



Exploring perceptions and attitudes towards vaccines in a remote western DRC health zone

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ABSTRACT

The Democratic Republic of the Congo (DRC) struggles with low full childhood vaccination coverage (around 50 %) and a high children-under-five mortality rate (79 deaths per 1000 live births). This situation is potentially exacerbated by vaccine hesitancy, which was identified by the World Health Organization (WHO) as one of the top 10 global health threats in 2019. To gain deeper insights into levels of vaccine confidence possibly influencing vaccination coverage, we explored perceptions and attitudes towards childhood and adult vaccines in Boende (Tshuapa province, western DRC), which experienced an Ebola outbreak in 2014 and hosted the EBL2007 Ebola vaccine trial (2019–2022). Using purposeful sampling, we conducted 29 individual interviews and 14 focus group discussions with diverse community members between July 2022 and March 2023. Our findings suggest the prevalence of a relatively low level of trust in COVID-19 vaccines compared to other vaccines. Additionally, the fear of Ebola disease seemed to lead to general acceptance of the EBL2007 trial vaccine, although some concerns were voiced about pre-testing and the decision to conduct the trial in the DRC. While trust in childhood vaccines and reported uptake appeared to be high, concerns existed regarding potential adverse effects and the possibility that vaccines targeted African children specifically. Our analysis further identified four recommendations to possibly enhance vaccine confidence in the region. This study highlights the multifaceted nature of vaccine confidence, influenced by the perceived risk of the targeted diseases, past experiences with medical interventions and staff, and sociopolitical contexts. However, we emphasise that increasing vaccine uptake requires a comprehensive approach, addressing not only vaccine confidence, but also crucial aspects like access to vaccines and robust disease surveillance activities. This would ultimately reduce the burden of vaccine-preventable diseases and lead to better public health outcomes in the region.

1. Introduction

In the Democratic Republic of the Congo (DRC), the mortality rate of children under five is 79 per 1000 live births, ranking among the highest in the world [1]. While malaria, for which vaccines are not widely available yet, highly contributes to this mortality rate, thousands of deaths are caused by vaccine-preventable diseases like measles, respiratory infections, and diarrhoeal diseases [2,3]. Before the COVID-19 pandemic, the percentage of fully vaccinated children at the national level hovered around 50 %, but it declined to 41 % during the pandemic

before slowly recovering to 45 % in 2022 [4]. Moreover, reports have indicated that the DRC has one of the highest numbers of children who have not received any vaccine doses “zero dose children” in the world [5]. In regards to adult vaccines, apart from the antenatal tetanus vaccine, the country has introduced three vaccines thus far, targeting yellow fever, Ebola, and COVID-19. In contrast to well-established childhood vaccination programmes such as those for measles and polio, these vaccines are primarily deployed reactively in response to (active) outbreaks. In 2021, the yellow fever vaccine coverage rate was at 56 %, well below the 80 % level recommended for adequate protection [6].

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This suboptimal coverage has contributed to multiple disease outbreaks in the country between 2010 and 2019. Concerning Ebola vaccines, the country has seen efforts to roll out two Ebola vaccines in response to active outbreaks, and it is expected to increase vaccine access following the WHO's recent recommendation to vaccinate healthcare workers preventatively even in the absence of outbreaks in most at risk countries [7–9]. With regards to COVID-19 vaccines, the DRC currently ranks among the bottom 10 countries globally in terms of vaccines administered per 100 persons [10]. This emphasises the challenges in both the childhood and the adult vaccination landscapes and the urgent need to address vaccine coverage across various diseases in the country.

The reasons for DRC's low vaccine coverage levels are largely attributed to penury in vaccination programmes' funding, and the lack of infrastructure and logistics that can support effective vaccine delivery and quality control activities [11,12]. The armed conflict in the east of the country, which has led to millions of internally displaced individuals, might have added to the complexities of vaccine delivery and surveillance [13]. According to a recent study, caregivers of under-vaccinated children in the DRC did not continue vaccinating children after the first doses because of practical reasons, including financial and geographical barriers [14]. However, the caregivers' primary reasons for not vaccinating their children with any dose were rumours, perceived low vaccine importance, and fear of side effects, collectively categorised as vaccine hesitancy.

