

1 **Poliovirus outbreak in New York State, August 2022: Qualitative assessment of**  
2 **immediate public health responses and priorities for improving vaccine coverage**

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31 **Summary**

32 In 2022, a case of paralytic polio was reported in an unvaccinated adult in Rockland  
33 County (RC), New York. Genetically linked detections of vaccine-derived poliovirus type  
34 2 (VDPV2) were reported in multiple New York counties, the United Kingdom, Israel and  
35 Canada. The aims of this qualitative study were to: i) review immediate public health  
36 responses in New York to assess the challenges in addressing gaps in vaccination  
37 coverage; ii) inform a longer-term strategy to improving vaccination coverage in  
38 undervaccinated communities and iii) collect data to support comparative evaluations of  
39 transnational poliovirus outbreaks. Twenty-three semi-structured interviews were  
40 conducted with public health professionals, healthcare professionals and community  
41 partners. Results indicate that i) addressing suboptimal vaccination coverage in RC  
42 remains a significant challenge after recent disease outbreaks; ii) the poliovirus  
43 outbreak was not unexpected and effort should be invested to engage mothers, the key  
44 decision-makers on childhood vaccination; iii) healthcare providers (especially  
45 pediatricians) received technical support during the outbreak, and may require  
46 resources and guidance to effectively contribute to longer-term vaccine engagement  
47 strategies; vi) data systems strengthening is required to help track under-vaccinated  
48 children. Improving vaccination coverage in populations vulnerable to VPD outbreaks is  
49 critical, given growing risks of virus importation. Public health departments should  
50 prioritize long-term investments in appropriate communication strategies, countering  
51 misinformation, and promoting the importance of the routine immunization schedule to  
52 improve vaccination coverage.

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54 **Key words: Childhood Vaccination; New York; Poliovirus; Qualitative Research;**  
55 **Vaccine Engagement.**

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65 **1.Introduction**

66 In July 2022, genetically linked detections of vaccine-derived poliovirus type 2 (VDPV2)  
67 were identified in wastewater from the United States, United Kingdom (UK), and Israel,  
68 and in September 2022 they met the World Health Organization (WHO) definition of  
69 circulating VDPV2 (cVDPV2).[1-2] These countries were subsequently included by the  
70 WHO as 'infected' with cVDPV2 in November 2022, alongside many lower- and middle-  
71 income countries.[3] The same genetically linked cVDPV2 was also detected in Canada  
72 in specimens collected in August 2022.[4] Alarm has been raised that circulation of  
73 VDPVs might emerge in high-income countries that do not routinely use live oral  
74 poliovirus vaccines (OPV), even though these countries have optimal sanitation and  
75 public health infrastructure, and that maintain high overall polio vaccination coverage by  
76 using only inactivated polio vaccines (IPV).[5] Global polio eradication efforts still rely on  
77 use of OPV due to logistics, cost, and passive immunization. Yet, the attenuated  
78 poliovirus contained in the live OPV has the risk of significantly mutating if allowed to  
79 circulate widely among un or under-vaccinated individuals. Occasionally, these  
80 mutations can precipitate the return of neurovirulence in the virus and result in paralysis  
81 in unvaccinated individuals.[6] Hence, use of OPV has been broadly discontinued in  
82 higher-income countries that have eliminated polio.[6]

83 Public health agencies in the United States and UK have stressed that the risk of  
84 contracting polio in their countries is extremely low for people who are vaccinated with  
85 IPV according to the recommended immunization schedules, but that areas and  
86 populations with lower-level vaccination coverage will remain vulnerable to infection,  
87 transmission, and ongoing circulation. Despite high overall national coverage in both  
88 countries, rates of childhood vaccination coverage can vary between communities and  
89 persistent gaps in coverage will continue to render under-vaccinated populations  
90 vulnerable to vaccine-preventable disease (VPD) outbreaks.[7-10] Addressing  
91 disparities in coverage will require appropriate policies and sustainable delivery  
92 strategies.

93 The aim of this qualitative assessment was to i) review immediate public health  
94 responses to the poliovirus outbreak in New York State (NYS) in August 2022, ii)  
95 determine the challenges in addressing gaps in vaccination coverage; iii) inform a  
96 sustainable longer-term strategy to improve vaccination coverage in NY and iv) collect  
97 data to support comparative evaluations of transnational poliovirus outbreaks.

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99 **1.1. Circulating VDPV2 in NYS**

100 A confirmed case of paralytic polio in an unvaccinated young adult without a relevant  
101 travel history for poliovirus exposure was reported by the New York State Department of

102 Health (NYSDOH) and Rockland County Department of Health (RCDOH) in July  
103 2022.[1] Viral genotyping isolated VDPV2, and wastewater surveillance confirmed the  
104 presence of Sabin-like poliovirus type 2 or VDPV2 in multiple counties in NYS.[1]  
105 Residents and providers in Rockland County were immediately advised to ensure that  
106 children were up to date with polio vaccinations. Additionally, IPV boosters were  
107 recommended to at-risk groups. A public health emergency was declared in NYS on 9<sup>th</sup>  
108 September 2022,[11] and the United States clinical and environmental poliovirus  
109 detections met the WHO definition of cVDPV2 on 13<sup>th</sup> September 2022.[2]

