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Public Health Sciences

Identifying COVID-19 Related Concern Patterns: A Mixed-Methods Study of Vaccine Decision-Making in Zambia

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Executive Summary

Vaccination is one of the most effective public health strategies, yet concerns about vaccine safety, and mistrust in institutions influenced acceptance in Zambia, particularly following the COVID-19 pandemic. This practicum examined how adults in Lusaka Province, Zambia prioritize COVID-19 vaccine concerns and how these concerns shape willingness to accept other novel vaccines. Using the COVID-19 Best-Worst Scaling (BWS) dataset, this project identified five distinct concern profiles that reflect different patterns of beliefs, motivations, and information needs. A focused literature search identified 14 relevant sources provided context for understanding vaccine hesitancy in the country. Descriptive analyses showed meaningful differences in demographic variables across profiles. Regression analyses demonstrated that some profiles were less likely to express high intention to accept future vaccines, even after accounting for demographic and behavioral factors. These findings indicate that vaccine concerns in Zambia are not uniform but cluster into recognizable patterns that influence intention. Understanding these profiles can help guide more targeted, context-specific

communication strategies aimed at strengthening vaccine confidence and improving uptake of upcoming novel vaccines in Zambia and similar low-and middle-income settings.

Introduction

Vaccines are among the most effective public health strategies for preventing infectious diseases and reducing mortality. The Centers for Disease Control and Prevention (CDC) has recognized vaccinations as one of the top ten greatest public health achievements of the 20th century due to its profound impact on disease control and eradication.[1] According to the World Health Organization (WHO), childhood immunizations prevent about four million deaths each year, and vaccination efforts have saved an estimated 154 million lives over the past 50 years.[2] By stimulating protective immune responses, vaccines provide individual protection and contribute to community-wide benefits through herd immunity.[1,2]

Zambia, like many sub-Saharan countries, has made significant progress in expanding immunization coverage over the past decades through national and community-level efforts.[3] The country's Expanded Programme on Immunization (EPI), launched in 1974, successfully

increased uptake of childhood vaccines. However, structural challenges, including limited health infrastructure, inequitable access in rural areas, and reliance on external funding, continue to influence vaccination efforts.[3,4] These existing barriers became even more apparent during the coronavirus disease 2019 (COVID) pandemic.

Coronavirus disease 2019 (COVID-19) is a highly transmissible respiratory illness caused by the SARS-CoV-2 virus.[5] Infected individuals can experience mild symptoms such as cough and fever to severe respiratory complications requiring hospitalization.[5] Zambia reported its first confirmed COVID-19 cases in March 2020.[6] In response, the government implemented several public health measures including border closures, restrictions on public gatherings, and temporary school shutdowns, although a full nationwide lockdown was not enforced.[6] The Ministry of Health (MOH) launched the national COVID-19 vaccination campaign in April 2021, prioritizing healthcare workers (HCWs) and high-risk populations.[7] As of 2025, approximately 47.6% of Zambia's population is fully vaccinated, higher than the continental average of 31.1% but still below levels needed for broad population protection.[8]

Globally, vaccine rollout occurred at varying rates, with high-income countries achieving broad coverage much faster than low-income nations. By March 2022, fewer than fifteen percent of people in low-income countries had received at least one dose of COVID-19, compared to approximately 80 percent in high-income countries.[9]

The rapid development of COVID-19 vaccines represented a scientific milestone, yet their introduction reignited longstanding issues in vaccine hesitancy. The World Health

Organization defines vaccine hesitancy as the delay in acceptance or refusal of vaccinations despite the availability of vaccine services.[10] This phenomenon is complex and context-specific, influenced by complacency, convenience, and confidence. Concerns about vaccine safety, side effects, pharmaceutical motives, and distrust in government and medical institutions contribute to reluctance toward vaccination.[10]

During vaccine rollout, many low – to – middle income countries (LMICS) faced supply shortages, poor cold-chain infrastructure, and inequitable distribution, reinforcing perceptions of exclusion from global health priorities.[10] The temporary freeze of the U.S. Agency for International Development (USAID) global health programs in early 2025 further disrupted immunization and outreach efforts in several African countries.[11] This pause led to reduced funding for vaccine delivery, health communication, and community engagement.[11] While the decision reflects broader administrative and budgetary actions, its impact reveals the fragility of health systems that depend on external aid and highlights the importance of sustainable, locally led public health infrastructure.

Existing literature across Zambia and sub-Saharan Africa show that vaccine intention is shaped by a combination of perceived safety, prior experiences, information sources, and contextual structural factors.[12] One study highlighted that caregivers' acceptance of COVID-19 vaccines was strongly influenced by perceived vaccine safety and efficacy, while misinformation and fear reduced willingness in some districts in Zambia.[13] A similar study found that adults' intention to receive a second vaccine dose was shaped by gender, prior side effects, and health

perceptions, although most participants were willing to complete the vaccine series.[14] Moreover, it was noted that women often rely on HCWs, neighbors, and church leaders for guidance, while misinformation and limited access created barriers.[14, 15] Studies among specific groups in Zambia, such as HCWs, school pupils, pharmacy students, and persons with disabilities, reveal similar themes in which intention improves when individuals trust vaccine safety, feel at risk of disease, and receive clear information from credible sources.[16, 17, 18, 19, 31] Social media analyses further emphasize the role of rumors, religious narratives, and misinformation in shaping vaccine discourse nationwide.[20] Together, this literature demonstrates that vaccine hesitancy in Zambia is multi-dimensional and driven not by demographics along but by a combination of community beliefs, disease perceptions, past experiences, and credible news outlets.

Although COVID-19 vaccine uptake in Zambia has increased over time, lingering skepticism may influence the acceptance of future adult vaccines. Research shows that populations are heterogenous in their beliefs, motivations, and information-seeking behaviors, which shape how individuals perceive and respond to vaccination efforts.[21, 32] Recognizing and addressing these differences is essential for developing effective communication strategies that promote vaccine confidence.

This practicum project builds on Dr. Anjali Sharma's recent COVID-19 Best-Worst Scaling (BWS) study. The study explores how adults in Zambia prioritize different vaccine-related concerns and how these perceptions influence willingness to accept future vaccines for other infectious diseases (e.g., influenza, tuberculosis, malaria).[22] This practicum focuses on

identifying the most influential COVID-19 concerns by developing "concern profiles", that is, identifying groups of individuals who share similar worries, beliefs, and motivations related to vaccination. Examining how these patterns vary across demographic and experiential factors will provide evidence-based insights to guide communication and outreach strategies that strengthen vaccine uptake in Zambia and other LMIC settings.