Vaccine hesitancy has been gaining increased attention over the last decade with reports available at both national and global levels for the majority of the countries of the world. A global study by the Vaccine Confidence Project between 2015 and 2019 demonstrated high levels of trust in vaccines' importance and safety in the DRC [15]. Peckeu-Abboud and colleagues also found high levels of confidence and vaccine uptake in the country, particularly in routine vaccines if compared to outbreak vaccines (cholera, Ebola, COVID-19) [16]. However, we observed that the majority of studies on vaccine hesitancy in the DRC are either COVID-19-focused, take only a quantitative approach, or target big cities and urban areas [14,17–19]. Additionally, as measles outbreaks are recurrent in the country (causing around 150,000 cases and 1800 deaths in 2022), there is a crucial need to map drivers and barriers to vaccine uptake in different parts of the DRC [20]. Recognising this research gap, we conducted a qualitative study aimed at exploring vaccine confidence in Boende, a remote¹ town situated in Tshuapa province, in western DRC. This research was carried out as part of the EU-funded multi-national EBOVAC3 project [21]. EBOVAC3 aims to generate necessary evidence to aid in delivering a safe, and immunogenic Ebola vaccine to the market through a series of clinical trials in three African countries that were affected by the disease in the last decade. The project also sought to explore vaccine confidence levels as a key component of enhanced preparedness for future outbreaks at the national, provincial, and local levels. Our qualitative study was conducted as part of the DRC's arm of the project alongside the EBL2007 vaccine trial (NCT04186000) [22]. The trial involved multinational partners with the University of Antwerp as the sponsor and the University of Kinshasa as the principal investigator and had healthcare providers and frontliners (hereafter: HCPs) as the target population. One of the reasons for choosing the trial location was that in 2014, the

¹ Reaching Boende from Kinshasa is mainly limited to two options: flying, which is the quickest option, or taking a boat, a journey that can take up to two weeks.

Boende Health Zone² witnessed an Ebola outbreak that led to 69 suspected, probable, and confirmed cases and 49 deaths [23]. This study explored perceptions of vaccines broadly, including those administered during both childhood and adulthood. Additionally, this paper seeks to identify best practices during sensitisation and vaccination campaign activities, recognising that although vaccine confidence plays a crucial role, it is not the sole factor contributing to low vaccine coverage in the area.

2. Methods

2.1. Study setting

We conducted the study in Boende town (*Zone de Santé*), one of the 12 health zones of the Tshuapa province. The EBL2007 vaccine trial was conducted in the general reference hospital of the Boende Health Zone and involved HCPs from different health zones of Tshuapa province. Our study was conducted in Boende town in two phases (data collection periods): one towards the end of the EBL2007 vaccine trial and another following its completion.

2.2. Study design, sampling, and data collection

To get insight into the perceptions and attitudes towards both adulthood and childhood vaccines, as well as perceptions of the EBL2007 trial vaccine, we used a qualitative descriptive research design, using individual interviews and Focus Group Discussions (FGDs) to collect data. An additional aim of the qualitative design was to map best practices concerning vaccination campaigns and sensitisation activities.

Purposive sampling was used to identify and contact different community members through colleagues working at the Boende General Reference Hospital. Different persons and categories were selected for interviews and FGDs to explore the largest variety possible of perceptions among different community members, some of whom could have an influential role on public opinion. Interviews and FGDs followed semi-structured topic guides, available in the supplementary materials (Supp 1 and Supp 2).

2.3. Data collection process

Interviews and FGDs were conducted over two periods: a first one in July/August 2022, mainly to collect data on the perceptions of the EBL2007 trial vaccine, and a second one in March 2023, to further explore vaccine confidence and best practices in vaccine trials and vaccination campaigns. Data was collected in French or Lingala by MS (woman, non-Congolese, PhD student), FB (man, Congolese, PhD student), and AP (woman, non-Congolese, post-doctoral researcher). All three researchers have previous experience in qualitative research methods by training and/or education. A female French-Lingala interpreter from Tshuapa province was present when translation from Lingala was needed. The FGDs included 6 to 8 participants, were conducted in the Boende General Reference Hospital, and lasted around 45–60 min. Individual interviews were conducted at a location selected by the interviewee, which could include their residence, workplace, or another preferred setting, and lasted around 15–30 min. Individual interviews and FGDs (partially) conducted in Lingala were translated and transcribed in French by the interpreter; the interviews done in French

