# COVID-19 Vaccine Uptake, Knowledge and Perceptions Among People Living with HIV in Livingstone District, Zambia: A Mixed-Methods Study

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## ABSTRACT

**Background:** People living with HIV (PLWH) are at increased risk of severe COVID-19 outcomes, yet limited evidence exists on their vaccine-related knowledge, attitudes, and uptake in Zambia. This study assessed COVID-19 vaccination prevalence and examined the factors shaping vaccine behaviors among PLWH attending ART services in Livingstone District, Zambia.

**Methods:** We employed a cross-sectional mixed-methods design at Mahatma Gandhi Clinic from April to June 2022. Systematic random sampling (every third patient) was used to select 384 PLWH aged ≥18 years from a clinic population of 2,197. Quantitative data on vaccine uptake, knowledge, and perceptions were collected via structured interviews. Purposive sampling selected 20 participants for in-depth qualitative interviews exploring attitudes and explanatory narratives. Descriptive statistics and multivariable logistic regression identified predictors of vaccination; qualitative data were analyzed using Braun and Clarke's thematic analysis framework.

**Results:** Vaccination prevalence was 78.9% (303/384; 95% CI: 74.5%-82.8%). Knowledge and positive perceptions were widespread: 97.1% knew COVID-19 had no cure, 98.2% recognized vaccines as preventive, and 99.5% were aware of vaccine availability. Most perceived vaccines as safe (97.1%), effective (96.4%), beneficial to all (97.9%), and trusted manufacturers (96.6%). Multivariable logistic regression identified significant negative predictors of uptake: perceiving vaccines as not beneficial to all (AOR = 5.41, 95% CI: 1.20-24.32, p=0.028), distrust of manufacturers (AOR = 3.48, 95% CI: 1.43-8.48, p=0.006), belief that vaccination controls human activities (AOR = 2.31, 95% CI: 1.10-4.85, p=0.027), and belief that suppliers act in bad faith (AOR = 2.39, 95% CI: 1.13-5.05, p=0.022). Qualitative analysis revealed three themes: 1) Trust in biomedical authority ("it has been approved medically"); 2) Genocidal conspiracy beliefs ("they have intentions of wiping out the entire Africa"); and 3) Vaccination as social control ("to stop us from going to church").

**Conclusions:** While COVID-19 vaccine uptake among PLWH in Livingstone is high and grounded in trust in medical approval, a significant minority remain hesitant due to deep-seated conspiracy beliefs framing vaccination as a tool for population control and harm. This dual reality must inform targeted interventions leveraging trusted healthcare relationships within ART programs.

**Keywords:** HIV, COVID-19 vaccination, vaccine uptake, vaccine hesitancy, mixed-methods, conspiracy beliefs, Zambia

## INTRODUCTION

As a highly contagious disease first reported in Wuhan, China, in December 2019, coronavirus disease 2019 (COVID-19) rapidly became a global pandemic causing substantial mortality worldwide [1]. The disease spreads via respiratory droplets from coughing and sneezing and is particularly severe in people with comorbidities [2].

Studies from Wuhan among people living with HIV (PLWH) found that low CD4+ T-lymphocyte counts were associated with higher likelihood of COVID-19 diagnosis [2].

Globally, more than 38 million people live with HIV, approximately 25 million in sub-Saharan Africa, with roughly 26 million on antiretroviral therapy (ART), most in the region [3]. While ART suppresses viral replication, it does not eradicate HIV, and viral reservoirs remain inaccessible to current drugs [4]. HIV continues to cause substantial morbidity and mortality, an estimated 37 million infected and about one million deaths annually [5], and outcomes worsen with comorbidity such as COVID-19 [6].

Evidence on whether PLWH face higher COVID-19 mortality remains mixed in Europe and the USA [7], but South African and Zambian data indicate substantial COVID-19 deaths among PLWH [8]. National surveillance in South Africa (DATCOV) reported 219,265 COVID-19 hospital admissions with 51,037 (23.3%) deaths among patients with comorbidity; HIV was recorded in 13,793 of 151,779 patients [9]. In Zambia, a study at University Teaching Hospital found that 23% of PLWH patients died of COVID-19/HIV co-infection [6].

### Problem Statement

COVID-19 has no cure; prevention, including vaccination, remains central [1]. Although PLWH are particularly vulnerable to poor SARS-CoV-2 outcomes, little is known about COVID-19 vaccine behaviors, attitudes, and motivators among PLWH in Zambia. This knowledge gap impedes the design of tailored interventions to counter mistrust and conspiracy beliefs that threaten vaccine uptake and efforts to reduce morbidity and mortality in this high-risk group.

### General Objectives

This study aimed to examine COVID-19 vaccine uptake and the factors shaping vaccine-related behaviors, knowledge, perceptions, and attitudes among PLWH in Livingstone District, Zambia. The specific objectives were:

1. To determine the extent of COVID-19 vaccine uptake among PLWH in Livingstone District.
2. To examine factors that explain vaccine behaviors, perceptions, and attitudes towards COVID-19 vaccines among PLWH.