110 The outbreak constitutes only the second identification of community transmission of  
111 poliovirus in the United States since 1979, when the country was declared polio free.[1]  
112 Routine use of OPV was replaced with an all-IPV immunization schedule in 2000 to  
113 remove all risk of vaccine-associated paralytic polio. In this outbreak, it is likely that  
114 cVDPV2 emerged in NYS following viral shedding in proximity to unvaccinated or  
115 undervaccinated close contacts, who in turn extended transmission of VDPV2 within a  
116 large collective of people who were unvaccinated and in an area where IPV vaccination  
117 coverage is lower than the required 80-85% threshold to protect population health.[1,5]

118 Childhood vaccinations, including IPV, are typically available via private sector pediatric  
119 clinics or county health departments in NYS. Children resident in NYS and who might  
120 not otherwise be vaccinated because of inability to pay may be entitled to receive all  
121 vaccines recommended by the Advisory Committee on Immunization Practices via the  
122 publicly-funded Vaccines for Children program.[12,13] In NYS, all children must receive  
123 all required doses of vaccines on the recommended schedule to attend day care and  
124 pre-kindergarten (under the age of 5) through to 12<sup>th</sup> grade (ages 17-18), or provide  
125 proof of immunity via titers (when permitted), or a medical exemption.[14]

126 At the time that VDPV2 was isolated, coverage for 3 doses of IPV at 24 months of age  
127 in Rockland County was 60.3% compared with the 79% state average.[7] Rates vary  
128 across Rockland County (37.3%-91.3%), but the ZIP codes with the lowest-level  
129 coverage in Rockland County were in Monsey (37.3%) and Spring Valley (57.1%).[15]  
130 Rockland County has the largest Jewish population per capita of any county in the  
131 United States (31.4% of the county population).[16] Monsey and Spring Valley are  
132 home to a number of neighborhoods that are exclusively Haredi Jewish (often termed  
133 'ultra-Orthodox'). Haredi neighborhoods in Rockland County remain closely connected  
134 with those in other areas of NYS (NY City and Orange County) and New Jersey.

135 Previous outbreaks of VPD in Rockland County have primarily affected Haredi children,  
136 in part due to low vaccination coverage and importations from similarly undervaccinated  
137 communities. Public health agencies frequently report outbreaks of VPD in areas of  
138 Jerusalem, NYS, and London that are home to large Haredi neighborhoods [8-10, 16-  
139 18]. Studies report that vaccine uptake among Haredi populations is influenced by a

140 range of issues, including access and convenience challenges due to larger families, a  
141 preference for delayed acceptance, and targeted activism and misinformation  
142 campaigns. [17,19] In 2018, a measles outbreak spread in Rockland County ZIP codes  
143 with the lowest levels of vaccination coverage, and transmission was sustained in un or  
144 under-vaccinated populations; this outbreak was associated with a larger regional,  
145 national and international measles outbreak. As a result, the United States and Israel  
146 consequently reported the largest cases of measles in a quarter century.[9-10]

147 Haredi Jews form diverse movements (sub-groups) that are distinguished by ethnicity  
148 and place of origin, and differences in customs and stringencies that influence social  
149 organization and how religious law (*halachah*) is interpreted. Haredi Jews may be  
150 characterized as self-protective and may carefully manage encounters with the broader  
151 society,[20] which can have implications for healthcare [18-21]. Health decisions among  
152 Haredi families may be influenced by socio-economic background, health literacy and  
153 religious legal positions.[21-24] Engagement with healthcare services should be  
154 understood within the respective national context of health systems, but also the global  
155 circulation of information via social networks that spans Europe, North America, and  
156 Israel.

157 Poliovirus detections were repeatedly identified via wastewater surveillance in Rockland  
158 County and NYS between March-October 2022, indicating on-going transmission.[25]  
159 Hence, unvaccinated children and adults in this community remained vulnerable to  
160 paralysis and were a priority in efforts to promote vaccine uptake. Understanding the  
161 context in which poliovirus spread is important to: i) address gaps in vaccination  
162 coverage and ensure targeted distribution of resources as part of public health  
163 engagement activities; ii) compare and evaluate responses to linked outbreaks reported  
164 in Israel (April 2022) and London (June 2022), in addition to detection in Canada  
165 (reported in January 2023).[4,26,27]

166 The purpose of this qualitative study was to examine what long-term and sustainable  
167 strategies for vaccine engagement in populations vulnerable to VPD outbreaks are  
168 required to support responses in the context of transnational poliovirus circulation.  
169 Vaccine engagement is premised on a relationship between public health agencies,  
170 primary care services, and populations. Vaccine engagement involves tailored,  
171 localized, and sustained dialog to aid delivery of immunization programs.

172

## 173 **2. Methods**

174 This qualitative study was conducted ancillary to the Centers for Disease Control &  
175 Prevention (CDC) epidemiologic investigation that was launched to support state and  
176 county poliovirus response efforts, at the invitation of New York State Department of

177 Health (NYSDOH).[28] Complementing the epidemiologic investigation, this qualitative  
 178 study sought to inform long-term vaccination strategies in Rockland County for related  
 179 populations in the region. Fieldwork was conducted in August 2022, after the positive  
 180 case detection on 21 July 2022 and prior to the declaration of a public health  
 181 emergency on 9 September 2022.

182 Methods consisted of 23 semi-structured in-depth interviews conducted with individual  
 183 participants or in paired interviews (in person and via Zoom) and 5 clinic visits. Interview  
 184 participants were recruited from professional networks and via snowball sampling and  
 185 were included in the study based on their experience as public health professionals (5),  
 186 healthcare professionals (9), and community organizations and partners (9) (Figure 1).  
 187 Interviews lasted between 20 and 60 min and were recorded with participant consent.