² In the DRC, the healthcare system is divided into 519 health zones covering the country's 26 provinces. A health zone (*Zone de Santé*) is a health system unit provided with one general reference hospital (*Hôpital Général de Référence*), one central office (*Bureau Central de la Zone de Santé*), and several health centres and posts. Each *Zone de Santé* is divided into different health areas (*Aire de Santé*); a health area is provided with one health centre (*Centre de Santé*) and occasionally also includes a health post (*poste de santé*) along with the health centre.

were transcribed by the Sonix™ software and checked by AP for accuracy.

2.4. Data analysis

We used a thematic analysis approach, in which the main themes were topic summaries derived from questions in the interview guide [24,25]. Our coding approach was both deductive (we focused on four major predefined themes, i.e., the topic summaries) and inductive (we identified codes and sub-themes within each topic). Interviews and FGDs transcripts were uploaded in French to QSR NVivo V.1.6.1. Codes were generated and thematic analysis was conducted by MS and AP with quality support from HB. The four major themes (topic summaries) were the following:

1. Perceptions of rolled-out adult vaccination
2. Perceptions of the EBL2007 trial vaccine
3. Perceptions of childhood vaccines
4. Vaccine uptake, good practices, and suggestions to increase vaccine acceptance

Narrative summaries of the main themes identified are presented in the Results section along with subthemes and quotes to support study findings. The subthemes were categorised as either 'positive' or 'negative' to provide a clearer and more organised summary of the data.

2.5. Ethical considerations

We received ethical approval of the study protocol (N 368/CNES/BN/PMMF/2022) from the DRC's National Health Ethics Committee. Oral informed consent to anonymised audio recording and its use for research purposes was obtained before the start of interviews and FGDs.

2.6. Participant involvement

To ensure transparency and share the research outcomes with the interviewees, eight of the study participants were invited to attend a dissemination conference in Boende on the 4th and 5th of April 2024. The event included sharing the findings of this qualitative study, as well as the results of the EBL2007 vaccine trial results with trial participants.

3. Results

Overall, we conducted 29 individual interviews and 14 FGDs. Table 1 shows the number of interviews and FGDs conducted in our study, as well as the occupation and sex of study participants. The following paragraphs present the findings relating to each of the main topic summaries (themes) with quotes to back each finding.

1. Perceptions of rolled-out adult vaccination in general

Positive (?) perceptions: Pragmatic acceptance to be vaccinated.

In some cases, vaccines seemed to be accepted for practical reasons, when people were forced by the circumstances. Some explained that they agreed to get vaccinated against COVID-19 to facilitate their travels, as in order to travel, one needed to be vaccinated or have a negative COVID-19 test result. Vaccination offered a clear advantage: it eliminated the need for repeated, potentially uncomfortable nasopharyngeal swab tests, which cost can be a financial burden as well. Others explained that vaccination against yellow fever was compulsory, and one risked being brought to jail by the military if found without a vaccination card, which is what motivated many people to get vaccinated.

"Myself, I went to take [the COVID-19] vaccine under constraint! Because I was tired of going all the time and having those things put in my nose for the test..." (NGO representative, man, FGD, July 2022).

Table 1

Number of interviews and FGDs conducted in the study as well as the occupation and sex of study participants.

Individual interviews	
School teachers (men)	5
School teachers (women)	2
Hotel and restaurant managers (men)	2
Hotel and restaurant managers (women)	5
Religious leaders (men)	5
Journalists (man)	1
Journalists (woman)	1
Pharmacists (men)	5
Pharmacists (woman)	1
The chief medical officer of the Expanded Program on Immunization (EPI) in Tshuapa (man)	1
Traditional healer (man)	1
Total	29
Focus Group Discussions	
Vendors (men)	2
Vendors (women)	3
Taximen	2
Housewives	1
Relais communautaires (RECO) ^a (women)	1
CODESA ^b (men)	1
Journalists (men)	1
Human rights non-governmental organization representatives (men)	1
Nurses (women) (non-participants in the EBL2007 vaccine trial)	2
Total	14

^a Relais communautaires are community members who received training in health communication and volunteer to inform the rest of the community on different health topics like (non)communicable diseases and vaccination.