Practicum Objectives

Supported through the collaboration with the Centre for Infectious Disease Research in Zambia (CIDRZ), this practicum project sought to examine how self-reported COVID-19 vaccination concerns shape intentions to accept other novel vaccines. The objectives of this practicum were to 1) conduct a literature review to identify existing research on vaccine concerns, intention, and uptake with a particular emphasis on COVID-19 and novel vaccines; 2) analyze the BWS survey dataset to develop COVID-19 concern profiles and examine how these profiles differ across sociodemographic and experiential subgroups; 3) translate findings into an accessible format by synthesizing results into an internal report; 4) disseminate findings by presenting results in a virtual forum at the CIDRZ Think Tank meeting to an academic and research audience. Collectively, these objectives were designed to address the overarching research question: *How do self-reported COVID-19 vaccination concerns shape intentions to accept other novel vaccines?*

Methods

This practicum serves as an ancillary facet of the larger COVID-19 BWS project led by principal investigator (PI) Dr. Anjali Sharma at CIDRZ, with supervision and support from Dr. Jake Pry. Best-Worst Scaling (BWS) is a theory-driven method used to measure how individuals prioritize or value a set of items.[23] Participants are presented with a list of items and are asked to identify which they consider the "best" and the "worst" within each set.[23] By analyzing these repeated choices, researchers can determine the relative importance or preference assigned to each item across the sample population, making the method highly relevant for policy development, patient-centered care, and health communication.

This project uses the same dataset described in Dr. Anjali's paper and the two preprints, which examine vaccine concerns, preferences, and intention. Referencing these studies provides transparency regarding the data source and situates the practicum within ongoing analyses of the same study.

All practicum activities described were conducted by the student with the oversight and approval of Dr. Jake Pry, in collaboration with the CIDRZ research team. The following sections describe the review of the literature, study setting, and secondary data analysis used in this practicum.

Literature Review

A comprehensive literature search was conducted in PubMed to identify peer-reviewed articles related to COVID-19 vaccine hesitancy in Zambia. The search strategy included the following key terms: "vaccination", "COVID-19", "hesitancy", "confidence", and "Zambia".

Searches were filtered to include articles published within the last five years (2020-2025). The search initially yielded 35 peer-reviewed articles. Additionally, two preprints provided by Dr. Pry have presented early analyses of the BWS dataset and were included as grey literature, bringing the total initial record to 37.

The screening process followed the PRISMA 2020 flow diagram (**Figure 1**).[24] During the title and abstract screening, 17 articles were excluded for not meeting the specific research criteria. The primary exclusion reasons included lack of direct relevance to COVID-19 vaccines, absence of focus on hesitancy or attitude, and insufficient connection to the Zambian context.

Relevant articles were downloaded and uploaded in Zotero, a citation management tool, for organization.[25] Of the remaining 20 articles, six were further excluded during the full-text review. Five articles were eliminated due to including Zambia as part of a broader multi-country study, which would not allow for specific generalizability to the Zambian context. One additional article was excluded for not directly addressing COVID-19 vaccine-related attitudes or intentions.

The final literature review comprised of 14 sources, including 12 peer-reviewed articles and 2 preprints, all specifically focused on COVID-19 vaccine hesitancy in Zambia. The sources were compiled into a review matrix in Microsoft Excel to assist with the organization process and to facilitate synthesis of the literature.

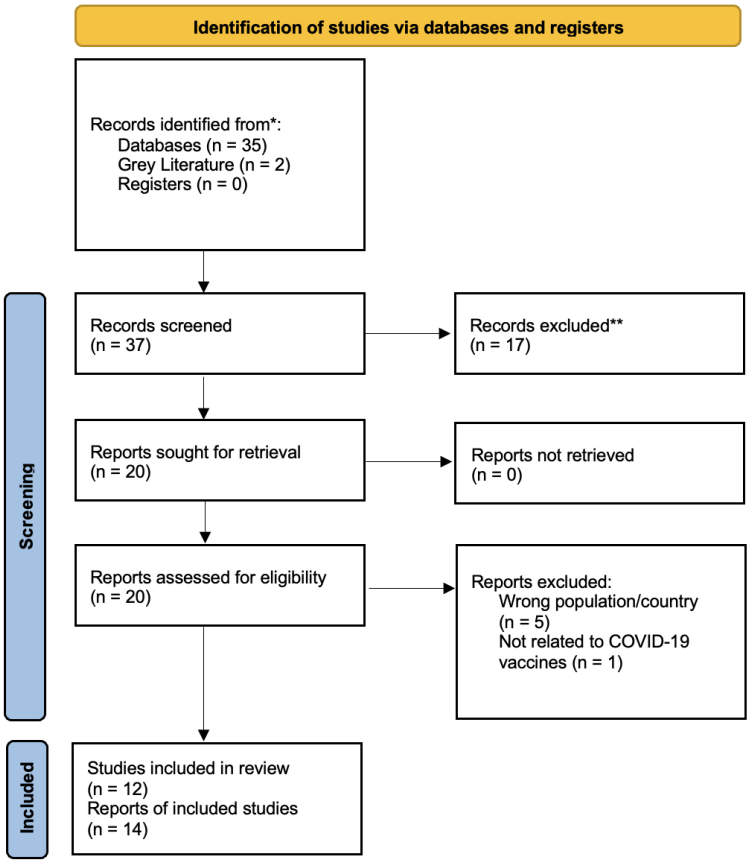

Figure 1. PRISMA 2020 Flow Diagram summarizing search, screening, and selection of articles included in literature review on COVID-19 vaccination in Zambia.

