.
23. exp immunization/or exp mass immunization/
24. immuniz*.mp.
25. vaccin*.mp.
26. exp health program/
27. immunization program.mp.
28. 'supplementary immunization'.mp.
29. exp disease surveillance/
30. surveillance.mp.
31. exp health program/
32. intervention.mp. or exp intervention study/
33. exp preventive health service/
34. advoca*.mp.
35. 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19
36. 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34
37. 10 and 35 and 36
38. limit 37 to english language and yr='2000 -Current'
39. campaign.mp.
40. program.mp.
41. 36 or 39 or 40
42. 10 and 35 and 41
43. limit 42 to english language and yr='2000 -Current'