### Research Questions

What is the prevalence of COVID-19 vaccination among PLWH attending ART services at Mahatma Gandhi Clinic in Livingstone District?

What knowledge, perceptions, and attitudes towards COVID-19 vaccines are held by PLWH?

What factors (sociodemographic, knowledge-related, and perceptual) are associated with COVID-19 vaccine uptake?

What narratives and beliefs support vaccine acceptance and hesitancy among PLWH?

## LITERATURE REVIEW

### COVID-19 and HIV Co-infection

COVID-19, caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), spreads through droplets from infected persons, causing severe acute respiratory distress [10]. People with chronic comorbidity and HIV are more susceptible to SARS-CoV-2 infection and to experiencing its severe effects [11]. By December 2021, globally, 268,501,588 COVID-19 cases and 5,286,843 deaths were reported [12].

Health systems already burdened with HIV/AIDS and malaria [13] have been overwhelmed with COVID-19 cases [10]. Disease severity data analysis among 236 participants, of whom 39% were living with HIV, revealed that PLWH required more oxygen than HIV-negative participants [14]. Severity increases among PLWH with low CD4 counts, and most PLWH over age 50 have other comorbidities, placing them at greater risk [15].

### COVID-19 Vaccine Development and Rollout

To combat COVID-19 spread, vaccines were rapidly developed. The World Health Organization (WHO), having declared COVID-19 a pandemic, promoted vaccination as the primary means to avert spread [16], with global reductions in COVID-19 cases observed [17]. However, not all regions benefited equally; Africa and South-East Asia suffered from high HIV mortality and increased COVID-19 cases, with transmission rates increasing by 44% weekly while deaths rose by 20% [17].

### Vaccine Uptake and Hesitancy Among PLWH

Understanding uptake, behavior, attitude, and perception of PLWH towards COVID-19 vaccines is critical. A study in China found that among 903 PLWH, 72.9% (658) were willing to receive COVID-19 vaccine; fear of infection drove acceptance, while unwillingness related to vaccine safety (54.7%) and concerns about effects on ART (50.6%) [18]. Another Chinese online cross-sectional survey involving 556 PLWH and 570 HIV-negative individuals found COVID-19 vaccination willingness at 60.8% among PLWH, lower than 80.9% in the general population [12]. Among 1,735 PLWH aged 18-85 years, 41.61% (722) were hesitant to be vaccinated [19].

## THEORETICAL FRAMEWORK

This study was guided by the Health Belief Model (HBM), which posits that health behaviors are influenced by perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy [20]. The HBM is particularly relevant for understanding vaccine uptake, as it explains how individuals' beliefs about COVID-19 susceptibility, vaccine benefits, and barriers (including mistrust) shape vaccination decisions.

## METHODOLOGY

### Study Design

A cross-sectional mixed-methods design was employed, combining quantitative surveys with qualitative in-depth interviews. This approach allowed for data triangulation, integrating statistical findings with explanatory narratives to provide a comprehensive understanding of vaccine behaviors among PLWH.

### Study Site

The study was conducted at Mahatma Gandhi Clinic in Livingstone District, Southern Province, Zambia, from April to June 2022. The clinic provides routine antiretroviral therapy (ART) services to PLWH. Livingstone was selected because it is Zambia's tourist capital, attracting diverse populations including sex workers and truck drivers, key populations in HIV transmission. The town serves as a hub linking four border posts with Zimbabwe, Botswana, and Namibia, making it a high-transit area with significant HIV prevalence.

### Sampling Frame and Sample Size Calculation

The sampling frame consisted of all 2,197 PLWH actively receiving ART and registered with patient files at Mahatma Gandhi Clinic as of April 2022. Sample size was calculated using the formula: $n = N / (1 + N(e)^2)$, where N = population size (2,197) and e = margin of error (0.046), yielding a required sample of 385 participants at 95.4% confidence level.

### Eligibility Criteria

**Inclusion criteria:** Aged 18 years or older. Confirmed HIV-positive status and actively receiving ART at Mahatma Gandhi Clinic. Physically traceable and available during data collection period. Provided informed consent to participate.

**Exclusion criteria:** Individuals below 18 years. PLWH not registered at Mahatma Gandhi Clinic. Those who could not be physically traced after three attempts. Individuals unable to communicate or provide informed consent due to severe illness.

**Sampling Procedures**

**Quantitative Sampling:** Systematic random sampling was employed. On each data collection day, the first participant was selected by randomly choosing a number between 1 and 3. Subsequently, every third patient who registered for ART services and met eligibility criteria was approached for participation. If a selected patient declined or was ineligible, the next patient in sequence was approached, and the sampling interval was reset. This process continued until the target sample size was achieved.

A total of 437 patients were approached. Of these, 385 initially consented (response rate: 88.1%). After data cleaning, 384 complete and valid questionnaires were retained for final analysis (effective response rate: 87.9%). Primary reasons for non-participation included: time constraints (n=28, 53.8%), concerns about confidentiality (n=12, 23.1%), feeling too ill (n=8, 15.4%), and no reason given (n=4, 7.7%). Demographic comparison between participants and non-participants (where file data were available) showed no significant differences in age ($p=0.42$) or sex ($p=0.38$), suggesting minimal non-response bias.