Study Setting and Data Collection

This practicum builds on survey data from the COVID-19 BWS study conducted in Lusaka Province, Zambia, between November 13 and December 15, 2023.[22] Zambia is divided into ten provinces, with Lusaka Province being one of the most densely populated regions in the country.[26] Adults aged 18 years and older who resided in Lusaka Province and were able to

provide informed consent were eligible to participate. HCWs were additionally required to provide direct clinical care or community-based health services.[22]

A total of 499 participants were enrolled, including 395 community members and 104 HCWs. Community members were recruited from four high-density, low-income urban communities characterized by relatively low COVID-19 vaccination rates.[22] Each community contains 10 administrative zones subdivided into approximately 100 households per neighborhood. One zone per community was randomly selected, and households were selected using random sampling.[22]

HCWs were recruited from 10 purposively selected public healthcare facilities.[22] Of the 636 facilities in the province registered under the MOH, these ten sites represent a small but intentionally diverse subset of the broader health system.[27] HCWs were sampled from five clinical departments which included Antiretroviral Therapy and Treatment (ART), Mother and Child Health (MCH), Tuberculosis, Adolescent Services, and Outpatient Departments.[22]

This recruitment strategy was intentionally designed to enhance representation of unvaccinated and vaccinated adults. By focusing on communities with low vaccine uptake and HCWs providing frontline services, the sampling approach aimed to identify early indicators of concern, assess readiness for future vaccine introduction, and understand vaccine acceptance in settings that may present greater challenges for public health engagement.

Analytical Framework

A directed acyclic graph (DAG) was developed using DAGitty (v3.1),[28] a web-based software to analyze causal diagrams, to illustrate the hypothesized relationship between COVID-19 vaccination concerns and intention to accept future vaccines among adults in Zambia (**Figure 2**). In this model, vaccine concerns were listed as the exposure and intentions to receive future vaccine as the outcome. Demographic and experiential covariates (e.g., age, gender, education, and HIV status) were identified as potential confounders, as they influence both the exposure and outcomes. The DAG guided covariate selection and informed model specifications for the bivariate analysis. Notably, it provided the conceptual foundation for developing concern profiles, which characterize vaccine concerns through analytically distinct subgroups reflecting shared worries, beliefs, and motivations toward vaccination.

Variable selection was guided by the DAG, which informed the following key covariates: age, gender, education, marital status, income, community role, HIV status, COVID-19 vaccination status, and vaccine access. The green arrow represents the hypothesized causal pathway from concern profiles to intention. The pink nodes represent variables evaluated as potential confounders because they were observed to be associated with both concern profiles and vaccine intention. Religion is shown in blue to indicate that although it was considered during the development of the DAG and later examined in bivariate and regression analyses, it was not included as a confounder. At the time the DAG was created, early in the project, religion was not conceptually expected to influence concern profiles. These variables were retained for

bivariate analyses regardless of statistical significance, consistent with epidemiologic best practices.

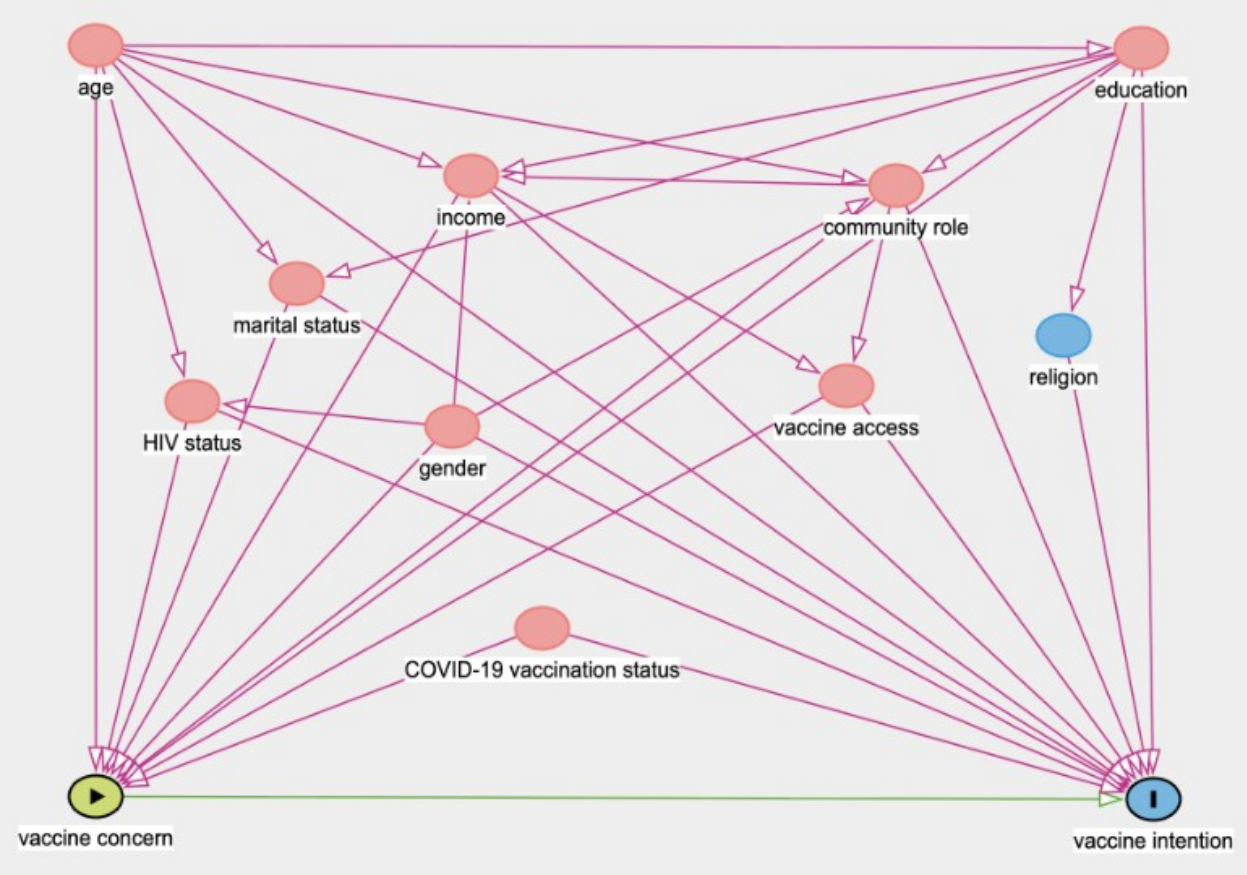

Figure 2. Directed Acyclic Graph depicting factors influencing the relationship between COVID-19 concerns and vaccine intentions.

