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Exploring public perceptions of vaccine-derived poliovirus and a novel oral polio vaccine in the Democratic Republic of the Congo, Kenya, and Nigeria

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ABSTRACT

Background: The Global Polio Eradication Initiative introduced novel oral polio vaccine Type 2 (nOPV2) to address circulating vaccine-derived poliovirus Type 2 (cVDPV2). Although nOPV2 is a more genetically stable vaccine, it may not have the immediate trust of communities and health workers due to its novelty, potential side effects, and introduction under an Emergency Use Listing (EUL). We explored how nOPV2 introduction might be perceived by stakeholders and identified communications barriers related to nOPV2 hesitancy.

Methods: This work was conducted in the Democratic Republic of the Congo, Kenya, and Nigeria between January and March 2020. We used a rapid qualitative approach to conduct focus group discussions and in-depth interviews with four stakeholder groups: caregivers of children under 5, polio frontline workers, healthcare practitioners, and social/health influencers. Data are presented according to awareness, attitudes/beliefs, and concerns about cVDPV2 and nOPV2.

Results: Stakeholders were largely unaware of cVDPV2. The causes of recent polio outbreaks were characterized as poor sanitation, under-immunization/in-migration, or poor vaccine management procedures. Caregivers were aware of and concerned by repeated vaccination campaigns. All stakeholder groups anticipated initial hesitancy, fear, and suspicion from caregivers due to nOPV2 introduction, with primary concerns linked to vaccine testing, safety, effectiveness, side effects, and support from authorities. Stakeholders thought the term “genetic modification” could be controversial but that introduction under an EUL would be acceptable given the emergency nature of cVDPV2 outbreaks. Stakeholders called for adequate and timely information to counter concerns.

Conclusions: Despite initial concerns, stakeholders felt nOPV2 would ultimately be accepted by caregivers. However, public health officials have a small window for “getting things right” when introducing nOPV2. Strategic communication interventions addressing key concerns and targeted communications with stakeholder groups, especially frontline workers, could improve community acceptance of nOPV2.

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Abbreviations: cVDPV2, circulating vaccine derived poliovirus Type 2; DRC, Democratic Republic of the Congo; EUL, Emergency Use Listing; FGD, focus group discussion; GPEI, Global Polio Eradication Initiative; IDI, in-depth interview; mOPV2, monovalent oral polio vaccine Type 2; nOPV2, novel oral polio vaccine Type 2; OPV, oral polio vaccine.

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1. Background

Widespread use of oral polio vaccines (OPV) has contributed to laudable progress toward global polio eradication. In August 2020, wild poliovirus was endemic in only Afghanistan and Pakistan, with Africa briefly declared free of wild poliovirus [1] until a new case was identified in Malawi in February 2022 [2]. Beyond wild

poliovirus, the global community faces a continued challenge in stopping circulating vaccine-derived poliovirus Type 2 (cVDPV2) [1,3]. In 2020, the year this research was conducted, 25 countries experienced one or more cases of cVDPV2 [4]; as of April 2022, the number was 29, representing a continuing distribution of cases [5]. Some of this spread can be attributed to disruptions in the polio outbreak response during the COVID-19 pandemic [6]. However, much of this was due to failure to achieve adequate population immunity against Type 2 poliovirus before phasing out Type 2-containing OPV [7]. Monovalent OPV Type 2 (mOPV2) was reintroduced in some countries to address growing cVDPV2 outbreaks, but as global supplies of a stockpiled mOPV2 continued to be depleted [8,9], the Global Polio Eradication Initiative (GPEI) planned to introduce a novel OPV Type 2 (nOPV2) as a new tool for curbing cVDPV2 outbreaks in 2020. nOPV2, a genetically more stable vaccine [10], was anticipated to lower the risk of Type 2 virus regaining its virulence in under-immunized populations. The vaccine was released under the World Health Organization's (WHO) Emergency Use Listing (EUL) procedure in November 2020 [11,12], given the urgent need to respond to cVDPV2 outbreaks. Although the EUL is a robust regulatory pathway to promote use of the new vaccine, there were concerns that it may be controversial for recipients, particularly against a backdrop of growing vaccine hesitancy around the world [13].