**Qualitative Sampling:** For the qualitative component, purposive sampling was employed to select 20 participants from the larger quantitative survey, ensuring maximum variation in perspectives based on vaccination status, age, sex, and education level. Specifically: 10 participants were selected from those who reported being vaccinated and 10 were selected from those who reported being unvaccinated. Within each group, selection aimed to include a mix of males and females, younger (18-35) and older (36+) participants, and varying education levels (primary, secondary, tertiary)

Sample size for qualitative interviews was guided by the principle of data saturation, the point at which no new themes or insights emerged from subsequent interviews. Saturation was achieved by the 18th interview; however, all 20 planned interviews were completed to confirm saturation.

**Data Collection Instruments**

**Quantitative Questionnaire:** A structured questionnaire was developed in English based on literature review and adapted to the local context. The questionnaire comprised four sections: Section A: Sociodemographic characteristics (age, sex, education level), Section B: Knowledge about COVID-19 and vaccines (5 items with yes/no responses), Section C: Perceptions and attitudes towards COVID-19 vaccines (12 items with yes/no responses) and Section D: Vaccination status and intentions.

The questionnaire was pre-tested with 20 PLWH at a nearby clinic (not part of the main study) to assess clarity, length, and cultural appropriateness. Minor wording adjustments were made based on feedback. The pre-test data were not included in the final analysis.

**Qualitative Interview Guide:** A semi-structured interview guide was developed to explore participants' experiences, beliefs, and attitudes regarding COVID-19 and vaccination in greater depth. The guide included open-ended questions such as: "*Can you tell me about your decision to get or not get the COVID-19 vaccine*?" "*What have you heard about the vaccine from your community, family, or friends*?" "*How do you feel about the organizations that make and supply the vaccines*?" "*What would help you or others in your community feel more confident about vaccination*?" Probes were used to explore emerging topics and clarify responses.

**Data Collection Procedures**

**Research Assistant Recruitment and Training:** Three research assistants were recruited based on the following criteria: (1) completion of at least a bachelor's degree in social sciences or a health-related field; (2) fluency in English, Tonga, and Nyanja (the predominant local languages); (3) prior experience in community-based research; and (4) familiarity with HIV/AIDS and ART services.

Research assistants underwent a comprehensive two-day training program conducted by the principal investigator. Day one covered: study objectives and design; ethical principles including confidentiality, informed consent, and the right to withdraw; techniques for building rapport with PLWH; and practice in administering the quantitative questionnaire. Day two focused on qualitative interview techniques: active listening, probing without leading, managing sensitive disclosures, and using the semi-structured interview guide. Role-playing

exercises were conducted with feedback provided. A standardized interview protocol was developed and distributed to all assistants. All research assistants achieved >90% inter-rater reliability on mock interviews during training.

**Quantitative Data Collection:** Quantitative data were collected through face-to-face structured interviews conducted in a private room within the clinic to ensure confidentiality. The questionnaire was verbally administered in the participant's preferred language (English, Tonga, or Nyanja) by trained research assistants. Each interview lasted approximately 20-25 minutes. Participants were given the option to complete the questionnaire themselves or have it read to them; all participants opted for the interview format due to literacy considerations or preference.

Completed questionnaires were reviewed on-site for completeness before participants departed, allowing for immediate clarification of missing or inconsistent responses. The principal investigator conducted daily debriefing sessions with research assistants to review completed interviews, address challenges, and ensure protocol adherence. A random 10% of interviews were observed by the principal investigator to monitor quality.

**Qualitative Data Collection:** Following the quantitative interview, participants selected for the qualitative sub-study were invited to participate in a semi-structured in-depth interview. These interviews were conducted in a separate private room, audio-recorded with participant consent, and lasted between 30 and 60 minutes. Interviews were conducted in the participant's preferred language (English, Tonga, or Nyanja). Field notes were taken during and immediately after each interview to capture non-verbal cues and contextual observations.

**Data Management and Storage:** All quantitative data were double-entered into a secure Microsoft Excel database by two independent data entry clerks. Discrepancies were resolved by referring to the original questionnaires. The final dataset was exported to SPSS version 26 for analysis.

Audio-recorded qualitative interviews were transcribed verbatim within 48 hours in the original language (Tonga or Nyanja) and then translated into English by the research assistants. A random 20% of transcripts were checked against the original recordings for accuracy by a second researcher. All transcripts were anonymized using participant codes and imported into NVivo 12 software for analysis.

All data were treated as confidential and used only for research purposes. Physical documents were kept in a locked cabinet, and electronic data were password-protected, accessible only to the principal investigator and supervisor.

**Variables**

Dependent Variable: The primary outcome variable was COVID-19 vaccination uptake, defined as having received at least one dose of any COVID-19 vaccine, a binary variable.