Quantitative Data Analysis

Provided by Dr. Pry, this practicum utilized a dataset from the COVID-19 BWS study, which examined vaccine intention across multiple pathogens including influenza, tuberculosis, pneumonia, diarrheal disease, malaria, HIV, and new COVID-19 booster. All quantitative data

preparation, recoding, and analysis were conducted in R (version 4.4.2), a free open-source software used for statistical computing and data visualization.[29]

The raw dataset included 524 observations and 530 variables, representing survey responses exported from the BWS instrument. Some rows reflected non-participant data (e.g., structural rows or free-text entries), so a participant ID variable was used to identify unique cases. Variable types were examined, distributions were summarized, and character variables were converted into factors where appropriate. Several categorical variables contained inconsistencies or overlapping categories. These variables were recoded to ensure alignment with the analytic approach used in Dr. Sharma's paper. This included reorganizing education into four levels (less than secondary, some secondary, completed secondary, post-secondary) and collapsing religious affiliation into seven mutually exclusive categories to reduce sparsity. Age was converted into a five-level age group variable. All data cleaning, re-coding, and visualization were completed using packages from the *tidyverse* suite.

A complete case analysis approach was used, meaning participants were included in each analysis only if they had complete data for all variables required for that specific model or table. Concern domains contained multiple items. Therefore, participants with missing values for all items within a domain were coded as having "No concern". This decision was made because a lack of responses could not be interpreted as evidence of concern. After consulting with Dr. Pry, the absence of selections was interpreted as an absence of expressed concerns rather than missing data that needed to be assigned.

Concern Profiles

Concern profiles were developed to identify groups of participants who shared similar patterns of vaccine-related concerns. Each participant received a score for five concern domains (logistic, health, community, COVID-19 experience, and other/personal concerns) based on their responses to the BWS items.

Employing latent class analysis, clustering was used to group participants according to similarity in their concern patterns. In clustering, observations are grouped so that members within the same cluster are as similar to one another as possible, while being distinctly different from members of other clusters. The method identifies meaningful clusters of participants who share common characteristics across their concern scores.

To determine the sufficient number of profiles that best captured distinct patterns in the data, both the elbow method and silhouette scores were applied (See **Figure 3**). Although the four- and five-cluster solutions performed similarly, the five-cluster solution was selected because it captured more heterogeneity in concern patterns as determined by the bend at k =5. Each participant was then assigned to the cluster for which they showed the strongest similarity, yielding five distinct concern profiles that were used in descriptive and regression analyses.

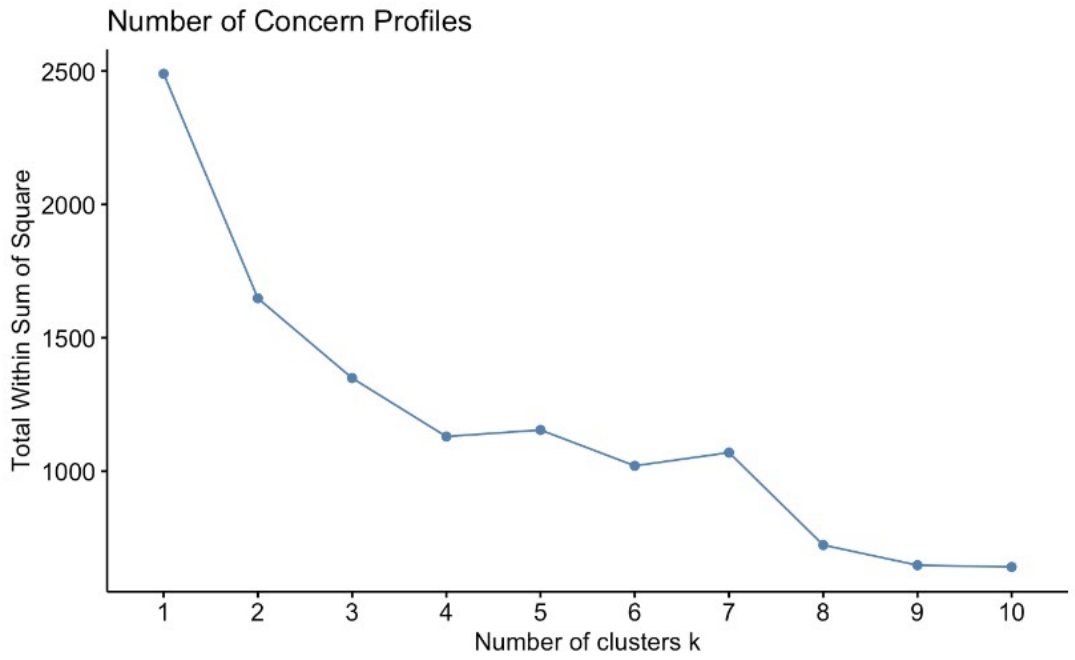

Figure 3. Elbow method plot used to determine the optimal number of concern profiles.

Descriptive Analyses

Descriptive analysis was conducted to summarize demographic and experiential characteristics across the five concern profiles. Key variables included age, gender, education, religion, employment, community role, marital status, HIV status, and COVID-19 vaccine dose. Summary statistics, including counts and percentages for categorical variables, were generated using the *gtsummary* package in R. These descriptive analyses provided an overview of participant characteristics prior to regression analyses.

Regression Analyses

Regression analysis was conducted to examine how different participant characteristics were related to the five concern profiles. Because each participant belonged to only one of the five concern profiles, a yes-or-no variable was created for each profile to show whether a participant was a member of that profile. This approach required running the same analysis five times, once for each profile. These unadjusted, bivariate models compared the characteristics of people within each profile to those of all other participants (**Table 2**).

Before running these models, reference groups were selected to make the comparisons meaningful and easy to interpret. For age, the middle category (30-34 years) was chosen so that participants who were younger or older could be compared to a central group. For COVID-19 vaccination status, participants who had received two doses were used as the reference because two doses are considered full vaccinated, allowing for clear comparisons with those who were unvaccinated, partially vaccinated, or fully vaccinated and boosted. These selections created consistent and interpretable comparisons across all regression models.

Adjusted models for **Table 3** were developed to examine whether concern profile membership was related to intention to receive future novel vaccines while accounting for other factors. The outcome variable, *intention_score85*, helped identify participants with high vaccine intention when their composite intention score was greater than 85 and low intention when the score was 85 or below. One profile was selected as the reference group to facilitate comparisons across the other profiles.

An unadjusted model was first run to estimate crude prevalence ratios for the associations between concern profile membership and high vaccine intention. After fitting the crude model, the variables identified in the DAG (**Figure 2**) were added to build the adjusted model. Including these variables allowed the analysis to control key participant characteristics and determine whether concern profile membership was independently related to high intention.