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|                         | <b>Public health (PH):</b><br>Professionals from local and federal<br>public health agencies | <b>Healthcare professionals (HCP):</b><br>Primary care providers (physicians<br>and nurse practitioners) | <b>Community organizations and partners (CO)</b><br>Jewish Doulas (birth supporters), Jewish EMT<br>personnel, rabbinic authorities, editors of Orthodox<br>Jewish press |
|-------------------------|--|--|--|
| Number of participants: | 5  | 9  | 9  |

190

191 **Fig. 1** Description and recruitment numbers of interview participants

192

193 Public health (PH) professionals were based in county and federal agencies. The  
 194 Healthcare professionals (HCP) were based in 5 clinics that serve Jewish families in the  
 195 area under study. HCP participants included a variety of professionals, such as  
 196 physicians and nurse practitioners. Community organizations and partners (CO) ranged  
 197 in their professional background and were interviewed as key male and female figures  
 198 of influence (Figure 1). Jewish doulas and EMT were categorized as community CO  
 199 because we spoke to them in their capacity as community health advocates rather than  
 200 their specific care practices in childbirth or emergency care. CO represented a variety of  
 201 sects within the Haredi movement. The particulars of their affiliations have been  
 202 removed for anonymity.

203

## 204 2.1 Analysis

205 Interview data involved a combination of inductive and deductive analytical  
 206 approaches.[29] Existing literature was used to frame the research questions, and key  
 207 analytical themes were drawn directly from the data via a qualitative method termed

208 grounded theory.[29] Emergent coding themes were reviewed and discussed  
209 extensively between BK and SM-J and refined as the results of these discussions.  
210 Findings were then organised using critical phases of the public health response with a  
211 view to informing how differences in coverage can be addressed and a longer-term  
212 strategy of vaccine engagement developed.

213

### 214 **3. Findings**

215

216 Results illustrate that a succession of public health challenges locally and globally,  
217 combined with deficits in resources, meant that the county and federal public health  
218 (PH) officials involved in the polio outbreak response felt inadequately prepared to  
219 address low vaccination coverage in the affected areas. Healthcare provider (HCP)  
220 participants indicated that the poliovirus incident was not unexpected after previous  
221 local VPD outbreaks and the increase in circulating VDPV2 outbreaks globally. Diverse  
222 vaccine engagement and implementation activities were mobilized, but participants  
223 reported limitations in health systems. Community organizations and partners (CO)  
224 participants identified a need for investment in public health engagement to support  
225 vaccine programme delivery. Longer-term strategies to monitor vaccine uptake will  
226 require health systems strengthening.

227

#### 228 **3.1 Pre-outbreak: existing challenges to vaccine engagement**

229 The 2018-19 measles epidemics and COVID-19 pandemic were described as  
230 milestones in understanding challenges in vaccine engagement by PH and HCP  
231 participants. During the 2018-19 measles outbreak, religious exemptions from NYS  
232 school vaccination requirements were removed, and unvaccinated children were  
233 banned from public spaces (including schools) that were intended for gathering of more  
234 than 10 people in Rockland County.[30] Approximately 5 schools were fined for  
235 withholding vaccination records from the health department (PH1). However, a CO who  
236 supported the control efforts did not feel sufficiently consulted by county officials on  
237 enforcement, *“it didn't feel like they were taking our opinions into consideration and our  
238 thoughts of how to do things that may have made certain things easier. So, we're just  
239 not eager to jump into work with them, period”* (CO4). The legacy of the 2018-19  
240 measles outbreaks then had adverse implications for the polio incident response in  
241 2022.

242 Activism against vaccination proliferated before and during the 2018-19 measles  
243 outbreaks and control orders, with rumours of unregistered schools being established

244 for parents against vaccination and circulation of targeted material. One CO described  
245 being approached to lease their private building and re-purpose it as an unregistered  
246 school for children to evade vaccination requirements. As early as 2017, Haredi  
247 neighborhoods in the United States were targeted by an organization named PEACH  
248 (Parents Educating and Advocating for Children’s Health), which portrays itself as a  
249 grassroots Haredi effort to promote ‘vaccine choice’ among parents.[19,31] Their  
250 pamphlet, the ‘Vaccine Safety Handbook: An Informed Parent’s Guide,’ was cited by  
251 one HCP as a key source of disinformation that has influenced vaccine decisions  
252 among parents in their clinic:

253 *“The turning point was the PEACH magazine. That’s when it [non-vaccination or*  
254 *delayed vaccination] became popular. I think the trickle-down effect from that has lasted*  
255 *for years. I think a lot of people got very swept up in the propaganda of that, and that*  
256 *became the truth. So, we spend all day, every day, fighting against things that have*  
257 *been passed down from that time”* (HCP5).

258 Opportunities to develop vaccine engagement strategies following the 2018-19 measles  
259 outbreaks, however, were derailed by the COVID-19 pandemic. Rates *“did increase for*  
260 *MMR. And then 4 months later COVID hit, so we couldn’t measure well what was done.*  
261 *That was our moment to try and figure out where we were and COVID hit and*  
262 *everything got shut down”* (PH1).

263 The onset of the COVID-19 pandemic in 2020 impacted uptake and delivery of  
264 childhood vaccinations. Misinformation and questions of trust, too, were amplified:

265 *“I think that COVID really affected uptake of vaccines twofold [...] it was just increased*  
266 *misinformation and less ability for people to access care. I have learned that there is a*  
267 *very strong anti-vax group in this county. They make robocalls, they have that kind of*  
268 *resources, and they are very incessant. I think this is a very vulnerable community that’s*  
269 *easy to target. There is a large mistrust of the government”* (PH2).