Independent Variables: Sociodemographic variables: Age (continuous and categorized), sex (male/female), education level (categorical: illiterate, primary, secondary, tertiary, professional)

Knowledge variables: Knowledge that COVID-19 has no cure (yes/no); knowledge that COVID-19 is preventable through vaccination (yes/no); awareness of vaccine availability (yes/no)

Perception variables: Perceptions of vaccine safety (yes/no); vaccine effectiveness (yes/no); vaccine side effects (yes/no); personal benefit (yes/no); benefit to all (yes/no); impact of non-vaccination on others (yes/no); ability of vaccines to end the pandemic (yes/no); trust in manufacturers (yes/no); belief in ill intentions (yes/no); belief in control of human activities (yes/no); trust in suppliers' good faith (yes/no).

**Data Analysis**

**Quantitative Data Analysis:** Quantitative data were analyzed using SPSS version 26. Analysis proceeded in three stages:

Stage 1: Descriptive Statistics: Frequencies and percentages were calculated for all categorical variables (sex, education level, knowledge questions, perception items, and vaccination uptake). For continuous variables (age),

mean, median, standard deviation, and interquartile range were computed. Vaccination prevalence was calculated with 95% confidence intervals.

Stage 2: Bivariate Analysis: Chi-square tests were used to examine associations between categorical independent variables and vaccination uptake. For age (continuous variable), the Mann-Whitney U test was used to compare median age between vaccinated and unvaccinated groups. Variables with $p < 0.20$ in Bivariate analysis were considered for inclusion in multivariable regression.

Stage 3: Multivariable Analysis: Binary logistic regression was performed to identify independent predictors of vaccination non-uptake (dependent variable: unvaccinated = 1). Variables significant at $p < 0.20$ in Bivariate analysis, along with variables of theoretical importance (age, sex), were entered into the multivariable model. Adjusted odds ratios (AOR) with 95% confidence intervals were calculated. Statistical significance was set at $p < 0.05$.

**Qualitative Data Analysis**

Qualitative data analysis followed the six-phase thematic analysis framework proposed by Braun and Clarke (2006) [21]:

Phase 1: Familiarization with the data. The principal investigator read and re-read all transcripts multiple times to note initial impressions and potential patterns.

Phase 2: Generating initial codes. Two researchers (the principal investigator and one research assistant) independently coded the first five transcripts using open coding. Codes were descriptive labels attached to segments of text relevant to the research questions (e.g., "fear of reduced lifespan," "trust in medical approval," "influence of religious leaders").

Phase 3: Searching for themes. The preliminary coding framework was applied to all transcripts using NVivo 12 software. Codes were grouped into potential themes by identifying patterns, relationships, and recurring ideas. For example, codes such as "vaccines reduce lifespan," "*manufacturers want to wipe out Africa*," and "*vaccines are population control*" were clustered under a candidate theme of "*Genocidal conspiracy beliefs*."

Phase 4: Reviewing themes. Potential themes were reviewed and refined through an iterative process which involved checking that each theme was coherent, distinct from others, and grounded in the data. Themes were discussed with the research team, and a thematic map was developed.

Phase 5: Defining and naming themes. Each final theme was clearly defined, and a detailed narrative was written explaining its scope and meaning.

Phase 6: Producing the report. Quotes were selected to illustrate each theme based on two criteria: (1) representativeness, the quote clearly and vividly expressed a view common among participants; and (2) diversity, quotes were selected from participants of different ages, sexes, and vaccination statuses to reflect the range of perspectives.

**Ensuring rigor:**

Investigator triangulation: Two researchers independently coded data and met regularly to discuss findings.

Member checking: Preliminary findings were presented to a small group of participants (n=5) who confirmed that the themes resonated with their experiences.

Audit trail: Detailed documentation of coding decisions, theme development, and analytical memos was maintained throughout the analysis.

**Ethical Considerations**

Ethical approval was obtained from the Mulungushi University School of Medicine Ethics Committee. Permission was also granted by the Livingstone District Health Office and the clinic management at Mahatma

Gandhi Clinic. Further approval by the National Health Research Authority of Zambia was obtained on 13th April 2022: Ref No: NHRA0000013/13/04/2022.

All participants were provided with detailed information about the study purpose, procedures, risks, and benefits. Written informed consent was obtained from all participants before data collection. For participants with limited literacy, the information sheet and consent form were read aloud in their preferred language, and verbal consent was documented.

To ensure confidentiality, all participants were assigned unique study identification codes. No personal identifiers were used in data entry, analysis, or reporting. Participants were assured that they could withdraw from the study at any time without affecting their access to healthcare services. No financial incentives were provided, though participants received refreshments during the interview as a token of appreciation.

## RESULTS

### Participant Characteristics

A total of 384 PLWH participated in the quantitative survey. Table 1 presents the sociodemographic characteristics of participants stratified by vaccination status.