Results

Qualitative Analysis

5 major themes were identified from the literature review. Across almost all studies, the most prominent theme was concern about safety, side effects, and misinformation. Many individuals worried about how the vaccine might affect their health. Misinformation from social media and community networks intensified fears, making safety one of the strongest drivers of hesitancy.

The second theme involved structural and logistical challenges such as transportation, long distances to clinics, and limited staffing. These concerns were especially important in rural areas. The third identified theme was trust. Many studies found that people trusted HCWs more than government or political leaders. Trust also depended on how information was delivered. Direct conversations with HCWs were far more influential than formal messaging.

Social and community influences involving family members, community norms, and religious leaders also play a significant role in decision-making. In several studied, support or skepticism from these groups affected whether individuals felt comfortable receiving the vaccine.

Finally, perceived risk and disease severity were key predictors of vaccine uptake. People who believe they were at higher risk were more willing to be vaccinated. Those who perceived low personal risk, particularly younger adults, tended to show lower intention to vaccinate.

These themes are very consistent with survey responses from the dataset. The distribution of COVID-19 vaccine concerns by domain (see **Figure 4**) show that a large proportion of participant selected health-related concerns, especially fear of side effects, followed by concerns about the number of doses required and uncertainty about how to decide whether to receive a vaccine. These patterns reflect the same issues highlighted in published studies: people worry about safety, struggle with inconsistent information, and many feel unsure about what is necessary or recommended.

In the survey, several participants commented that “Too many doses are required” or that “One dose is enough for me”, reflecting frustration with changing guidelines and dose schedules. Others expressed confusion, such as “I do not have proper information about these vaccines”, pointing to gaps in communication and trust. Some participants described fatalistic beliefs like, “I believe if it’s your time, you will die”, showing how personal and cultural frameworks shape decision-making. And still, others shared that rumors circulating in the community made them hesitant saying, “I heard a lot of rumors about the vaccine which made me not want to get the covid vaccine”.

Together, these concerns show not only the prevalence of safety worries but also the broader social and informational landscape that people are navigating when they make vaccine decisions.

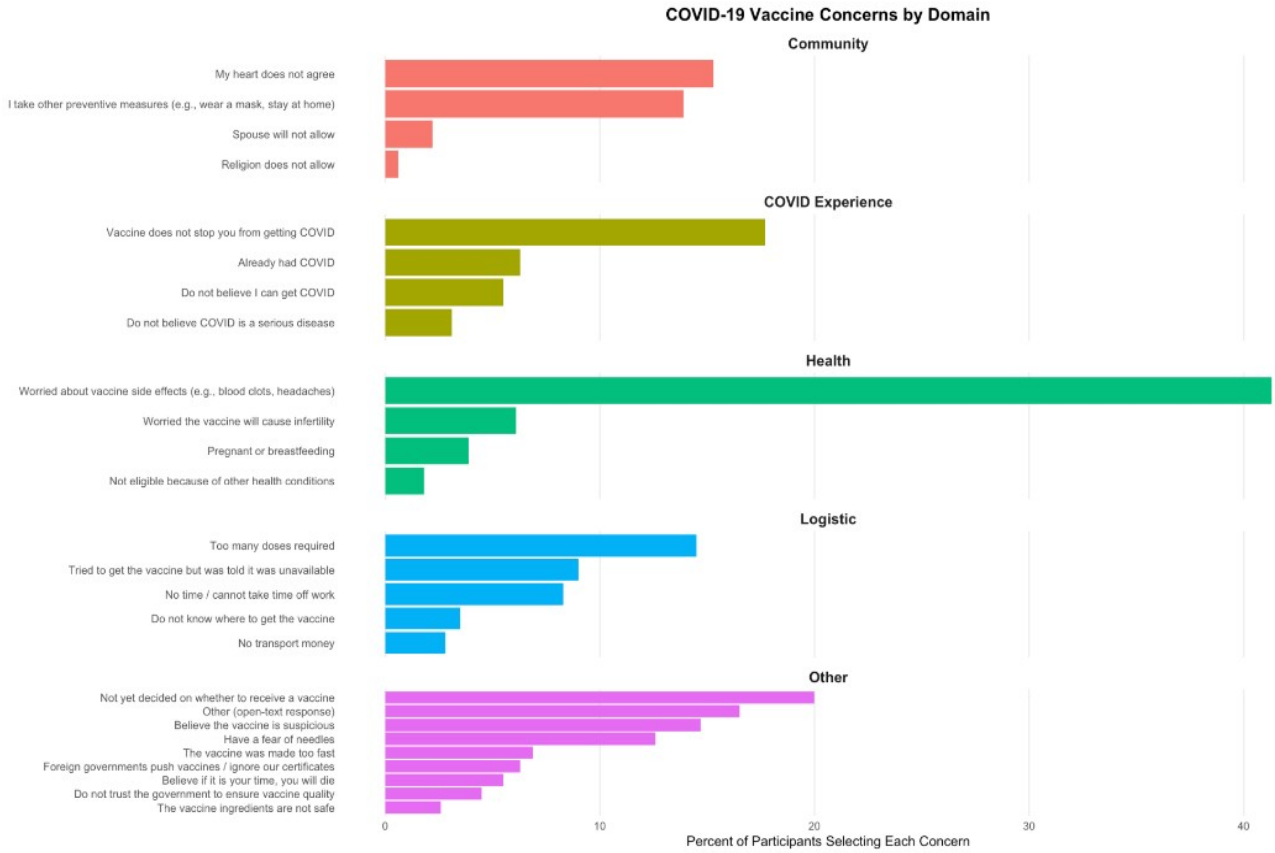

Figure 4. Proportion of selected COVID-19 vaccine concerns by domain

Quantitative Analysis

Participant characteristics across concern profiles

A total of 499 participants were included in the analysis. The distribution of demographic and behavioral characteristics varied across the five concern profiles (**Table 1**). Gender proportions were similar across profiles, with no meaningful differences between males and

females. Age differed meaningfully across profiles. Profile 2 contained the largest proportion of adults aged 45 years or older (31%), indicating a comparatively older group. In contrast, Profile 1 had the youngest age distribution, with most participants falling within the 18-24 and 25-29 age ranges.

Marital status also varied across profiles. Profile 3 had the highest proportion of single participants (67%), while Profile 2 included more widowed or divorced individuals compared with other profiles.