For many years, the Polio Programme has been confronted by the need to explain decisions made on medical or epidemiological bases to communities affected by them. Scientifically-informed decisions intended to benefit the community may not be well-received by communities if they are not supported by adequate communications interventions. As the Polio Programme prepared to adapt its vaccine strategy, we sought to understand how such a change might be perceived by key stakeholders and to identify communications considerations around nOPV2 to ensure a smooth strategic transition. Specifically, we examined: (1) awareness and

perceptions of cVDPV2, and (2) reactions to a description of nOPV2 among caregivers, frontline workers, healthcare practitioners, and social influencers. Discussion of the potential introduction of nOPV2 also explored perceptions of genetic modification related to a new vaccine and release under WHO's EUL.

2. Materials & Methods

We conducted a cross-sectional qualitative study in the Democratic Republic of the Congo (DRC), Kenya, and Nigeria between January and mid-March 2020, immediately prior to global shut-downs due to the COVID-19 pandemic. This work was meant to inform the roll-out of nOPV2, which was officially approved under the WHO's EUL in November 2020 [12].

2.1. Settings

We used a rapid qualitative approach to inform communications strategies in three sites, which were purposively selected from among countries designated as "outbreak" or "at-risk" by GPEI. Criteria for selecting the sites included having recent experience with polio vaccination campaigns, growing numbers of cVDPV2 cases, and a stable security situation to enable rapid in-person data collection. We also sought to include countries that represented a range of health systems and polio campaign experience. Data were collected in: (1) Lubumbashi in the south of the DRC, a region that experienced a cVDPV2 outbreak from 2018 to 2019; (2) Akure and Kano, Nigeria, which experienced recent intensive efforts to respond to ongoing transmission of cVDPV2; and (3) the district of Kamukunji in Nairobi, Kenya, an area of immigration for Somali migrants and a location where environmental samples of cVDPV2 were confirmed in 2018.

Table 1
Type of stakeholders sampled by site.

Stakeholder/Rationale	DRC	Kenya	Nigeria
Caregivers Decision-makers on children receiving vaccine	Separate groups of female and male guardians of children under 5		
Frontline workers Administer OPV in community-based campaigns; educate caregivers and answer questions	<ul style="list-style-type: none"> o Community relays o Head nurses o Vaccinators 	<ul style="list-style-type: none"> o Nurses o Community health volunteers o Maternal and child health nurses o Laboratory technicians o Public health officers o Sub-county surveillance coordinator o Nurse-in-charge of public health clinic o Sub-county depot manager and immunization mentor o Clinical officer at public health clinic o Community resource person o Community elder o Madrassa teacher o Imam o Chief o Journalist 	<ul style="list-style-type: none"> o Volunteer community mobilizers in the north (Kano) o Vaccinators and supervisors in the south (Akure) o State immunization officer o Zonal technical officer o Pediatrician o Director of Education at State Primary Health Care Development Agency o Health journalists working in radio, television, and print media
Healthcare practitioners Doctors, nurses, or health administrators with experience administering OPV	<ul style="list-style-type: none"> o Head of health zone o Head nurse 		
Social influencers Influential voices that shape community perceptions about campaigns and outbreaks	<ul style="list-style-type: none"> o Traditional chief's assistant o Midwife o Traditional healer o Postolo (resistant sect) leader o Healer/health committee member o Behavior change agent o Neighborhood chief o Journalists 		

2.2. Sampling & recruitment

We focused on four specific stakeholder groups: caregivers of young children, polio frontline workers, healthcare practitioners, and social influencers, as defined in Table 1. All participants were at least 18 years of age and spoke the local language or English.

We conducted a mix of focus group discussions (FGDs) and in-depth interviews (IDIs) with stakeholders identified above. Given the exploratory and qualitative nature of this assessment, all sampling for data collection events was purposive, with an aim to provide input from diverse stakeholders who might identify the range of opinions, perceptions, and concerns the Polio Programme might encounter if/when rolling out nOPV2. Sample sizes were based on empirical evidence that 3 to 6 FGDs or 8 to 12 IDIs per sub-population should yield approximately 80% of relevant themes on a focused topic, including the most salient themes [14,15]. In DRC and Kenya, we conducted FGDs with caregivers and frontline workers within the catchment area of health facilities selected by local polio program officials and IDIs with health practitioners and influencers serving these same communities. In Nigeria, all data collection activities were planned as FGDs with an aim to conduct at least three per stakeholder group. Total numbers of FGDs, IDIs, and participants by country are indicated in Table 2.