^b CODESA are committees for the development of the Health Area (sub-division of the Health Zone) and represent the institutional link between the health system and the community.

"The vaccine against yellow fever. The doctors told us that if [the disease] catches you, you will die. And they told us that those who will not take the vaccine will not receive the card either. If by disgrace you run into the military and you have no card, they bring you to jail. That is why many people came [to receive the vaccine]" (Relais communautaires³ (RECO), woman, FGD, July 2022).

Negative perceptions: Uncertainty about vaccines' safety, especially the COVID-19 vaccine.

Uncertainties were voiced about adult vaccines (yellow fever and COVID-19), which were generally less trusted in comparison to more traditional routine childhood vaccines (e.g., measles, polio). The safety of these vaccines was the main concern of the study participants. For example, a religious figure who worked in sensitisation and vaccination campaigns mentioned that he is not vaccinated against yellow fever or COVID-19. This is notable considering the common engagement of faith leaders in sensitisation and vaccination campaigns in DRC. Fuelling these safety concerns, rumours circulated about injections causing epidemics or death. The story of a church pastor who had taken a vaccine and then suffered grave side effects, leading to his death, was recalled multiple times. However, in the story, the vaccine sometimes was portrayed to be against COVID-19, and sometimes against yellow fever.

"But the vaccine that caused a lot of problems today is the COVID-19 vaccine. It caused too many deaths when it came, and it caused the deaths of people I know. They took it, and in the morning, they were found dead [...]. I did not get vaccinated." (Religious leader, man, interview, March 2023)

2. Perceptions of the EBL2007 trial vaccine

Positive perceptions: Fear of Ebola disease and death as a main driver

³ Relais communautaires are community members who received training in health communication and volunteer to inform the rest of the community on different health topics like (non)communicable diseases and vaccination.

of Ebola vaccine acceptance.

Overall, the EBL2007 trial vaccine was perceived as beneficial because its aim was believed to be protection from Ebola in the area. This attitude seemed to be particularly strong after witnessing death during the 2014 Ebola outbreak in the Boende Health Zone.

“We all know the harm that Ebola caused here. We had no fears [when the EBL2007 trial started], rather we considered this as a way of healing” (Market vendor, man, FGD, July 2022).

“It is a bit as if we were here outside and it was raining, and all of a sudden an umbrella came to cover and protect us” (Restaurant manager, interview, woman, July 2022).

The fact that only HCPs were recruited as trial participants caused some disappointment because a larger portion, if not the entirety, of the population of Boende, was said to expect to receive the vaccine. This also highlights people’s desire to be vaccinated in order to obtain protection:

“We thought that these vaccines would arrive and be given to the entire population of the Tshuapa province. But they only gave [them] to HCWs. We could just observe” (Market vendor, man, FGD, July 2022).

Negative perceptions: Suspicions about the vaccine development process and target populations.

When interviewees knew that the vaccine was part of a clinical trial, and was therefore not being given to the entire community, the vaccine was sometimes said to have skipped animal testing and been tested on humans directly.⁴

Distrust in the vaccine also stemmed from the fact that Ebola was sometimes considered less worrying because less prevalent than other diseases.

“You see how [often] we get malaria, and they do not give us any vaccines against malaria; why only for this? It is only for diseases that we do not see that they bring us vaccines” (Restaurant manager, woman, interview, July 2022).

Questions surrounding the Ebola trial vaccine were further backed by doubts regarding the choice of the DRC as a trial location. The presence of international researchers in Boende might have raised suspicions about foreigners opting for the DRC as a trial site and Congolese as trial participants, instead of considering other countries, for instance in Europe.

“Why do the whites⁵ come to do their vaccine study only in the DRC? In their own countries, are they also vaccinated?” (Market vendor, woman, FGD, March 2023)

3. Perceptions of childhood vaccines

While the study participants voiced opinions, worries, and recommendations in response to questions about the Ebola trial vaccine and adult vaccines in general, a predominant focus on childhood vaccines emerged when they were talking or giving examples about vaccines. This likely reflects the population’s greater familiarity with these childhood vaccines due to their longer inclusion in state-provided health services, unlike previously mentioned vaccines, which are mainly rolled out in special outbreak situations.