Educational attainment showed moderate variation. Profile 1 included more participants with post-secondary education, whereas Profile 2 had higher proportions of individuals who had completed secondary school as their highest level of education. Profile 5 exhibited the highest proportion of individuals with less than secondary school education.

There were notable differences in patterns of concern between profiles. Profiles 1, 3, 4, and 5 reported consistently high concerns across nearly every domain. In comparison, Profile 2 consistently displayed lower concern levels. Logistics concerns were highly prevalent across the profiles, though domain-specific patterns varied.

Notably, COVID-19 vaccine uptake did not differ significantly across the five profiles, indicating that past COVID-19 vaccination does not necessarily predict someone's willingness to accept future vaccines. These findings are consistent with Dr. Sharma's results.

Table 1: Participant characteristic by concern profile								
Covariate	*Level*	*Profile 1 n (%)*	*Profile 2 n (%)*	*Profile 3 n (%)*	*Profile 4 n (%)*	*Profile 5 n (%)*	*Total n (%)*	*p-value*
N		100	170	33	81	115	499	
Gender	Male	45 (45.0)	73 (42.9)	18 (54.5)	42 (51.8)	52 (45.2)	230 (46.1)	0.593
	Female	55 (55.0)	97 (57.1)	15 (45.5)	39 (48.2)	63 (54.8)	269 (53.9)	
Age	18-24 years	35 (35.0)	39 (22.9)	14 (42.4)	21 (25.9)	26 (22.6)	135 (27.1)	0.007
	25-29 years	23 (23.0)	31 (18.2)	6 (18.2)	18 (22.2)	18 (15.7)	96 (19.2)	
	30-34 years	16 (16.0)	17 (10.0)	5 (15.2)	9 (11.1)	23 (20.0)	70 (14.0)	
	35-44 years	14 (14.0)	30 (17.6)	5 (15.2)	15 (18.5)	28 (24.3)	92 (18.4)	
	45+ years	12 (12.0)	53 (31.2)	3 (9.1)	18 (22.2)	20 (17.4)	106 (21.2)	
Marital status	Single	47 (47.0)	64 (37.6)	22 (66.7)	37 (45.7)	38 (33.0)	208 (41.7)	0.009
	Stable relationship, not married	3 (3.0)	8 (4.7)	0 (0.0)	6 (7.4)	7 (6.1)	24 (4.8)	
	Co-cohabiting/Married	47 (47.0)	71 (41.8)	11 (33.3)	29 (35.8)	62 (53.9)	220 (44.1)	
	Divorced/Separated	0 (0.0)	11 (6.5)	0 (0.0)	3 (3.7)	6 (5.2)	20 (4.0)	
	Widowed	3 (3.0)	15 (8.8)	0 (0.0)	6 (7.4)	2 (1.7)	26 (5.2)	
	Prefer not to answer	0 (0.0)	1 (0.6)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.2)	
Educational attainment	Less than secondary school	12 (12.0)	24 (14.1)	3 (9.1)	15 (18.5)	14 (12.2)	68 (13.6)	0.244
	Some secondary school	17 (17.0)	40 (23.5)	13 (39.4)	17 (21.0)	36 (31.3)	123 (24.6)	
	Completed secondary school	40 (40.0)	69 (40.6)	10 (30.3)	28 (34.6)	36 (31.3)	183 (36.7)	
	Post-secondary education	31 (31.0)	37 (21.8)	7 (21.2)	21 (25.9)	29 (25.2)	125 (25.1)	
Religion	Evangelical/Protestant/Other Christian	20 (20.0)	27 (15.9)	9 (27.3)	18 (22.2)	21 (18.3)	95 (19.0)	0.489
	Catholic	25 (25.0)	38 (2.4)	7 (21.2)	14 (17.3)	21 (18.3)	105 (21.0)	
	SDA	9 (9.0)	25 (14.7)	4 (12.1)	13 (16.0)	16 (13.9)	67 (13.4)	
	JW	6 (6.0)	11 (6.5)	1 (3.0)	2 (2.5)	4 (3.5)	24 (4.8)	
	Pentecostal	24 (24.0)	48 (28.2)	4 (12.1)	22 (27.2)	36 (31.3)	134 (26.9)	
	Other religion	16 (16.0)	20 (11.8)	8 (24.2)	12 (14.8)	14 (12.2)	70 (14.0)	
	Not religious	0 (0.0)	1 (0.6)	0 (0.0)	0 (0.0)	3 (2.6)	4 (0.8)	
Community role	Community member	72 (72.0)	142 (83.5)	27 (81.8)	65 (80.2)	89 (77.4)	395 (79.2)	0.240
	Healthcare worker	28 (28.0)	28 (16.5)	6 (18.2)	16 (19.8)	26 22.6)	104 (20.8)	
HIV status	HIV negative	82 (82.0)	118 (69.4)	22 (66.7)	64 (79.0)	88 (76.5)	374 (74.9)	0.245
	PLHIV	10 (10.0)	18 (10.6)	4 (12.1)	8 (9.9)	9 (7.8)	49 (9.8)	
	HIV status unknown	8 (8.0)	34 (20.0)	7 (21.2)	9 (11.1)	18 (15.7)	76 (15.2)	
COVID Vaccine	3+ doses	5 (5.0)	15 (8.8)	1 (3.0)	4 (4.9)	7 (6.1)	32 (6.4)	0.290
	2 doses	37 (37.0)	63 (37.1)	10 (30.3)	27 (33.3)	36 (31.3)	173 (34.7)	
	1 dose	23 (23.0)	42 (24.7)	6 (18.2)	30 (37.0)	36 (31.3)	137 (27.5)	
	No doses	35 (35.0)	50 (29.4)	16 (48.5)	20 (24.7)	36 (31.3)	157 (31.5)	
Logistic concern	No concern	20 (20.0)	170 (100.0)	6 (18.2)	0 (0.0)	115 (100.0)	311 (62.3)	<0.001
	Concern	80 (80.0)	0 (0.0)	27 (81.8)	81 (100.0)	0 (0.0)	188 (37.7)	
Health concern	No concern	11 (11.0)	170 (100.0)	7 (21.2)	63 (77.8)	0 (0.0)	251 (50.3)	<0.001
	Concern	89 (89.0)	0 (0.0)	26 (78.8)	18 (22.2)	115 (100.0)	248 (49.7)	
Community concern	No concern	12 (12.0)	151 (88.8)	8 (24.2)	76 (93.8)	99 (86.1)	346 (69.3)	<0.001
	Concern	88 (88.0)	19 (11.2)	25 (75.8)	5 (6.2)	16 (13.9)	153 (30.7)	
Experience concern	No concern	13 (13.0)	147 (86.5)	12 (36.4)	75 (92.6)	98 (85.2)	345 (69.1)	<0.001
	Concern	87 (87.0)	23 (13.5)	21 (63.6)	6 (7.4)	17 (14.8)	154 (30.9)	
Personal concern	No concern	11 (11.0)	55 (32.4)	0 (0.0)	56 (69.1)	62 (53.9)	184 (36.9)	<0.001
	Concern	89 (89.0)	115 (67.6)	33 (100.0)	25 (30.9)	53 (46.1)	315 (63.1)	
Note: p-value results of Pearson's Chi-squared test								

Table 1. Participant characteristics across concern profile.