To maximize diversity of stakeholder experiences, in each country we sought to include stakeholders from urban and rural locations. In Nigeria, sampling was also disaggregated between Akure in the south and Kano in the north. In Kenya, although we only included an urban site, we sought diversity of populations by including Somali, Ethiopian, and Eastern Kenyan migrants. Data were collected in Nigeria in late January through early February 2020 and in DRC and Kenya between late February and mid-March 2020.

2.3. Data collection

2.3.1. Content of FGDs and IDIs

FGD and IDI guides for caregivers, frontline workers, and health practitioners/influencers covered the same topics; however, each guide contained tailored questions and varied slightly (Appendix I & II), based on timing of data collection and local health officials' input. Participants received a thorough explanation of nOPV2 to ground discussions of its perceived acceptability. Note that when

Table 2
Number of FGDs, IDIs, and participants per stakeholder group per country.

Stakeholder Group	FGDs	IDIs	Participants
Caregivers			
DRC	4	–	30
Kenya	4	–	33
Nigeria	8	–	77
Frontline workers			
DRC	4	–	32
Kenya	4	–	32
Nigeria	4	–	36
Healthcare practitioners			
DRC	–	2	2
Kenya	–	3	3
Nigeria	3	–	27
Social influencers			
DRC	–	8	8
Kenya	–	6	6
Nigeria	2	–	8
All Groups			
DRC	8	10	72
Kenya	8	9	74
Nigeria	17	–	148
Total	33	19	294

these data were collected in early 2020, preliminary evidence suggested that nOPV2 was more genetically stable than mOPV2, and although there were no population-level or modeling studies available, it was anticipated that this stability would yield reductions in cVDPV2 cases. As such, nOPV2 was described as a potentially more “effective” vaccine, which was broadly meant to explain some of the benefits of introducing nOPV2 to stakeholder groups with different education levels.

Stakeholders were asked for opinions of nOPV2, perceptions of how the community would react to nOPV2 introduction, and questions or challenges that nOPV2 might raise. Stakeholders other than caregivers were also asked about genetic modification of the virus in the vaccine – how they understood it and how genetic modification might be talked about in relation to nOPV2 – and about the use of nOPV2 under an EUL. We note in the findings where a topic or question was not covered for a stakeholder group or location.

2.4. Analysis

We collected, analyzed, and interpreted FGD and IDI data in an iterative manner using a rapid team-based approach. During field work in DRC and Kenya, data analysis occurred on a daily, rolling basis. Teams began with detailed notes from the FGD or IDI, supplemented by audio-recordings. Teams collectively completed structured data extraction matrices in English after each FGD/IDI. FGDs in Nigeria were audio-recorded, transcribed in the local language, then translated into English. We used the same matrices developed in DRC and Kenya, with slight adaptations, to analyze data from Nigeria. A qualitative researcher reviewed the transcripts, using the matrices to pull out key themes and verbatim text for each question/group. Insights from debriefing notes from the Nigerian data collection team were also incorporated. Summaries were created for each topic domain by pulling information from each country-specific matrix, following a framework analysis approach [16].

2.4.1. Ethical considerations

This activity was granted a non-research determination per the federal regulatory definition of Human Subjects Research (45 CFR 46) by FHI 360's Office of International Research Ethics. We received local approvals from the *Programme National de Communication pour la Promotion de la Santé* and the *Ministère de la Santé Publique* in DRC. In Kenya, the protocol and materials were reviewed by the Director General of the Ministry of Health. Materials were then forwarded to the Nairobi City County Operational Technical Working Group, which issued their approval. This work was considered programmatic data collection in Nigeria.

3. Results

To align with communications strategy needs, we have organized the findings on cVDPV2 and nOPV2 introduction according to awareness, attitudes/beliefs, and concerns about each topic, as applicable. We present a summary of the aggregated findings to reflect the range of themes for each category, rather than providing specific findings for each stakeholder group and country. Some detailed findings and/or illustrative quotes are provided in supporting tables. An analysis with disaggregated findings is presented elsewhere [17].

3.1. Perceptions of cVDPV2

Although all sites have experienced cVDPV2 outbreak responses in recent years, awareness and knowledge of cVDPV2 was low

across sites and stakeholder groups. Of Nigerian stakeholders, only caregivers were asked about cVDPV2. Of caregivers in DRC and Nigeria asked directly about cVDPV2, none were familiar with the term. Similarly, no caregivers in DRC and Kenya identified cVDPV2 as a cause of recent outbreaks. Frontline workers were more aware of polio outbreaks overall than they were of cVDPV2 specifically. Among the Kenyan groups, attention was focused on recent outbreaks in Somalia and on the environmental samples found in the neighborhood of Eastleigh in Nairobi. A few frontline workers in DRC and Kenya were familiar with the term cVDPV2, however their explanations of the term were limited to certain contributors to cVDPV2. Most associated cVDPV2 with under-vaccination, or “a way of getting polio by misplacing/mishandling the vials,” including dumping the vaccine in the environment or failing to maintain the necessary cold chain.