Positive perceptions: Vaccines protect children from diseases.

In general, childhood vaccines seemed to be well-trusted among the participants. The measles vaccine was the most frequently recalled when vaccines were mentioned in the interviews and FGDs. This could be due to the high number of cases and deaths that the virus causes, as well as the recurrent vaccination campaigns against it.

“The vaccine is good; since when I gave birth to my children and until one

⁴ This was mentioned in FGDs with non-participant female nurses (2) and with Human rights NGO representatives (1).

⁵ “White” in this context could mean EBOVAC3 staff from the University of Antwerp involved in the EBL2007 vaccine trial in Boende. It could also refer to staff from the US Centre for Disease Control and prevention (CDC) who conducted an Mpox vaccine trial in the same town in 2017 [26].

[of them] turned 12 years old, it has not caused anyone to fall ill with measles, so it is good, we cannot refuse [it].” (Market vendor, woman, FGD, March 2023).

Negative perceptions: Vaccines and diseases, a correlation or causation?

Some participants echoed preoccupations and doubts about childhood vaccines as well, mainly based on the belief that vaccines cause diseases. This belief derived from either personal bad experiences with children’s vaccination or rumours and bad experiences of other community members for instance, when a child became very sick after or around the time of vaccination.

“Two days after the vaccine, the child had malaria; after malaria, he started to have high fevers; [...]. This is why I do not like that they vaccinate; they pass, but I do not vaccinate my children anymore.” (Taximan who lost a child, FGD, March 2023).

Many parents expressed worries about the side effects associated with childhood vaccination (e.g., fever, pain at the injection site) and some even voiced concerns about malaria and anaemia episodes, which are allegedly caused by the vaccine and lead to hospital stays.

“[My kids] grow up just like that, just as I take care of them and [by the help of] divine god, but I don’t vaccinate my children so as not to spend days in the hospital.” (Housewife, FGD, March 2023).

While a majority of parents reported that vaccinators had informed them of potential side effects like fever or pain at the injection site, some parents still viewed coincidental illness following vaccination as evidence of causation. This perception contributed to vaccine hesitancy within the community, as participants equated the timing of illness with vaccine effects.

Negative perceptions: Consequences of logistical challenges to deliver vaccines.

Another set of reasons for distrust stemmed from the infrastructure and human resources components of a vaccination activity, especially in rural settings. Primarily, some participants were worried about the preservation and transportation conditions of vaccines allocated to remote villages. This is caused by the challenging geographical location and lack of infrastructure in the area, where heading from Boende to some health centres requires crossing rivers and forests with almost no proper roads for a sizeable part of the journey. This preoccupation was also voiced by the chief medical officer of the Expanded Program on Immunization (EPI) in the Tshuapa province. Additionally, concerns regarded HCPs in charge of vaccination activities who allegedly prioritised the submission of coverage reports over ensuring vaccines’ validity.

“I had seen with my own eyes that the vaccine had been thrown away, and the children are developing side effects,⁶ I have seen children with deafness. Here [in Boende town], measles causes little damage but [in the villages] it is a problem; even the IT⁷ does not verify [vaccination activities], they only seek to provide reports but do not monitor the vaccines; the roads are not in good condition, which is why they arrive late; [...] there are no refrigerators, that is what worries me.” (Housewife, FGD, March 2023).

“The vaccines leave Kinshasa and arrive at the provincial level; from the provinces to the villages, it is where [the process of vaccine delivery] gets blocked. [Health officials at the (inter)national level] see the provincial capitals, they see the small provincial towns, they think [vaccinating the population] is accomplished. They say: ‘I have sent it to the province, that is enough’. It is not the province that benefits when it comes to vaccines, it is the community, until the last person [who needs to be vaccinated]. Even in the forest, and in the smallest villages.” (Chief medical officer of EPI in Tshuapa province, man, interview, March 2023).

Negative perceptions: Vaccines and white people.