Bivariate Associations between characteristics and concern profiles

The bivariate analyses revealed distinct patterns across the five concern profiles (see **Table 2** in Appendix C). Profile 1 was defined by high levels of concern across multiple domains but did not differ meaningfully from other profiles in demographic characteristics. Participants in this profile were approximately 16 times more likely to exhibit community concerns, 15 times

more likely to express past COVID-19 experience concerns, and 8 times more likely to have health-related concerns. In contrast, Profile 2 displayed notable demographic distinctions. Members of this profile were about twice as likely to be 45 years or older (prevalence ratio [PR] = 2.06) and were more likely to be widowed (PR = 1.79). Profile 2 also demonstrated lower levels of community concerns (PR = 0.28, 95% CI: 0.18, 0.46) and experience-related concerns (PR = 0.35, 95% CI: 0.23, 0.54), reinforcing its position as a relatively low concern group overall.

Profile 3 was composed largely of younger, single adults and exhibited heavy concerns across nearly all domains. Participants in Profile 3 were approximately seven times more likely to endorse logistical concerns and community-level concerns, and four times more likely to endorse health-related concerns and concerns related to past vaccine experiences.

Profile 4 did not differ in demographic characteristics but represented the most concern-free group overall. Individuals in this profile were less likely to endorse nearly all categories of concerns relative to the other groups, positioning them as another concern-free group. Profile 5 consisted primarily of single and non-religious participants and may represent a younger group of individuals. Members of this profile were significantly less likely to report concerns related to their community, prior vaccine experiences, or personal factors.

Collectively, these findings demonstrate that concern profiles are strongly differentiated by multi-domain concern patterns and, to a lesser extent, by demographic characteristics such as age, marital status, and education.

Crude Associations between concern profiles and high novel vaccine intention

Intention to receive a novel vaccine (intention score >85) varied across concern profiles. Profile 3 demonstrated the highest proportion of participants with high intention (90.9%), followed by Profile 4 (80.2%) and Profile 1 (71.0%). Profile 5 and the reference group, Profile 2, had similar levels of high intention at 69.6% and 70.0%, respectively. Profile 3 demonstrated a higher crude prevalence of high intention compared with Profile 2 (PR = 1.30, 95% CI: 0.81,1.94), while Profile 4 showed a smaller increase (PR = 1.15, 95% CI: 0.85,1.55). Profiles 1 and 5 exhibited intention levels comparable to the reference group.

Adjusted Associations between concern profiles and high novel vaccine intention

After adjusting for age, gender, marital status, education, religion, community role, HIV status, and COVID-19 vaccination status (**Table 3**), the estimated associations were reduced, and none remained statistically significant. Profile 3 continued to show the highest adjusted prevalence of high intention (aPR = 1.26, 95% CI: 0.83, 1.91), followed by Profile 4 (aPR = 1.13, 95% CI: 0.83, 1.54). Profiles 1 and 5 had adjusted prevalence ratios near 1.0, indicating intention levels similar to Profile 2. Overall, the adjusted findings suggest that demographic and contextual factors accounted for much of the initial variation in intention across profiles, and that concern profile membership itself was not independently associated with intention to receive novel vaccines.

Table 3: Association between concern profile and intention to receive a new novel vaccines								
Profile	n (%)	Outcome (%)	*PR*	*95% CI*	*p-value*	*aPR*	*95% CI*	*p-value*
1	100 (20.0)	71.0	1.01	(0.76, 1.36)	0.925	1.01	(0.74, 1.37)	0.96
2	170 (34.1)	70.0	1.00 (ref)	ref	ref	1.00 (ref)	ref	ref
3	33 (6.6)	90.9	1.30	(0.87, 1.94)	0.201	1.26	(0.83, 1.91)	0.288
4	81 (16.2)	80.2	1.15	(0.85, 1.55)	0.376	1.13	(0.83, 1.54)	0.435
5	115 (23.1)	69.6	0.99	(0.75, 1.32)	0.966	1.01	(0.75, 1.35)	0.973
Note: PR- prevalence ratio, Adjusted for age, gender, marital status, education, religion, community role, HIV status, and COVID-19 vaccination status (DAG-dereived adjustment set), vaccine pathogen for influenza, pneumonia, tuberculosis, diarrheal disease, malaria, HIV, and new COVID booster.								

Table 3. Association between concern profile and intention to receive new novel vaccines

Discussion

This study examined how distinct concern profiles were associated with intention to receive novel vaccines among adults in Lusaka Province, Zambia. Although concern profiles differed in demographic composition and concern patterns, their associations with high vaccine intention were modest, and no profile remained significantly associated with intention after covariate adjustment. These findings suggest that the psychological and contextual determinants of vaccine intention are more complex than concern categories alone and that demographic and structural factors play meaningful roles in shaping intention.

These findings are consistent with Dr. Sharma's paper in which perceived disease severity was the strongest predictor of intention to receive future non-COVID vaccines.[22] The additional pre-prints derived from the same dataset also found that disease perceptions, trust, and practical barriers shape intention more consistently than demographic characteristics alone.[30, 31] The most important decision-making factors for a new adult vaccine were the disease it prevents,

how severe the disease is, vaccine effectiveness and duration of protection.[30,31] The studies also revealed mixed feelings about COVID-19 vaccines due to misinformation, rapid development, and confusing guidance.