Healthcare practitioners in Kenya and DRC were more aware of cVDPV2 than other stakeholder groups (particularly in Kenya). A provider in DRC asked directly about cVDPV2 stated awareness of the term, though referenced improper vaccine storage as its cause. Of three Kenyan healthcare practitioners, their familiarity with cVDPV2 ranged from being aware of the Eastleigh sample, to a suggestion that cVDPV2 could result from expired or improperly stored vaccine, to a clear relationship with vaccine-related viral shedding. Among the social influencers interviewed in DRC, none had heard of the term cVDPV2.

Although few stakeholders were aware of cVDPV2 specifically, many described their beliefs regarding the causes of recent polio outbreaks or positive environmental samples in their countries. Caregivers raised poor hygiene (DRC) and under-immunization linked to cross-border travel (Kenya) as explanations. Frontline workers and healthcare practitioners reported that cVDPV2 was caused primarily by poor vaccine management practices. However, frontline workers also offered the following as causes of outbreaks: (1) social resistance in rural areas or among religious groups; (2) in-migration and low immunization coverage in originating areas; and (3) viral resistance and mutation. One Kenyan healthcare provider also associated cVDPV2 with the high level of community vaccination that resulted in viral shedding. Social influencers

expressed few beliefs about cVDPV2, as they were largely unfamiliar with the term or unaware of the outbreaks and environmental samples, except one Kenyan journalist who reported that poliovirus found in the sewer system is a threat to unvaccinated children in the community. Table 3 summarizes perceived causes of cVDPV2 and/or recent polio outbreaks along with illustrative quotes.

3.2. Perceptions of the introduction of nOPV2

Since most stakeholders were unaware of cVDPV2, we discussed the introduction of nOPV2 in the context of combatting recent polio outbreaks. As a new vaccine, there was no baseline awareness among target populations; however, there was high awareness of previous OPV campaigns and common expressions of campaign fatigue across sites, which provide the context for findings related to attitudes, beliefs, and concerns regarding the potential introduction of a new vaccine.

The consensus across sites and stakeholder groups was that the introduction of nOPV2, like many new products, would inspire numerous questions and initial hesitancy. Questions posed by stakeholders are listed in Table 4 and reflect the primary concerns related to vaccine safety, effectiveness, and side effects. Nevertheless, stakeholders felt that nOPV2 would ultimately be accepted if the rationale for the new vaccine is explained and accepted by the relevant stakeholders, especially caregivers. Frontline workers and healthcare practitioners were generally supportive of the introduction of nOPV2 and tended to view it as a positive development if it is proven to be an *improved* vaccine (for example, if it is shown to be more effective and, therefore, reduces the need for frequent polio campaigns), well-tested, and proven safe.

In response to the introduction of a novel vaccine, caregivers across sites often reported fear stemming from lack of information or experience with the vaccine. Their attitude was one of caution, with many expressing a “wait and see” approach, allowing time to confirm there were no adverse reactions. Across sites, all other stakeholder groups anticipated this initial fear and hesitancy among caregivers based on experience from previous OPV cam-

Table 3
Illustrative quotes describing potential causes of cVDPV2 or recent outbreaks of polio.