270 Questions around the COVID-19 vaccination, as a rapidly developed and implemented  
271 campaign, had negatively impacted parental engagement with routine vaccinations:

272 *“There has been some damage towards vaccination because of COVID, it politicised*  
273 *vaccines and there was misinformation about quality and effectiveness [...] Politics has*  
274 *done extreme damage to medicine, the average individual becomes confused of what*  
275 *they should or shouldn’t do. COVID has done damage, but we can come back from that”*  
276 (CO6).

277 All HCP acknowledged issues of refusal and trust following the COVID-19 pandemic,  
278 but consistently described deferral as a major cause for low vaccination coverage by 24  
279 months of age:



280 *“The biggest issue, especially in the past 5 years, has been deferring vaccinations until*  
281 *an older age. So rather than start at the typical 2 months, some people want to start at*  
282 *around 6 months or 1 year. Some people want to vaccinate just when the school*  
283 *requires them to”* (HCP4).

284 Rather than an issue of broadscale vaccine refusal, Haredi parents may deliberate over  
285 the timing of when to vaccinate children.

286

## 287 **3.2 Outbreak**

288 Following an unrelated vaccine derived poliovirus type 3 (VDPV3) incident in Israel in  
289 March 2022 (prior to the subsequent VDPV2 incident in Israel in April), PH sought to  
290 highlight the risk of spread from Israel to NYS due to lower-level vaccination coverage in  
291 New York’s Haredi population. The RCDOH distributed alert letters to the public via  
292 pediatric clinics, *“because we knew of our low immunization rates, and frequent travel to*  
293 *and from Israel, especially going into Passover”* (PH2). HCP, too, were concerned about  
294 the potential for spread in linked populations, as occurred with measles in 2018-19:

295 *“I did start discussing it with parents who were not vaccinating or deferring vaccinations*  
296 *at that point, because even if it started outside of the country, in England or in Israel, it's*  
297 *only a matter of time that it comes here through travel”* (HCP4).

298

### 299 **3.2.1 Field team response**

300 After the positive case identification in Rockland County, public health agencies  
301 expanded clinical and wastewater surveillance into neighboring NYS counties and NYC  
302 to understand size and spread of the outbreak, intensified outreach to undervaccinated  
303 children, and initiated communication and vaccination campaigns. The CDC field team  
304 assisted RCDOH by looking through provider records for unvaccinated children and  
305 invited parents through letters or phone calls to visit their pediatrician for routine  
306 immunization catch up. Amidst pressures on resources, PH valued the technical support  
307 offered to them and to pediatricians:

308 *“At least from my perspective, the work that needed to be done was really to go through*  
309 *the providers to contact their patients. And that’s a lot of work, right? Like call your*  
310 *patients in, call and talk to each and every provider. That’s a lot of work which we don’t*  
311 *have the manpower for. Chronically, public health in the United States is under-funded”*  
312 (PH2).

313

### 314 **3.2.2 Communications and engagement**

315 Vaccination and sanitation engagement activities included infographics; handwashing  
316 posters for children and adults; public letters in English and Yiddish addressed to  
317 residents from the CDC Director and NYSDOH Commissioner of Health, and separately  
318 from the RCDOH Commissioner of Health; and a public letter signed by rabbinic  
319 authorities (in English and Hebrew). An external agency was commissioned to produce  
320 infographics in English, Yiddish, Spanish and Creole, as an attempt to engage with a  
321 range of communities within the county at risk of paralysis due to low vaccination  
322 coverage (Appendix 1).

323 The infographic was endorsed by select healthcare providers and the local *Hatzolah*  
324 division (an Orthodox Jewish emergency medical technician [EMT] service). The  
325 cautious use of the Internet among Haredi populations meant that print materials were  
326 considered crucial for public engagement, "*I think the circulation of materials is essential*  
327 *here, especially since we can't really rely on social media and the internet to reach all*  
328 *groups*" (PH2). The infographic was revised and re-issued following the need for clarity  
329 in messaging surrounding transmission routes, and incorrect interpretations that VDPV2  
330 was spreading (rather than being detected) via the sewage system (Appendix 2):

331 "*The first infographic came out with the wastewater graphic; I did not like it and I had*  
332 *them change it. Somebody said to me over Shabbos, 'well I don't go anywhere near*  
333 *wastewater so I'm safe' [...] Nobody understands what the heck wastewater is*" (CO3).

334 A key message of the infographic was the historical impact of immunization in poliovirus  
335 prevention efforts, '*what matters is to show the timeline of cases, immunization, cases*  
336 *drop*' (CO3). However, an HCP viewed the infographic as being information-dense and  
337 unsuitable for quick synthesis of key messages in clinic waiting rooms:

338 "*They won't stop to look at it when they come in with four kids. 'The only protection is*  
339 *immunization' in the red box shouldn't be at the bottom because people, if they don't*  
340 *read the information, won't get the take home message*" (HCP2).