Furthermore, questions about the vaccines’ objectives and intended

⁶ The interviewee probably meant symptoms of measles instead of side effects, as the disease has been associated with hearing loss in some cases.

⁷ IT: *infirmier titulaire* = registered nurse at the head of a health centre.

recipients were posed by interviewees. Concerns about racial disparities arose, with some individuals wondering whether these vaccines were exclusively administered to black African populations in low-income countries, or were universally available. Notably, the widespread portrayal of children from black communities in national and social media channels, within the framework of vaccination campaigns and general health promotion activities, seemed to raise queries about whether vaccines were given to white populations. These concerns were primarily related to childhood vaccines. Participants noted the visibility of white adults receiving the COVID-19 vaccine, yet questioned whether the same recommendations applied to childhood routine vaccination.

“The COVID-19 vaccine for adults, we have seen that; but what about children? Are white children also getting vaccinated? Because I have never seen a white child being vaccinated [...], not even on vaccination calendars. It is always Africans getting vaccinated.” (Market vendor, woman, FGD, March 2023).

On the other hand, some of the participants who believed that white populations get vaccinated questioned whether people in different countries receive the same vaccine.

“Is the vaccine that they sent to us the same vaccine that Europeans have used? Or was it sent only to Africa, so that Africans can use it?” (Taximan, FGD, March 2023).

4. Vaccine uptake, good practices, and suggestions to increase vaccine acceptance

Although many interviewees voiced concerns about childhood vaccines, the majority of participants had their own kids (or the kids of their family members) vaccinated. Furthermore, people stressed the fact that although side effects scare them, they do not categorically refuse vaccines.

“We do not refuse vaccines, whether for children or adults, [...] even the COVID vaccine. Some people have already been vaccinated, and even I have to get vaccinated, even though I am afraid it could lead to other things happening to me.” (Market vendor, woman, FGD, March 2023).

When asked what could facilitate (childhood) vaccination, many people mentioned good practices witnessed in Boende, like passing information about vaccination campaigns using megaphones in the streets. This was particularly appreciated at night or around 5 a.m. when the town is still quiet and most people have not left for their jobs yet. Another appreciated vaccination information source was the radio, at the same times of the day. Additionally, house-to-house vaccination was preferred to calling people to come to vaccination centres.

“What is good is like [what they did in the] the recent polio vaccination: they went house by house to see how many children of such [...] age were there, and wrote on the walls [of the house] [...] to know that the child has been vaccinated. The ‘house by house’ way is better than calling to [vaccination] centres because many people do not show up [there]”. (Housewife, FGD, March 2023).

In order to increase public trust in vaccines, several interviewees praised the fact that the head of the Boende General Reference Hospital took the COVID-19 vaccine in public. Some interviewees suggested publicising other vaccination activities in the presence of healthcare providers who would receive the vaccine in front of the public.

“The best way to ensure that we listen carefully to doctors and physicians, before advertising that we can be vaccinated, is that they come and take [the vaccine themselves], so we see that they and their children are exemplary.” (Housewife, FGD, March 2023).

Another suggestion was to include pictures of white adults and children being vaccinated in vaccination campaigns and other forms of vaccine communication, to reassure people that immunization programmes run worldwide.

“If you have, for example, a vaccination [campaign/activity] that involves people with white skin, please put that in the awareness material. So that we have images of a white child being vaccinated.” (Journalist, man, interview, March 2023).