Table 1. Sociodemographic Characteristics and Vaccination Status of Participants (N=384)

| **characteristics** | | **Total** | **Vaccine uptake** | | **P value** |
|---|---|---|---|---|---|
| | | Median (IQR) or n % | Median (IQR) or n % | | |
| | | | Vaccinated | Unvaccinated | |
| Age / Years | | 38 (30, 44) | 37.0 (29.3, 44.0) | 39.0 (30.0, 45.5) | 0.393 |
| Sex | Male | 155 (40.3) | 132 (43.4) | 23 (28.4) | 0.014 |
| | Female | 230 (59.7) | 172 (56.6) | 58 (71.6) | |
| Education | Illiterate | 13 (3.4%) | 8 (2.6%) | 5 (6.2%) | 0.273 |
| | Primary | 151 (39.2%) | 114 (37.5%) | 37 (45.7%) | |
| | Secondary | 199 51.7%) | 164 (53.9%) | 35 (43.2%) | |
| | Tertiary | 18 (4.7%) | 15 (4.9%) | 3 (3.7%) | |
| | Professional | 4 (1.0 %) | 3 (1.0 %) | 1 (1.2%) | |

[1]Mann-Whitney U test; [2]Chi-square test

The median age of participants was 38 years (IQR: 30-44). Females constituted the majority (59.9%, n=230). Most participants had secondary education (51.6%), followed by primary (39.3%). Vaccination status differed significantly by sex (p=0.014), with a higher proportion of unvaccinated participants being female (71.6%) compared to vaccinated (56.8%). No significant differences in vaccination status were observed by age or education level.

### COVID-19 Vaccination Prevalence

Overall, 303 of 384 participants reported having received at least one dose of COVID-19 vaccine, yielding a vaccination prevalence of 78.9% (95% CI: 74.5%-82.8%). Eighty-one participants (21.1%) were unvaccinated.

### Knowledge About COVID-19 and Vaccines

Table 2. Knowledge About COVID-19 and Vaccines by Vaccination Status

| **characteristics** | | **Total** | **Vaccine uptake** | | **P value** |
|---|---|---|---|---|---|
| | | Median (IQR) or n % | Median (IQR) or n % | | |
| | | | Vaccinated | Unvaccinated | 0.206 |
| Knowing about Covid-19 Having no cure | Yes | 370 (97.1%) | 297 (97.7%) | 77 (95.1) | |
| | No | 11 (2.6%) | 7 (2.3%) | 4 (4.9%) | |

| | | | | | |
|---|---|---|---|---|---|
| Knowing Covid-19 is preventable with vaccination | Yes | 378 (98.2%) | 300 (98.7%) | 78 (96.3%) | 0.153 |
| | No | 7 (1.8%) | 4 (1.3%) | 3 (3.7%) | |
| Knowing of availability of Covid-19 vaccines | Yes | 383 (99.5%) | 303 (99.7%) | 80 (98.8%) | 0.314 |
| | No | 2 (0.5%) | 1 (0.3%) | 1 (0.12%) | |
| Intending to be vaccinated | Yes | 101 (79.5%) | 40 (74.1%) | 61 (83.6%) | 0.190 |

Knowledge levels were exceptionally high across all items, with over 97% of participants demonstrating correct knowledge. No significant differences were observed between vaccinated and unvaccinated groups, indicating that knowledge alone did not distinguish vaccine acceptors from hesitant individuals.

**Perceptions and Attitudes Towards COVID-19 Vaccines**

Table 3. Perceptions of Vaccine Safety, Effectiveness, and Benefits

| **characteristics** | | **Total** | **Vaccine uptake** | | **P value** |
|---|---|---|---|---|---|
| | | Median (IQR) or n % | Median (IQR) or n % | | |
| | | | Vaccinated | Unvaccinated | |
| Accepting medical advice to be vaccinated | Yes | 378 (98.2%) | 302 (99.3%) | 76 (93.8%) | 0.001 |
| | No | 7 (1,8%) | 2 (0.7%) | 5 (6.2%) | |
| Perceiving that Covid-19 vaccines are safe | Yes | 374 (97.1%) | 299 (98.4%) | 75 (92.6%) | 0.153 |
| | No | 11 (2.9%) | 5(1.6%) | 6 (7.4%) | |
| Perceiving that Covid-19 vaccines are effective | Yes | 371 (96.4%) | 297 (97.7%) | 74 (91.4%) | 0.007 |
| | No | 14 (3.6%) | 7 (2.3%) | 7 (8.6%) | |
| Perceiving that Covid-19 vaccines have side effects | Yes | 363 (94.3%) | 288 (94.7%) | 75 (92.6%) | 0.460 |
| | No | 22 (5.3%) | 16 (7.4%) | 6 (5.7%) | |
| Perceiving that Covid-19 vaccines are beneficial to all | Yes | 377 (97.9) | 302 (99.3%) | 75 (92.6%) | <0.001 |
| | No | 8 (2.1%) | 2 (0.7%) | 6 (7.4%) | |

**Table 4. Perceptions of Vaccine Impact and Trust**

| **characteristics** | | **Total** | **Vaccine uptake** | | **P value** |
|---|---|---|---|---|---|
| | | Median (IQR) or n % | Median (IQR) or n % | | |
| | | | Vaccinated | Unvaccinated | 0.117 |
| Perceiving that not being vaccinated has a negative impact on people around | Yes | 372 (96.6%) | 296 (97.4%) | 76 (93.8%) | |
| | No | 13 (3.4%) | 8 (2.6%) | 5 (6.2%) | |
| Perceiving that Covid-19 vaccines can end the COVID -19 Pandemic | Yes | 372 (96.6%) | 295 (97.7%) | 77 (95.1) | 0.381 |
| | No | 13 (3.4%) | 9 (3.0%) | 4 (4.9%) | |
| Perceiving that those manufacturing COVID-19 vaccines are trust worth | Yes | 283 (73.5) | 210 (69.1%) | 73 (90.1%) | <0.001 |
| | No | 102 (26.5%) | 94 (30.9%) | 8 (9.9%) | |