341

### 342 **3.2.3 Vaccination response**

343 Poliovirus-containing vaccines were delivered via pediatric primary-care clinics and  
344 RCDOH POD sites. A total of 240 IPV doses were administered by RCDOH on-site and  
345 at off-site polio PODS in August 2022, though uptake data is not disaggregated by  
346 population. During the study period, RCDOH held 2 point-of-distribution (POD)  
347 vaccination clinics in the Spring Valley ZIP code, on Wednesday 17 August (13:00-  
348 16:00 in a center for family planning services) and Wednesday 24 August (15:00-18:00  
349 in the Martin Luther King Multi-Purpose Center, which serves diverse communities).[32]  
350 Uptake among this target group was low according to PH participants, but past public  
351 health evaluations indicate how appropriate, accessible and convenient clinic

352 arrangements serve as important enablers to vaccination for Haredi parents with larger-  
353 than-average family sizes.[17] Appropriate modes of advertising were considered  
354 crucial:

355 *“We'll send out our fliers electronically [...] My other colleagues will come through town*  
356 *and put posters up in laundromat, libraries, stores. The way I see it is, yes, we have*  
357 *everything up electronically, but the community we really need to reach doesn't use that*  
358 *electronic communication as efficiently, so we really do have to have posters” (PH5)*

359 EMT respondents felt it was the role of HCP to provide guidance about routine  
360 childhood vaccination recommendations and not the EMT. However, EMTs reported  
361 that they would consider participating in supplementary campaigns (if authorized to do  
362 so):

363 *“We don't ordinarily go around saying, “Get vaccinated.” That's not really part of what*  
364 *we do. To say, “vaccinate your children,” is the norm. But if it's specific, like, “the*  
365 *recommendation is anybody above a certain age should get a booster,” and this is*  
366 *based on real information that's going to help protect people, Hatzolah will participate in*  
367 *that” (CO2).*

368

### 369 **3.3 Future goals: achieving sustainable gains in vaccination coverage**

370 Participants across all three groups interviewed reported a need for investment in  
371 targeted vaccine engagement and suggested improvements in program delivery and  
372 health systems strengthening to achieve sustainable gains in vaccination coverage.  
373 Their responses offer three priorities for strengthening vaccine program activities: i)  
374 maternal engagement; ii) communications to counter misinformation; iii) vaccine policy  
375 and data management.

376

#### 377 **3.3.1 Maternal engagement**

378 Haredi women tend to consult rabbinic authorities on a range of health-related issues  
379 and interventions. [21-24] However, Female CO did not expect mothers to take their  
380 dilemmas around childhood vaccines to rabbinic authorities, *“I consult with my rabbi on*  
381 *a lot of different matters but I would never ask him what he thinks about vaccines”*  
382 *(CO3).*

383 PH did not perceive rabbis to be the dominant influence on women's vaccine decisions,  
384 *“so whether the rabbi says, ‘do this, do that,’ the women will make their own decisions*  
385 *about that” (PH5).* For this reason, PH were explicit that engaging directly with mothers

386 on vaccination was important because of their decision-making power around child  
387 health:

388 *“It is very important to be able to have the ear of the women, because one thing has*  
389 *consistently been brought to my attention, that healthcare decisions are made by the*  
390 *mothers. And the mothers have an internal network and talk to each other”* (PH2).

391 Engaging rabbis in vaccine delivery strategies was not considered to be detrimental,  
392 and a public letter signed by approximately two-dozen rabbinic authorities in Rockland  
393 County was circulated to encourage parental engagement with the poliovirus response.  
394 HCP suggested that rabbinic announcements may help to encourage parents who delay  
395 vaccines to come forward, but would have little influence over Haredi parents who  
396 refused vaccines:

397 *“As far as hearing from rabbonim in the community, I didn’t see it helping with measles*  
398 *and I didn’t see it helping with mumps, for the people who are strongly anti-vaccination.*  
399 *So, if you have people deferring, yes it would help, but for people who are strongly anti-*  
400 *vax, they have this belief and nothing really helps”* (HCP4).

401 Rabbis themselves felt that focusing only on rabbinic authority could exclude other  
402 avenues of influence: *“I think the media has all types of pushes that are much stronger*  
403 *than what the rabbis have to say”* (CO1).

404 CO viewed women in Haredi communities as were influential on decisions around  
405 pediatric vaccination, and hence important for vaccine engagement strategies. Women  
406 in Haredi communities may hold influential roles such as doulas, teachers, pre-school  
407 leads, and wives of rabbinic authorities. Discussing the contributions of Orthodox  
408 Jewish HCP in promoting vaccine engagement in Haredi neighborhoods, one female  
409 CO asserted:

410 *“When we talk about vaccines, the lack of access or confidence, it’s part of the story to*  
411 *talk about all the women who are doing the work and are talking about vaccines. They*  
412 *bring confidence [...] They’re healthcare professionals but they’re also moms, and they*  
413 *are entrenched in their communities”* (CO5).

414

### 415 **3.3.2 Communications to counter misinformation**

416 Establishing strong information pathways into the Haredi community was considered  
417 crucial to counter misinformation that has actively targeted Haredi neighbourhoods:

418 *“The very first thing to do is address and block the misinformation [...] then it’s about*  
419 *building good information and having trusted community partners that can spread that*  
420 *through word of mouth and through public meetings and sharing stories of survivors*

421 *making these diseases real. A longer-term plan that would involve a lot of in-depth*  
422 *community work to identify where the fear comes from, what the fear is about and how*  
423 *to make it better” (PH4).*

424 HCP were regarded as the most influential sources of information by CO, “*The general*  
425 *majority will listen to their pediatrician, so we need to try to target that population with*  
426 *information” (CO6).* HCP requested guidance on how to communicate poliovirus  
427 transmission risk to parents and agreed this information should be presented as coming  
428 from providers rather than public health agencies:

429 *“I would love to hear some easily explainable facts that we could give to explain to them*  
430 *how it's passed from person to person. How they are monitoring it. What the symptoms*  
431 *[are]. But I sometimes wonder whether having an official CDC or Department of Health*  
432 *[logo] would be negative, if they would rather just have something that we could put our*  
433 *own letter head on” (HCP5).*