4. Discussion and recommendations

In this study, we explored perceptions and attitudes towards both childhood and adult vaccines in Boende. We found lower levels of confidence in adult vaccines than in childhood vaccines. Our results align with the findings of other studies conducted in the DRC among both the general community and healthcare providers. These studies have similarly shown outbreak response vaccines, particularly the COVID-19 vaccine, tend to be less trusted, compared to routine childhood vaccinations [16,17]. Reports have shown that the DRC has one of the lowest COVID-19 vaccine confidence and uptake levels in the African continent and that trust levels have even decreased between 2020 and 2022 [10,27]. The confidence situation in the country is complex and several factors could contribute to this, which are often also applicable in other countries, such as distrust in the healthcare system, corruption, and challenges related to vaccine production and accessibility [11,28]. However, also country-specific factors could have exacerbated this phenomenon; for example, the volatile political scene at the time of the vaccine rollout, as well as an Ebola outbreak between 2018 and 2020 that killed more than 2000 people in over a year and a half [29,30]. For reference, the reported number of COVID-19-associated deaths in the country is around 1500 (in three and a half years of surveillance) [10]. While COVID-19 deaths, and to a lesser degree Ebola deaths, are likely to have been underestimated, these numbers suggest that COVID-19 was not as much of a health threat in the DRC compared to other countries, and compared to the Ebola outbreak in the country. The relatively low number of reported cases and deaths, coupled with a soaring high number of cases and deaths from other diseases like Ebola, malaria, and tuberculosis, could partially explain the low levels of trust in and uptake of the COVID-19 vaccine [31]. Therefore, it could be challenging to convince people to protect themselves from a threat that they do not see, like COVID-19.

We could not widely explore attitudes towards Ebola vaccines as none were rolled out in Boende town outside of the EBL2007 vaccine trial context. We could only briefly explore the knowledge and perceptions of people who were aware of the vaccine trial that took place in Boende between 2019 and 2022 [22]. The majority of the people who had some knowledge about the candidate vaccine reported that they would take it -if given the chance- out of fear of dying. Quantitative studies conducted in Nigeria and Guinea about the acceptability of a hypothetical Ebola vaccine have also shown moderate to high acceptance rates due to the disease’s perceived lethality [32,33]. However, it is important to highlight that perceptions and attitudes towards the vaccine could be different in the case of an active outbreak. According to Doshi and colleagues, 99 % of HCPs who worked in an Ebola-affected area in the DRC during the 2018 outbreak self-reported to have taken the vaccine, as they recognised that they were in danger of contracting the disease [34]. Additionally, within the scene of an Ebola vaccine trial during an active outbreak (2018–2020) in the east of the DRC, protection from the disease was also found to be one of the primary goals of participating [35]. This also suggests a proportional relationship between the perceived degree of lethality of a disease and the acceptability of a vaccine against it.

Increasing vaccine confidence is a key pillar in building epidemic preparedness. This is a challenging task that is highly context-specific. Based on our results, we elaborated specific and actionable recommendations that could help increase trust in vaccines in areas like our study region (Tshuapa province). Each recommendation is followed by a brief contextualisation derived from the literature and our study observations.

1. Knowledge dissemination of vaccine-associated adverse events is key.

Many of our study participants believed that vaccines were a reason for diseases like malaria and anaemia. Information about this could be

provided when vaccinating children, or during awareness sessions that usually take place around the time of vaccination activities. Additionally, attention should be paid to people's concerns on the topic, in order to see which diseases specifically are associated with vaccination in public opinion, and why that could be. This may help to better tailor sensitisation messages to the needs of the population.

- Representation of individuals from various skin colours and countries in vaccine-related communication can help dispel suspicions and reassure communities.

Rumours and conspiracy theories about vaccines' origins and goals are a global problem that threatens vaccine uptake in different countries [15]. The reasons for such mis/disinformation are numerous and occasionally context-dependent. In general, people do not adopt conspiracy theories about medical approaches without a reason or a logic behind them. In countries that endured colonisation, like in sub-Saharan Africa, vaccine hesitancy may be compounded by historical trauma from colonial atrocities and/or unethical clinical trials lacking valid informed consent [36,37]. Fears of sterilisation are also common after practices like eugenics, the administration of contraceptives to black women in South Africa during the Apartheid, or the sterilisation of HIV-positive women in different African countries [38,39]. Moreover, while many international guidelines call for ethnically representative (or inclusive) and culturally sensitive forms of health communication, for many of our study participants, showing only black adults and children in vaccine-related health communication inadvertently led to suspicions around the target population.

- When recruiting for late-stage clinical trials, it could be helpful to inform potential participants about where the initial stages of the trial were conducted.

Addressing concerns and misinformation about the concentration of vaccine trial sites in Africa and the lack of pre-trial testing for target interventions is crucial to avoid drops in trial participation and vaccine confidence. To that end, it could be feasible to show that most investigational products with phase 2 and 3 trials in African countries have often undergone phase 1 trials in non-African countries, especially the US, China, and the UK [40]. This is a point that is not exclusive to vaccines but extends to clinical trials in general.