Perceived Cause	DRC	Kenya
Improper vaccine disposal or handling procedures	“The vaccine is an attenuated virus. Thus, the vaccine-derived virus can be contracted if storage of the vaccine or vial is not assured.” (HP)	“I have never witnessed it, but I have heard some healthcare providers pour out vaccines, and when children play they are able to swallow this vaccine, and since it is live-attenuated they can get it through this ‘disposal issue.’” (FLW)
Poor sanitation/hygiene	“The cause, I believe, is due to poor living conditions. Because of financial difficulties, the children are exposed to different diseases.” (CG)	NA
Social resistance	“There is always resistance to vaccination especially in certain religious sects, and if we do not vaccinate all children there are always strains that arise.” (FLW)	“[Vaccines are] not accepted in rural areas because of political interference - they think people want to reduce the birth rate there.” (FLW)
In-migration and low immunization coverage	NA	“We have a situation of under-immunized, and one case means the opportunity to multiply. That is why in Kenya we are doing the boosters because we neighbor very unstable countries and every now and then we can have some coming into our country from there.” (FLW)
Viral resistance and mutation	“I think that viral resistance may be why we want to use a new vaccine.” (FLW)	“There is mutation of the original vaccine once it adapts to a new environment. Anything mutated changes its form to refuse the drug used against it. It happens after the pouring in the environment and then since it’s taken orally, while babies play and don’t have time to wash, they come to contact with it.” (FLW)
Viral shedding in stool	NA	“My understanding is that as we immunize the kids, there are kids that end up emitting the virus in the stool, then this polio ends up affecting other kids... It means there is a lot of vaccination going on, we are achieving more than 90% target of coverage that is required by [Kenyan vaccination] program, but the concern is the fact that it is passing cVDPV2.” (HP)

* No data from Nigeria were available given questions were only asked of caregivers, none of whom had heard of cVDPV2.

Table 4
Contextual, nOPV2 specific, and logistical questions by stakeholder group.

Group	Contextual	nOPV2 specific	Logistical
Shared by All Stakeholders	<ul style="list-style-type: none"> • Why this change? Why a new vaccine? • Has polio changed/increased? • Is OPV as currently used not effective? What is wrong with the current OPV? 	<ul style="list-style-type: none"> • Will nOPV2 be effective? • What is the difference between new vaccine and current one? • Is nOPV2 government approved? • Will nOPV2 have the same side effects as the current vaccine? • Is nOPV2 safe? • Will nOPV2 cure the disease/eradicate polio? 	
Caregivers	<ul style="list-style-type: none"> • Why will there be another campaign with a new vaccine? 	<ul style="list-style-type: none"> • What ingredients are in this new vaccine? Have things been added? • When will nOPV2 be available? • Will nOPV2 follow the same guidance on calendar and age for administration? 	
Frontline Workers	<ul style="list-style-type: none"> • Why only now? • Is this a business decision? 	<ul style="list-style-type: none"> • How will you prove it is effective like the first vaccine? • Are there new ingredients that will make it better? • Will it replace the old one or be supplemental? • What are the risks/ disadvantages? • What else will it cure? If nothing, why change it? 	<ul style="list-style-type: none"> • Will it have instructions? • Will it affect the RI schedule? • How will we convince those already resistant to the current vaccine? • Is it still only for children? (What about greater than 5yo that has never vaccinated?) • Will there be a sufficient, permanent supply? • How many doses? • How will it be administered?
Health Practitioners	<ul style="list-style-type: none"> • What necessitates adding a new intervention? 	<ul style="list-style-type: none"> • What are the safety and efficacy profiles? • What research has been done? • Will it replace the old one or be supplemental? 	<ul style="list-style-type: none"> • What role, if any, does this play in RI? • How do we explain the need to caregivers? • What is the (new) dose and administration protocol?
Social Influencers	<ul style="list-style-type: none"> • Will there be more campaigns? 	<ul style="list-style-type: none"> • What research has been done? Where? 	

paigms. Relatedly, across sites many stakeholders reported suspicion – their own or that of community members – as a likely attitude toward nOPV2. Suspicions among caregivers in DRC and Kenya often related to the belief that the “real” motivation behind vaccination campaigns was to sterilize certain groups. Mistrust and suspicion from religious sects were also raised in both Kenya and DRC as a long-standing barrier to acceptability. These attitudes were confirmed by other stakeholder groups, who had encountered similar suspicion or mistrust related to previous OPV campaigns. A few social influencers in Kenya expressed an added belief that a new vaccine was another sign of Western exploitation of Africans for pharmaceutical development.

At the same time, there was an attitude of appreciation for a medical advancement that could improve children’s lives. For caregivers, this attitude was often expressed in terms of protecting children from disease and minimizing the frequency of vaccination campaigns. Frontline workers welcomed the possibility of a newer vaccine that might be more stable and could potentially reduce repeat campaigns. Frontline workers also made suggestions to further improve the vaccine, such as making it less light-sensitive and to require a single dose. Healthcare providers demonstrated appreciation, particularly if the vaccine could finally eliminate polio; however, their attitudes were more reserved, pending further evidence. This attitude was less apparent among social influencers in all sites, who more commonly stressed hesitation or concerns.