434

### 435 **3.3.3 Vaccine policy and data management**

436 All HCP described immunization rates rising by the time children reach school  
437 enrolment (age 5) due to NYS school entry requirements. HCP felt additional metrics of  
438 vaccination coverage, beyond 24 months,[7] might help to determine patterns of deferral  
439 and when parents decide to accept vaccination to tailor communication messages:

440 *“The numbers go up tremendously, because by [age] 3 the kids are already going to*  
441 *school [licensed early child education facilities] [...]. So if you looked there, the numbers*  
442 *would look different” (HCP1).*

443 However, healthcare providers asserted that the link between delayed uptake and  
444 school-entry requirements indicated that vaccines were not primarily valued for their  
445 ability to protect child health:

446 *“I think what we are trying to say is, they are doing it more for requirement purposes for*  
447 *entry to somewhere as opposed to preventive purposes. So, it's reactive and not*  
448 *proactive’ (HC1b).”*

449 Issues of delay require different solutions and communications compared to vaccine  
450 refusal. Tailored vaccine engagement strategies may help to convey the role that the  
451 childhood vaccination schedule plays in preventing VPD and illness, not just as a  
452 requirement for school entry. Moreover, the idea that vaccines are solely required for  
453 school entry leaves an entire population of children less than 24 months vulnerable to  
454 infection.

455 HCP were frustrated by vaccine requirements for school entry that permitted proof of  
456 immunity via serology (in place of vaccination) for certain VPD of childhood.[14] They  
457 perceived such provisions as undermining the need for vaccines, *“the health*  
458 *department shouldn’t be accepting titers for anything”* (HCP1).

459 PH staff were tasked with examining immunization records to ascertain gaps in  
460 coverage and identified data limitations in the New York Immunization Information  
461 System (NYSIIS). Under NYS Public Health Law,[33] healthcare providers are required  
462 to report all immunizations administered to persons under the age of 19, along with their  
463 immunization history, to NYSDOH via NYSIIS. PH complained of inefficiencies in data  
464 searches and management, *“I can get the date of birth and then I have to calculate the*  
465 *age. It’s not a very smart system. I think it’s outgrown its initial build and it needs a lot of*  
466 *help”* (PH3). PH perceived such inefficiencies in data searches and management as  
467 affecting the pace of their outbreak operations, *“It’s a lot of leg work to get the*  
468 *information we need”* (PH1).”

469 Assessing vulnerable children who remained unvaccinated or undervaccinated may  
470 have been complicated by imperfections in health information systems. Enhancing the  
471 ability to track gaps and changes in coverage will support accurate evaluations of  
472 outbreak responses and vaccine engagement strategies.

473

#### 474 **4. Discussion**

475

476 Social science assessments of polio control programs are predominantly conducted in  
477 lower- and middle-income countries, which remain polio endemic or vulnerable to  
478 outbreaks. [34,35] Polio control efforts in such places face public health challenges that  
479 are not comparable to NYS, or the countries affected by such linked cVDPV2 outbreaks,  
480 which benefit from closed sewage systems and high vaccination coverage at the  
481 national level. This is the first polio outbreak in the United States in decades, prompting  
482 questions about appropriate response measures specific to communities within the  
483 United States. Improving vaccination coverage is urgent, given undervaccination likely  
484 facilitated local transmission and ultimately the case of paralysis in NYS. However, it is  
485 also imperative to monitor and address these vaccination coverage gaps through  
486 sustained and tailored engagement with undervaccinated populations.

487 This review of poliovirus response activities demonstrates that achieving sustainable  
488 improvements in vaccination coverage in undervaccinated populations remains a  
489 challenge for public health agencies. The spread of poliovirus underscores the  
490 importance of community-specific, regional as well as country-wide responsive  
491 vaccination programs that depend on a significant mobilization of public health

492 resources.[36,37] Priorities for improving and maintaining higher coverage levels  
493 include developing vaccine engagement strategies with populations that remain  
494 vulnerable to illness from VPD and enabling efficient data management and sharing for  
495 learning at regional and international levels.

496

#### 497 **4.1 Vaccine engagement**

498 Our research shows that investment in mothers and trusted pediatricians around the  
499 importance of routine immunization is urgently needed to improve vaccination coverage  
500 in Haredi communities in NYS.

501 Participants across all research clusters in this study acknowledged that Haredi mothers  
502 were critical to consult about vaccination because they are principal decision-makers on  
503 child health, as has been documented in England.[21] UNICEF consider religious  
504 leaders to be key partners in vaccine programme delivery as ‘they wield considerable  
505 social and political influence.’[38] However, our findings suggest that Haredi women do  
506 not routinely consult with rabbinic authorities on the subject of routine childhood  
507 vaccines and rabbis themselves highlighted more powerful sources of influence over  
508 parental decision-making. Direct engagement with Haredi women on childhood  
509 vaccination is therefore crucial.

510 Misinformation campaigns have targeted Haredi mothers before, during and since the  
511 2018-19 measles outbreaks, and during the COVID-19 pandemic, in NYS, London and  
512 Jerusalem. Public health staff perceived Haredi residents to have a lack of confidence in  
513 vaccination as a safe and effective way to protect child health. A vaccine engagement  
514 strategy produced by a collaboration between public health staff, healthcare  
515 professionals and community partners is required to counter non-vaccination advocacy  
516 and address concerns with credible information. The input of community organisations  
517 and partners, which includes mothers and parents, is crucial to ensure the content and  
518 delivery channels are acceptable to Haredi families.