- Healthcare providers or authority members could be vaccinated and vaccinate their children in a public space, for other community members to see.

Vaccine hesitancy among healthcare providers is a well-documented issue that threatens to lower general vaccine confidence levels in communities worldwide [17,41]. Some of our study participants appreciated the hospital director taking the COVID-19 vaccine at the market, where everyone could see him, as this initiative encouraged other people to take the same vaccine. This approach could be used for both adult and childhood vaccines.

5. Limitations

We acknowledge that answers to interview and FGD questions might have been influenced by desirability bias. It is important to be clear about this aspect for a better interpretation of the results. FB and the interpreter were Congolese medical doctors by profession with the latter actively practicing at Boende General Hospital. This professional association might have encouraged participants to show confidence in vaccines. Moreover, a large part of the interviews and focus groups were conducted by researchers affiliated with the University of Antwerp (sponsor of the EBOVAC3 trial) and perceived as white, which may have influenced participants' answers to questions on vaccine confidence,

and perceptions of vaccines in "rich countries" and for "white people". The presence of international researchers may have shaped discussions in different ways: it could have encouraged participants to focus on vaccines in the interviewers' countries of origin, deterred them from discussing certain topics, or prompted them to express more favourable opinions about vaccines. While our data suggest that participants appeared comfortable voicing concerns, it is important to acknowledge that we cannot be certain of this. To mitigate these influences, the research team included both international and local researchers. The local team members provided a familiar presence, which helped participants feel at ease when discussing sensitive topics, such as the Ebola trial and related rumours, that might have been harder to approach with international researchers. Additionally, our study was only conducted in Boende town, which could be considered as a semi-urban setting. Study participants in Boende talked about lower levels of trust and uptake in the villages, which we could not qualitatively investigate because of time constraints. We conducted nonetheless a vaccine confidence survey, targeting mainly rural areas in Boende Health Zone whose results (currently under analysis) could provide information on this.

6. Conclusion

In our study, we explored perceptions of and attitudes towards different vaccines in Boende town in Tshuapa province of the Democratic Republic of the Congo. Generally, confidence in vaccines was relatively high, especially in childhood vaccines. We found the key issues to revolve around lower trust in adult vaccines, particularly the COVID-19 vaccine; concerns about side effects; correlations of other diseases with childhood vaccines; and uncertainties about the source, and target population associated with vaccines. It is important to recognise vaccine confidence as a dynamic concept influenced by various factors such as past experiences (with healthcare providers), disease outbreaks, as well as local medical and political authorities. This highlights the importance of continuous assessments of confidence levels in different regions of the world to be able to address potential drops in a timely and context-tailored manner. Additionally, addressing the global challenge of increasing vaccine uptake requires a comprehensive multifaceted approach. In the DRC, enhancing vaccine confidence is one aspect, but challenges in access pose significant hurdles. Funding limitations, inadequate road infrastructure, and surveillance issues in maintaining local cold chains represent substantial barriers. A multidisciplinary effort is imperative to ensure the successful delivery of vaccines to all health centres and their administration to those who need them, ultimately contributing to improved public health outcomes.

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CRedit authorship contribution statement

Maha Salloum: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization. **Antea Paviotti:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Trésor Zola Matuvanga:** Writing – review & editing. **Gwen Lemey:** Writing – review & editing, Project administration. **Freddy Bikioli Bolombo:** Writing – review & editing. **Vivi Maketa:** Writing – review & editing, Funding acquisition. **Hypolite Muhindo-Mavoko:** Writing – review & editing, Funding acquisition. **Pierre Van Damme:** Writing – review & editing, Funding acquisition. **Patrick Mitashi:**

Writing – review & editing, Funding acquisition. **Jean-Pierre Van Geertruyden**: Writing – review & editing, Supervision, Funding acquisition. **Hilde Bastiaens**: Writing – review & editing, Supervision, Methodology.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the author(s) used Google's Gemini in order to enhance the readability and flow of certain sentences. After using this tool, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

All authors reports financial support was provided by Innovative Medicines Initiative 2. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The authors do not have permission to share data.

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Appendix A. Supplementary data

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