Across sites, most caregivers indicated they would allow their child to receive nOPV2 if proven safe and effective. Some caregivers believed that nOPV2 would be beneficial because international organizations or their government were endorsing its use. These caregivers often felt that the government could be trusted to “do no harm” to its citizens. However, certain caregivers across sites felt they would be forced to accept a new vaccine. In DRC, this was because families did not have the means to treat an illness like

polio; therefore, they would need to accept a free vaccine to prevent a costly disease. In Kenya among the majority-migrant sample of caregivers, a few were concerned they had little recourse to resist a mandated campaign in their host country.

4. Promoting nOPV2 through appropriate and timely information

Across stakeholder groups and sites, respondents believed that acceptability of nOPV2 hinged upon information, including content and source of messages. Caregivers emphasized the need to raise awareness, provide a clear explanation of the new drug, and answer common questions. Caregivers will expect information on what is being offered and why from healthcare providers and frontline workers, but they will look to traditional and religious leaders and their own social networks for endorsement and to build confidence. Many healthcare practitioners also requested information and training to disseminate accurate information down the chain of command to frontline workers, community stakeholders, and ultimately to caregivers. Frontline workers across sites frequently expressed a need for information and training to equip themselves with strategies for countering hesitation among caregivers. Nearly all frontline workers believed they could be effective in deploying nOPV2 if training and communication strategies were in place.

In DRC and Kenya, social influencers offered suggestions for effectively disseminating information to increase confidence in nOPV2, most of which focused on cultivating awareness and trust with religious and community leaders. A few social influencers also noted the role of media to affect public opinion about nOPV2. Journalists across sites wished to clearly explain the introduction of nOPV2 and reported needing answers about the testing conducted

to develop the vaccine, differences between old and new vaccines, and the reasons why a change had been made.

Stakeholders who believed that transparency would engender a positive response from caregivers cited three reasons: caregivers have a right to know what they are consenting to have administered to their children; well-sourced information prevents a void that can be filled with speculation and/or misinformation; and transparency builds trust in the healthcare system. However, a subset of frontline workers and social influencers believed that saying nothing about the switch to nOPV2 would better facilitate acceptability, as this would avoid raising alarm and, potentially, a new wave of vaccine hesitancy. Stakeholders who believed acceptability would be improved if information were limited cited three reasons: nuanced explanations of nOPV2 can cause confusion since baseline understanding of polio transmission and cVDPV2 is low; changes could undermine trust in the health system, particularly given existing vaccine fatigue; and some concepts related to the changes to OPV have associations with negative perceptions (i.e., genetic modification) that could be exacerbated by public discussion.

4.1. Perceptions of genetic modification and nOPV2

We asked stakeholders how the inclusion of a 'genetically modified' virus in nOPV2 might affect acceptability. This topic was discussed among all stakeholder groups in Nigeria and among healthcare providers and some social influencers in DRC and Kenya. Overall, few stakeholders were aware of the concept of genetic modification. Caregivers and frontline workers in Nigeria were largely unaware of this concept. However, Nigerian healthcare providers and journalists demonstrated high awareness and discussed its implications for nOPV2 introduction. Of five healthcare providers interviewed in Kenya and DRC, one per country had a clear understanding of genetic modification as related to nOPV2, while two others were familiar with the term "GMO" from the agriculture sector. Among social influencers in Kenya (excluding the journalist), there was very low awareness of the term "genetic modification."

The primary concern about discussing genetic modification related to nOPV2 was that it would increase vaccine hesitancy. Stakeholders in DRC and Kenya felt that using the term "genetic modification" could be problematic since "GMO" has negative connotations linked to cancer, suggesting it may be *"better just to say it's an improved vaccine."* A frontline worker in Nigeria similarly thought it may cause concern among caregivers. Without appropriate information, healthcare practitioners felt some caregivers may perceive a hidden agenda or that educated caregivers in Kenya and Nigeria would look online to learn about genetic modification and find only misinformation.