519 RCDOH hosted off-site polio vaccine PODs in ZIP codes vulnerable to transmission.  
520 Yet, the clinic locations and times may not have been appropriate, convenient or  
521 accessible for Haredi parents (as indicated by the enablers to vaccination cited in the  
522 WHO Tailoring Immunisations Programme study conducted with Haredi residents of  
523 north London in 2014-16).[17] A range of information guides on poliovirus and  
524 vaccination were produced by Orthodox Jewish health advocacy groups in NYS during  
525 the outbreak.[39] During the 2018-19 national measles outbreaks, a taskforce of  
526 American Orthodox Jewish nurses produced a myth-busting guidebook to support  
527 vaccine engagement efforts and influence relationships between parents, pediatric  
528 providers and public health services, which can be downloaded free of charge from the

529 NYSDOH website.[40] This guidebook was re-distributed in August 2022. Yet, vaccine  
530 engagement requires a commitment to *consistently* channel information about childhood  
531 vaccinations as part of a broader approach to family health messaging, not just in an  
532 outbreak. The preference for delayed uptake, as described by healthcare providers,  
533 requires particular attention to reduce the risk of susceptibility in the intervening time  
534 periods.

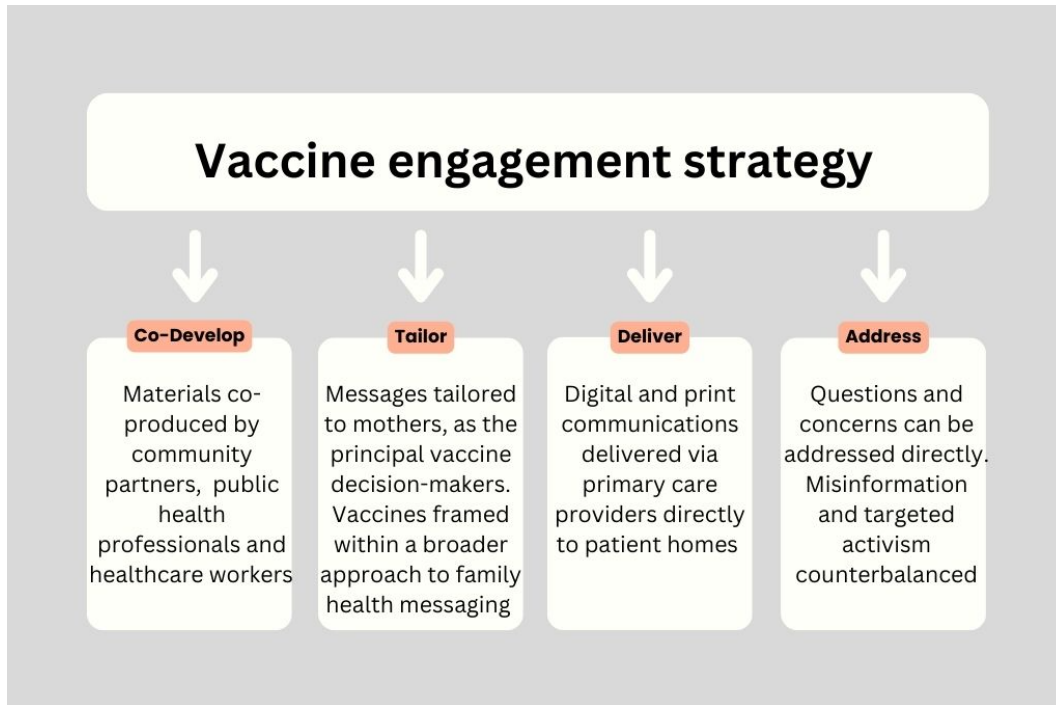
535 Collaboratively produced health updates can be directly and regularly channelled to  
536 Haredi mothers in print or through short, recorded phone messages. Such updates can  
537 be disseminated via primary care providers because healthcare providers are regarded  
538 as trusted sources of information, possibly more so than public health agencies (Figure  
539 2). Appropriate community branding may help to make the health updates appear  
540 relevant to local context.

541 Healthcare providers were supported with labor-intensive activities such as invite-  
542 reminders (call/recall) during the outbreak response, indicating that technical support  
543 may be required to effectively increase timely uptake of vaccination as a longer-term  
544 goal. Interventions to increase confidence in timely vaccination, such as conducting  
545 post-vaccination follow-up calls or counselling parents on vaccine timeliness during  
546 medical appointments, places additional requirements on providers. Vaccine  
547 engagement activities need resource investments broadly, but also focused on the ZIP  
548 codes with the lowest levels of vaccination coverage as part of an investment in  
549 achieving sustainable gains in population-wide health protection. The circulation of  
550 poliovirus and case of paralysis is a wake-up call to implement a strategy that can be  
551 delivered and sustained through committed funding and manpower. Haredi Jewish  
552 populations in the US, UK and Israel continue to experience a disproportionate burden  
553 of VPD. [8-10, 17,18] Tailored and localized communication and delivery strategies are  
554 required to address this challenge proactively.

555

556





557

558

559 **Fig. 2** Key elements of community-level vaccine engagement strategies

560

561 Public health relationships with community organizations and partners are important  
 562 components of successful engagement programs.[41] The division of responsibilities  
 563 should be explicit, and pursuit of goals should be shared to help maintain partnerships  
 564 over time. Partnerships can take the form of collaborating with community agencies on  
 565 communications or vaccine delivery. During the COVID-19 pandemic, Hatzolah  
 566 divisions collaborated with public health teams to co-deliver the COVID-19 vaccine  
 567 program in 2020-21.[42] Co-delivery models, however, operate most effectively when  
 568 partners administer vaccines and public health teams hold responsibility for maintaining  
 569 vaccination records,[42] which are critical to tracking improvements in coverage.