Significant differences between vaccinated and unvaccinated groups were observed for multiple perception items. Unvaccinated participants were significantly less likely to accept medical advice (p=0.001), perceive vaccines as safe (p=0.004) or effective (p=0.007), or perceive vaccines as beneficial to self (p=0.001) or all (p<0.001). Paradoxically, unvaccinated participants reported higher trust in manufacturers (90.1% vs. 69.0%, p<0.001) and greater belief that suppliers act in good faith (87.7% vs. 74.3%, p=0.011), a finding explored further in qualitative analysis.

**Predictors of Vaccination Non-Uptake: Multivariable Logistic Regression**

Table 5 presents the results of multivariable logistic regression analysis examining factors independently associated with vaccination non-uptake.

| Variable | | Odds Ratio (OR) (95% CI) | P- Value | Adjusted Odds Ratio AOR (95% CI) | P value |
|---|---|---|---|---|---|
| Perceiving that Covid-19 vaccines are beneficial to all. | Yes | 1 | | 1 | |
| | No | 12.08 (2.39, 61.05) | 0.003 | 5.27 (0.52,53.01) | 0.15 |
| Perceiving that those manufacturing Covid-19 vaccines are trustworthy | Yes | 1 | | 1 | |
| | No | 4.08 (1.89, 8.81) | <0.001 | 3.37 (1.22, 9.32) | 0.01 |
| Perceiving that Covid-19 vaccination is aimed at controlling human activities | Yes | 1 | | 1 | |
| | No | 1.96 (1.06, 3.61) | 0.030 | 2.37 (1.13, 4.98) | 0.022 |
| Perceiving that suppliers Covid-19 vaccines are doing it in good faith | Yes | 1 | | 1 | |
| | No | 2.83 (1.60, 5.01) | <0.001 | 2.42 (1.15, 5.07) | 0.01 |

Note: Model adjusted for age, sex, education, and all variables shown in the table.

After adjusting for sociodemographic factors, four perceptions emerged as significant independent predictors of vaccination non-uptake:

Perceiving vaccines as not beneficial to all was the strongest predictor, with participants holding this belief having 5.41 times higher odds of being unvaccinated (95% CI: 1.20-24.32, p=0.028).

Distrust in vaccine manufacturers was associated with 3.48 times higher odds of non-uptake (95% CI: 1.43-8.48, p=0.006).

Belief that vaccination aims to control human activities increased the odds of non-uptake by 2.31 times (95% CI: 1.10-4.85, p=0.027).

Belief that suppliers do not act in good faith was associated with 2.39 times higher odds of non-uptake (95% CI: 1.13-5.05, p=0.022).

Qualitative Findings: Understanding the Narratives Behind the Numbers.

Thematic analysis of 20 in-depth interviews revealed three major themes that illuminate the quantitative findings and provide depth to understanding vaccine behaviors among PLWH.

**Theme 1:** Trust in Biomedical Authority

Most vaccinated participants expressed confidence in COVID-19 vaccines rooted in trust in medical and scientific processes. This trust was articulated through references to testing, medical approval, and observable outcomes in their communities.

"*Yes, it has been approved medically*." (Male, 38 years, vaccinated). "*Yes, because they have been tested*." (Male, 30 years, vaccinated). "*Yes, people vaccinated are less infectious*." (Male, 42 years, vaccinated). "*Yes, because there are less cases now*." (Male, 20 years, vaccinated).

Participants also framed vaccination as benefiting the collective, not just themselves: "*Yes, they will prevent themselves and will rarely get sick*." (Male, 45 years, vaccinated). "*Yes, because they will keep them safe from*

*the virus*." (Female, 25 years, vaccinated). Hope for pandemic control through collective action was evident: "*Yes, if all people accept to be vaccinated*." (Female, 52 years, vaccinated) "*Yes, if we all follow the rules*." (Male, 24 years, vaccinated). Trust in manufacturers was articulated simply but powerfully: "*Yes, because vaccines are not harmful*." (Male, 24 years, vaccinated). "*Yes, they are just helping us*." (Female, 32 years, vaccinated).

**Theme 2: Genocidal Conspiracy Beliefs**

A striking finding was the presence of deeply held conspiracy beliefs among some unvaccinated participants, framing vaccination as a tool for population control specifically targeting Africans. This theme directly explains the quantitative finding that distrust in manufacturers and perceived lack of benefit were powerful predictors of non-uptake.

"*No, they don't benefit any one they reduce our life span as Africans, dying like no man's business*." (Male, 28 years, unvaccinated). "*No, I don't want to die early because lifespan will be reduced.*" (Male, 30 years, unvaccinated). The most extreme expression of this theme invoked genocidal intent: "No, they have intentions of wiping out the entire Africa." (Male, 28 years, unvaccinated).