Appropriate information was considered the only way to assuage fears and control the message. Journalists in Nigeria felt that clear and accurate information, presented in laymen's terms, would be the foundation of their own reporting. The Kenyan journalist recommended that information be shared carefully: *"I would see a big headline on the newspaper reading 'GMO Polio Vaccine Introduced in Kenya'. With the wrong knowledge this will definitely lead to poor acceptance of the vaccine."* In both Kano and Akure, there was concern about how social and informal media would report this information: *"The social media, like bloggers, are usually controversial. They may not appreciate the changes, [though] if they are knowledgeable, I don't think they can raise problems."*

4.2. Perceptions of nOPV2 roll-out under an emergency use listing

Only healthcare providers and social influencers were asked how the introduction of nOPV2 under WHO's EUL might affect

acceptability and uptake of the vaccine. As with findings on genetic modification, stakeholders called for clear communication to caregivers and those who influence their decision to vaccinate about the rationale for roll-out under the EUL. Healthcare providers reminded interviewers that *"we are parents, too"* when asked how caregivers might respond. In thinking through EUL from their dual role as provider and parent, providers expected some initial hesitancy from caregivers but ultimately felt that if they were aligned, as providers, on how to answer questions, they could assuage concerns. As providers, they were generally understanding of the potential need to start using nOPV2 under an EUL, with the caveat (particularly in Nigeria) that policy makers and practitioners would need a clear rationale to justify use under an EUL. Although one Nigerian provider felt that a case for nOPV2 being introduced under the EUL might be made to urgently address polio outbreaks, similar to the rapid introduction of the Ebola vaccine in 2019, another was very concerned that the EUL was a ploy to test the vaccine on Nigerian children. Healthcare providers in Kenya focused on the word "emergency" and felt a swift response to an outbreak with an effective vaccine would be welcomed.

Among social influencers in Kenya, three anticipated that use of nOPV2 under an EUL would be controversial, while three did not. Those with a positive attitude toward EUL cited the need to preserve health at the time of a crisis: *"You deal with the emergency that is there, for the betterment of the community, for them to be safe."* Social influencers in DRC did not think EUL would be too controversial – if well explained – and felt that caregivers would be happy there was a new drug to help during an outbreak. Journalists in Kano raised concerns but mostly related to the need for accurate reporting. Of those who felt EUL would raise questions (for themselves or the community), a shared concern was one of cutting corners and perhaps risking health or safety in the process: *"If [the vaccine was] developed quickly will it guarantee effectiveness or cause more illness? You're taking a shortcut... Why don't you test it slowly? Why the emergency?"*

5. Discussion

We assessed awareness, attitudes/beliefs, and concerns about cVDPV2 and nOPV2 among stakeholders in DRC, Kenya, and Nigeria to inform the development of communications interventions that support the introduction of nOPV2. Despite the epidemiological benefits of nOPV2, it is being introduced into social contexts with a range of pre-existing perceptions and concerns around OPV and around vaccines more generally. Our findings provide an indication of key factors that must be addressed in GPEI's communications around nOPV2. For example, we found that communities are not familiar with the concept of cVDPV2 specifically. The lack of awareness related to cVDPV2 is likely linked to communications strategies that focus on eradicating polio generally, rather than on specific types of outbreaks. If communities are not aware of the specific types of poliovirus, the August 2020 announcement that the Africa region is free of wild poliovirus [1] may have provided a false sense of safety in that communities may no longer have perceived polio as a threat. This perception could reinforce existing questions regarding the necessity of further rounds of polio vaccination and repeated campaigns. Such insights present a communications challenge for the introduction of a novel vaccine to combat cVDPV2, including whether or how to raise caregiver awareness.

Given sensitivities around the introduction of a new vaccine, some stakeholders argued for withholding information from caregivers on the introduction of nOPV2, pointing to low baseline understanding of vaccines and the potential for misunderstood information to bolster misperceptions. However, as other stake-

holders argued, unaddressed concerns increase doubt, reduce confidence in local health systems, and can ultimately increase hesitancy, particularly among communities with digital access. Stakeholders anticipated at least initial suspicion and fear of nOPV2 among caregivers, based on experience with rumors and mistrust from previous OPV campaigns and the fact that nOPV2 is new and unknown. There have been documented rumors and mistrust of the similarly new and unknown COVID-19 vaccines across Africa in the time since this research was conducted [18], underscoring the importance of understanding and appropriately engaging with vaccine hesitancy.