570

571 **4.2 Health systems and policy**

572 Longer-term strategies will require addressing limitations in health systems, as  
 573 reducing gaps in vaccination coverage requires effective data management and  
 574 surveillance. As part of the outbreak response, the CDC and NYSDOH disaggregated  
 575 data to assess gaps by age, delayed uptake, and when vaccines were initiated but not  
 576 completed. Such data could be routinely shared with healthcare providers (as many  
 577 requested), to provide more comprehensive understanding of vaccine coverage, and for

578 providers to convey information about transmission risk and vulnerability to patients via  
579 tailored communications and messages. As vaccine deferral requires different  
580 approaches and solutions than refusal, healthcare providers may benefit from a clearer  
581 understanding of the patterns of vaccine uptake in their clinics. Intense efforts were  
582 made during the COVID-19 pandemic to improve national immunization information  
583 systems and to use these data for action; to better understand vaccine uptake, access,  
584 and equity.

585 Extracting data from childhood vaccination record systems was slower than public  
586 health staff would have liked in an outbreak scenario. Longer-term strategies should  
587 focus on ensuring all pediatric vaccine providers submit vaccine records to NYSIIS in a  
588 timely manner. Such measures may help to strengthen immunization record keeping,  
589 support regional outbreak responses, and rapidly share intelligence during linked VPD  
590 outbreaks.

591 Healthcare providers in this study argued that NYS school vaccination requirements  
592 should not permit serologic evidence of antibodies as proof of immunity to certain VPD  
593 (in place of vaccination).[14] The Advisory Committee on Immunization Practices  
594 permits proof of immunity via serologic evidence in place of vaccination in certain  
595 instances (e.g. measles, mumps, rubella and varicella disease), but not for polio.[13]  
596 Public health agencies and healthcare providers should, however, assertively explain to  
597 parents that infection as a way to circumvent vaccinations is not preferable due to the  
598 short and long-term risks of disease exposure (including death).[43]

599 Precedents exist for reviewing vaccine legislation due to VPD outbreaks, as occurred in  
600 Rockland County in 2019, when religious exemptions for immunizations required for  
601 school attendance were removed. Mandatory vaccination, however, does not help with  
602 equitable access to vaccination and accurate information, and is not in itself a pathway  
603 to promoting vaccine confidence. As social scientists have argued, if 'mandatory  
604 measures are required, the policy should be undergirded by a commitment to building  
605 trust in immunisation and understanding of immunisation as a social good.'[44] Hence,  
606 vaccine engagement strategies are a priority to improve local-level coverage and to  
607 address concerns around childhood vaccinations in the populations that are most  
608 vulnerable to VPD outbreaks.

609 This qualitative assessment of the poliovirus outbreak and immediate response in  
610 Rockland County raises implications for how public health agencies collaborate amid  
611 transnational outbreaks. The simultaneous detections of genetically linked polioviruses  
612 in the US, UK and Israel offer an opportunity to evaluate response strategies across  
613 countries. Lessons learned from countries who have responded to polio outbreaks in  
614 networked communities might help develop transnational solutions to shared  
615 challenges.

616

#### 617 **4.1 Limitations**

618 This study was conducted to rapidly inform decision-making as the poliovirus response  
619 unfolded, and hence the study has three main limitations. First, interviews were not  
620 conducted with Haredi parents, in particular mothers, which is required to better  
621 understand their processes of vaccine decision-making. Second, the study period was  
622 limited, making it difficult to rapidly engage residents without taking appropriate  
623 sensitization steps through key religious and community leaders, which led to fewer  
624 numbers of participants than if more time had been allowed to fully familiarize residents  
625 with the study aims. While the study involved nine Community Partners and  
626 Organizations (ranging from Jewish doulas and EMT to rabbinic authorities), access to  
627 participants working in schools and playgroups would offer more precise knowledge  
628 about how vaccine entry requirements are managed in community settings. Lastly,  
629 these data represent perceptions shared during the acute phase of the outbreak, shortly  
630 after the case-patient was identified, and could have changed throughout the course of  
631 the response. Suggested next steps could explore the entire timeline of the response to  
632 better understand household expectations of vaccine communication strategies and  
633 their perceptions of accessible services how effective longer-term vaccine engagement  
634 strategies might be.

635

#### 636 **5. Conclusion**

637 This study reviewed immediate responses to a poliovirus outbreak in NYS, which was  
638 linked to wastewater detections of genetically linked poliovirus in the UK and Israel.  
639 Sustained investment in vaccine engagement and immunization systems strengthening  
640 is strongly recommended for public health services to proactively address low  
641 vaccination coverage and public doubt in vaccine safety and efficacy and improve  
642 understanding of the importance of routine immunization schedules in preventing the re-  
643 emergence of vaccine preventable diseases.

644

#### 645 **Statements and Declarations**

646 Ethical approval to conduct this study was provided by the University of Bristol on 10  
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649 Ben Kasstan, Sandra Mounier-Jack and Tracey Chantler are affiliated to the National  
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656 None of the authors declare any conflicts of interest. The CDC had no role in the  
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659 in the previous three years; no other relationships or activities that could appear to have  
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661 BK, SMJ, JR planned the study; BK collected data and conducted analysis; all authors  
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663

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673

## 674 **Data Availability**

675 The authors do not have permission from study participants to share the data presented  
676 in this paper.

677

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