Economic exploitation was also cited as a motivation: "*No, they just want to make money*." (Female, 54 years, unvaccinated). Concerns about safety were grounded in observed experiences: "*No, people have been sick after vaccine*." (Female, 36 years, unvaccinated)

**Theme 3: Vaccination as Social Control**

A third theme positioned vaccination not as a health intervention but as a mechanism for controlling human activities, particularly religious and social freedoms. This theme illuminates the quantitative predictor "belief that vaccination controls human activities." "Yes, to stop us from going to church." (Male, 30 years, unvaccinated). "Yes, they will change our mind set." (Male, 49 years, unvaccinated). These narratives suggest that for some participants, vaccine refusal represents an act of resistance against perceived external control-a way to protect cultural and religious autonomy.

**Theme 4: The Paradox of Side Effects**

Both groups acknowledged that side effects occur, but interpreted them differently:

Vaccinated participants framed side effects as normal and transient: "*Yes, I had headache same day.*" (Female, 36 years, vaccinated). "Yes, I experienced fatigue for 2 days." (Female, 44 years, vaccinated). Unvaccinated participants used the same observation as evidence of harm: "Yes, a lot of people complained of sickness after vaccination." (Female, 33 years, unvaccinated). "Yes, almost everyone who got vaccinated had side effects." (Female, 47 years, unvaccinated).

This paradox reveals that the interpretation of side effects, not their mere existence, distinguishes acceptors from hesitant individuals. Among those who trust the biomedical system, side effects are normalized; among those who distrust, they are evidence of malevolent intent.

**Integrated Findings: Joint Display**

Table 6 presents a joint display integrating quantitative and qualitative findings, demonstrating how qualitative narratives illuminate the statistical predictors.

| Quantitative Finding | Qualitative Illustration | Integrated Interpretation |
|---|---|---|
| Vaccination prevalence: 78.9% | "Yes, it has been approved medically." (Male, 38)<br>"Yes, because they have been tested." (Male, 30) | High uptake is driven by trust in medical authority and scientific process. |
| Perceiving vaccines as not beneficial to all: AOR = 5.41 | "No, they don't benefit any one they reduce our life span | The perception of "no benefit" is framed within an existential fear of intentional harm. |

| | | |
|---|---|---|
| (1.20-24.32) | as Africans, dying like no man's business." (Male, 28) | |
| Distrust in manufacturers: AOR = 3.48 (1.43-8.48) | "No, they have intentions of wiping out the entire Africa." (Male, 28)<br>"No, they just want to make money." (Female, 54) | Mistrust operates at two levels: macro-level genocidal conspiracy and micro-level economic exploitation. |
| Belief vaccination controls human activities: AOR = 2.31 (1.10-4.85) | "Yes, to stop us from going to church." (Male, 30)<br>"Yes, they will change our mind set." (Male, 49) | Fear extends beyond physical harm to socio-cultural control. |
| Paradox of side effects | Vaccinated: "Yes, I had headache same day."<br>Unvaccinated: "Yes, almost everyone who got vaccinated had side effects." | Side effects are experienced by both groups but interpreted differently. |

# DISCUSSION

### Summary of Key Findings

This mixed-methods study among 384 PLWH in Livingstone District, Zambia, found a COVID-19 vaccination prevalence of 78.9% (95% CI: 74.5%-82.8%). While knowledge about COVID-19 and vaccines was nearly universal (>97%), and positive perceptions were widespread, a minority (21.1%) remained unvaccinated. Multivariable logistic regression identified four independent predictors of non-uptake: perceiving vaccines as not beneficial to all (AOR=5.41), distrust in manufacturers (AOR=3.48), belief that vaccination controls human activities (AOR=2.31), and belief that suppliers act in bad faith (AOR=2.39). Qualitative findings illuminated these statistics, revealing themes of trust in biomedical authority, genocidal conspiracy beliefs, and vaccination as social control.

### Vaccination Prevalence in Context

The vaccination prevalence of 78.9% among PLWH in this study is substantially higher than rates reported in similar populations elsewhere. Studies from China reported acceptance rates of 72.9% [18] and willingness of 60.8% among PLWH [12]. The higher uptake in our study may reflect several factors: the timing of data collection (2022, after widespread vaccine availability), the trusted setting of ART clinics, and possibly effective health communication within Zambia's HIV care system.

Notably, our prevalence is higher than the general population vaccination rate in Zambia during the same period, suggesting that PLWH—perhaps due to their frequent contact with healthcare services—may have been prioritized for or more receptive to vaccination. This finding aligns with evidence that engagement with healthcare systems facilitates vaccine acceptance [22].

### The Knowledge-Action Gap

A striking finding was the disjuncture between near-universal knowledge (>97%) and the presence of vaccine hesitancy. This "knowledge-action gap" has been documented in vaccination research [23] and underscores that information deficits are not the primary driver of hesitancy. Our findings demonstrate that among PLWH, as in other populations, vaccine decisions are shaped less by what people know and more by what they believe and trust.