According to respondents in this research, communications interventions that present appropriate information endorsed by local stakeholders have an opportunity to increase vaccine acceptability and reduce hesitancy, whether by trying to address rumors or assuage fears of the unknown. Given that stakeholders' primary concerns were related to the safety, effectiveness, and potential side effects of nOPV2, the Polio Programme can prioritize addressing these concerns before and during nOPV2 roll-out to communities. For example, it may be important to demonstrate that vaccines released under an EUL are still supported by rigorously collected safety and efficacy data, especially as nOPV2 and COVID-19 vaccines were both anticipated to be released under this banner. Also, to build on stakeholders' appreciation for new developments to protect children, emphasis should be placed on the advantages of nOPV2, including its improved nature. For example, authorities can share more recent data to clarify that nOPV2 is safe and well-tolerated with few vaccine-related adverse effects among children [19], and because it is more genetically stable, it may be associated with less paralytic disease [10]. Caregivers are likely to be satisfied by these benefits for their children, despite that recent modeling data suggests that nOPV2 may not be more effective at slowing transmission of cVDPV2 than mOPV2 [20]. However, longitudinal data describing population-level effects of nOPV2 on disease transmission are necessary to validate these findings.

Caregivers indicated that their confidence is boosted when they hear consistent messages from health authorities (from the ministry level down to frontline workers), media, and community and religious leaders. They are looking for trustworthy information from providers and frontline workers, strengthened by endorsement from traditional and religious leaders and their own social networks. Findings suggests that social media will be influential in shaping the perceptions of caregivers, though this will vary by location. Ensuring alignment of messaging among health officials, community leaders, traditional media, and social media will be important for maintaining caregiver acceptance of nOPV2. Each stakeholder group should be reached through targeted communications, especially frontline workers, as they field the majority of stakeholder concerns.

5.1. Limitations

This research was completed just before the start of the COVID-19 pandemic, which has drastically changed the global social context of vaccination campaigns and increased the potential for vaccine rumors and misinformation. Additional research is underway to understand how the pandemic and COVID-19 vaccination landscape may affect these findings, and communications will need to recognize the likelihood of simultaneous rollout of nOPV and COVID-19 vaccines. Another limitation is that nOPV2 was described to stakeholders as potentially more "effective" in an effort to address a range of potential benefits in plain language; however, the assumption that nOPV2 is more effective at controlling outbreak response than mOPV2 may have been overstated given the lack of longitudinal, population-level evidence to support

this claim. Nevertheless, vaccine effectiveness was a primary concern that was mentioned organically and will be important to address among all stakeholder groups. Finally, these findings are also limited by geographic reach in that only three countries are included. However, we sought to achieve geographic diversity by including a mix of countries representing western, eastern, and central Africa. We also aimed for diversity within sites by including urban and *peri-urban/rural* as well as different ethnic populations (i.e., Somali, Ethiopian, and eastern Kenyan migrants). Like most qualitative assessments the sample for this activity was non-representative, as the goal was not widespread generalizability but rather to get perspective on the *range* of responses the Polio Programme might encounter.

6. Conclusions

Despite initial concerns, most stakeholders concluded that nOPV2 would ultimately be accepted if the vaccine is proven to be tested, safe, effective, and supported by international and local authorities, including traditional and religious leaders. In many cases, the promise of a new vaccine, particularly one described as "improved" rather than genetically modified, was welcomed and anticipated by stakeholders across groups. However, public health officials have a small window for "getting things right" when rolling out new programs, highlighting the importance of incorporating and addressing the specific attitudes, beliefs, and concerns of stakeholders presented here in the development of an nOPV2 communication strategy.

CRedit authorship contribution statement

Lara Lorenzetti: Conceptualization, Methodology, Validation, Formal analysis, Data curation, Writing – original draft, Writing – review & editing, Visualization, Supervision, Project administration. **Rustam Haydarov:** Conceptualization, Methodology, Writing – review & editing, Supervision, Funding acquisition. **Emily Namey:** Methodology, Validation, Formal analysis, Investigation, Data curation, Writing – review & editing, Visualization, Project administration. **Anna Lawton:** Methodology, Validation, Formal analysis, Investigation, Data curation, Writing – review & editing, Visualization, Project administration. **Hayon Nam:** Conceptualization, Methodology, Validation, Writing – review & editing, Supervision, Project administration. **Muhamad Ridwan Hasan:** Conceptualization, Methodology, Validation, Writing – review & editing, Supervision, Project administration. **Claude Monj:** Conceptualization, Validation, Writing – review & editing, Supervision, Project administration. **Surangani Abeyesekera:** Conceptualization, Validation, Writing – review & editing, Supervision, Project administration. **Maria Amina Kabwau:** Methodology, Investigation, Data curation, Writing – review & editing. **Ross McIntosh:** Conceptualization, Methodology, Writing – review & editing, Supervision, Funding acquisition.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary material

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