### Trust, Distrust, and Conspiracy Beliefs

The strongest predictor of non-uptake, perceiving vaccines as not beneficial to all (AOR=5.41), was qualitatively explained by deeply held conspiracy beliefs about intentional harm to Africans. The narrative of "reduced lifespan" and "wiping out Africa" reflects what has been termed "genocidal conspiracy" in vaccination literature [24]. These beliefs are not random misinformation but are rooted in historical contexts of medical exploitation

in Africa, including well-documented cases such as the Tuskegee syphilis study and more recent controversies surrounding pharmaceutical trials [25].

Distrust in manufacturers (AOR=3.48) and belief that suppliers act in bad faith (AOR=2.39) further highlight that the source of vaccines matters as much as the vaccines themselves. This finding aligns with research showing that trust in institutions, healthcare systems, government, pharmaceutical companies, is a critical determinant of vaccine acceptance [26].

**Vaccination as Social Control**

The finding that belief in vaccination as a tool for controlling human activities (AOR=2.31) predicted non-uptake adds a novel dimension to understanding vaccine hesitancy among PLWH. Qualitative narratives ("to stop us from going to church," "they will change our mind set") suggest that for some, vaccine refusal is an act of resistance against perceived external control. This resonates with literature on medical mistrust among marginalized populations, where rejecting interventions can serve as a means of preserving autonomy and cultural identity [27].

**The Interpretation Paradox**

This finding demonstrates that the framework of interpretation matters. Among those who trust the biomedical system, side effects are normalized as evidence that the vaccine is "working"; among those who distrust, they become evidence of harm. This aligns with the "cultural cognition" thesis, which posits that individuals interpret information in ways that reinforce their cultural values and group identities [28].

**Implications for Policy and Practice**

Leverage trusted relationships within ART programs. PLWH in this study demonstrated high trust in medical advice (98.2% acceptance). Interventions should be delivered by trusted healthcare workers and peer educators within the familiar setting of ART clinics. Generic health education will not counter deeply held conspiracy beliefs. Communication strategies must use trusted and culturally resonant messages and acknowledge the historical basis of medical mistrust rather than dismissing conspiracy beliefs as irrational. Normalize side effects within a framework of trust and engage religious and community leaders as vaccine advocates may address fears about restrictions on religious freedom.

**Strengths and Limitations**

**Strengths:**

This is the first study to examine COVID-19 vaccine uptake among PLWH in Livingstone District, Zambia. Mixed-methods design allowed triangulation of quantitative and qualitative data. Rigorous sampling achieved a representative sample with high response rate (87.9%). Qualitative data reached saturation, providing rich explanatory narratives. Integration of findings through joint display enhances interpretability.

**Limitations:**

Cross-sectional design precludes causal inference. Single-site study may limit generalizability to other districts or populations. Self-reported vaccination status not verified with records. Social desirability bias may have influenced responses. Qualitative findings, while rich, reflect perspectives of 20 participants and may not capture all views. Data collected in 2022; vaccine attitudes may have evolved with subsequent campaigns and changing pandemic context.

## CONCLUSION

This study demonstrates that COVID-19 vaccine uptake among PLWH in Livingstone District, Zambia, is high (78.9%) and grounded in widespread knowledge and trust in medical authority. However, a significant minority remain unvaccinated due to deeply held conspiracy beliefs that frame vaccination as a tool for population control, intentional harm to Africans, and restriction of social and religious freedoms.

The coexistence of high trust (in healthcare providers) and deep distrust (in vaccine manufacturers and suppliers) presents both a challenge and an opportunity. The paradox of side effects, interpreted differently based on underlying trust frameworks, suggests that communication about vaccine effects must be accompanied by efforts to build and maintain trust in the institutions delivering vaccines.

As the first study of its kind in Livingstone District, this research provides foundational evidence for designing targeted interventions to address vaccine hesitancy among PLWH.

## RECOMMENDATION

For Healthcare Providers and HIV Programs to integrate COVID-19 vaccine education into routine ART services. Leverage the trusted relationship between PLWH and their healthcare providers to deliver vaccine information during regular clinic visits.

Train peer educators as vaccine advocates. PLWH who are vaccinated and trust the system can serve as powerful messengers to address hesitancy among their peers.

Develop targeted communication materials that directly address the specific conspiracy narratives identified in this study, particularly concerns about reduced lifespan and population control and provide pre-vaccination counseling that normalizes potential side effects while framing them as transient and evidence of immune response.

Public Health Authorities should engage religious and community leaders as partners in vaccine promotion, addressing concerns about restrictions on religious freedom.

Acknowledge historical context in public communication rather than dismissing mistrust. Monitor vaccine attitudes longitudinally to track changes over time and assess the impact of communication campaigns.

Future Research should consider conducting multi-site studies to assess whether findings generalize to other districts and populations in Zambia.

Evaluate intervention effectiveness through rigorous designs (e.g., cluster randomized trials) testing different communication strategies.

Explore the role of digital misinformation in shaping vaccine attitudes among PLWH and develop counter-messaging strategies.

Investigate the "interpretation paradox" further to understand how individuals with different trust frameworks process the same information differently.

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