Profiles characterized by younger, single participants and high concern burdens (e.g., Profiles 3 and 4) initially appeared more likely to express high intention, whereas the low-concern and older Profile 2 group showed more moderate intention levels. However, these differences were reduced in adjusted models, indicating that age, marital status, education, religion, community role, HIV status, and COVID-19 vaccination history accounted for much of the variability. These observations are consistent with the findings discussed in Dr. Sharma's paper. This highlights the nuanced reality that similar concerns may influence individuals in different ways. For example, the same concern domain may motivate one person to seek vaccination while discouraging another, depending on personal experience, perceived vulnerability, and broader contextual factors. These findings challenge the assumption that concerns operate uniformly within populations and underscore the importance of exploring how concern patterns intersect with sociocultural and demographic contexts.

Think Tank Meeting

Findings from the practicum were presented via Zoom to an interdisciplinary audience of researchers from CIDRZ. The session opened with an overview of the study context. Complex analytic processes were visually presented and included various figures such as a DAG, clustering outputs, series of tables, and an infographic of concern profiles. These visuals

supported interpretation by transforming statistically dense results into themes that could inform public health practices and policy.

The presentation highlighted the implications of targeting intervention strategies based on concern domains rather than demographic characteristics. These findings emphasize the need for domain-specific messaging as new vaccines are introduced.

The session concluded with an interactive discussion that prompted questions from the audience. Researchers asked whether disease perceptions and vaccine attributes, rather than social or demographic factors, are likely to shape intention to accept future vaccines and whether such factors have been analyzed. Another question focused on whether the proportion of variance in vaccine attitudes explained by demographic characteristics could be quantified. Overall, audience engagement was positive, and the interactive nature of the discussion highlighted the relevance of this work.

Future Implications

The results emphasize the importance of designing vaccine communication and outreach strategies that reflect the diversity of motivations within the population. Interventions targeted solely based on concern type may overlook the varied ways in which individuals interpret and respond to concerns. Tailored messaging that considers demographic variability, personal lived experiences, and previous interactions with the health system may be more effective than approaches based exclusively on concern categories. Future studies should examine how concern patterns interact with trust, risk perception, and social context to shape vaccine decisions.

Incorporating qualitative insights could deepen understanding of why individuals with similar concern profiles reach different conclusions about vaccination.

Strengths

A key strength of this study is the use of a large, diverse sample drawn from both HCWs and community members, allowing for exploration of variability within and across subgroups. The use of concern profiles allowed for the identification of meaningful psychological and experiential clusters rather than relying on predetermined categories. Additionally, the incorporation of a validated aggregate intention score provided a more comprehensive measure of vaccine intention across multiple disease conditions, rather than relying on a single-item indicator.

The two preprints also reveal several limitations and gaps that my practicum sought to address. Both studies identified which vaccine attributes matter most using best-worst scaling but did not examine how different types of concerns group together within people or whether they predict intention.[30, 31] The practicum used the same dataset to create multi-domain concern profiles and then tested whether these profiles predicted intention for several new vaccines.

The variation observed within profiles highlights that profiles themselves do not fully determine vaccine intention. Even within the most concern-heavy profiles, a considerable proportion of participants reported high intention to vaccinate. Conversely, individuals in low-concern profiles were not highly intended to vaccinate. This internal heterogeneity suggests that interventions must account for individual-level variability rather than relying solely on profile-

level trends. These findings support the notion that sociodemographic, experiential, and psychological factors intersect in complex ways that shape vaccine attitudes.

Limitations

This study has several limitations. First, the measure of past COVID-19 vaccine uptake relied on self-reporting, which is susceptible to recall bias and social desirability bias.[22] Second, because the sample was drawn from urban communities in Lusaka Province, the findings may not be generalizable to rural settings or even to other urban areas in Zambia. Third, although concern profiles capture broad psychological patterns, they cannot fully account for the complexity of individual reasoning, and the interpretation of concerns may differ widely across participants. The same concern domain may motivate vaccination for one individual but discourage it for another, underscoring that concerns are context-dependent and not universally predictive. Finally, intention was analyzed as one combined outcome across all vaccines rather than separately for each pathogen, which may mask vaccine-specific patterns in decision-making.

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Table of Abbreviations

BWS	Best-worst scaling
CDC	Centers for Disease Control and Prevention
CIDRZ	Centre for Infectious Disease Research in Zambia
COVID-19	Coronavirus disease 2019
HCWs	Healthcare workers
LMIC	Low-to-middle income countries
PR	Prevalence ratio
SSA	Sub-Saharan Africa
USAID	U.S. Agency for International Development
WHO	World Health Organization

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Appendix A

Product Competency Attainment	
Competency	**Description**
Apply epidemiological methods to settings and situations in public health practice	**Product #1: Internal Report for CIDRZ** Analyzed the COVID-19 BWS survey dataset which involved reviewing and cleaning the raw data, identifying patterns of missingness, and preparing analytical variables. Epidemiological reasoning guided the selection of adjustment sets and interpretation of prevalence ratios which translates findings into evidence-based conclusions for public health practice.
Analyze quantitative and qualitative data using biostatistics, informatics, computer-based programming and software, as appropriate	**Product #1: Internal Report for CIDRZ** Conducted quantitative analysis of the dataset using R to examine vaccine concerns and intention outcomes. Qualitative insights were integrated through the development of a literature review matrix that synthesized themes from existing research which contextualized the quantitative findings. **Product #2: Presentation of Findings** These components were incorporated into the Think Tank meeting, which visually presented statistical results alongside evidence from the literature to provide a comprehensive understanding of COVID-19 vaccination concerns and future vaccine intentions.
Interpret results of data analysis for public health research, policy or practice	**Product #1: Internal Report for CIDRZ** Interpreted quantitative findings to provide recommendations for vaccine communication and

	intervention. **Product #2: Presentation of Findings** Presented results in a concise and accessible format that emphasize actionable insights for decision makers. It highlighted the practical implications of concern profiles and need for domain specific communication strategies.
Critically analyze health literature when discussing health disparities.	**Product #1: Internal Report for CIDRZ** Critically analyze health literature on vaccine uptake and hesitancy in resource-limited settings, focusing on disparities that shape vaccine access and acceptance. These findings contextualized quantitative findings.
Synthesize and present health disparities research to a group.	**Product #2: Presentation of Findings** The slide deck presented disparities and gaps in vaccine concerns and intentions to Dr. Pry, the BWS research team, and stakeholders at the Think Tank meeting.

Appendix B

Report Competency Attainment	
Competency	**Description**
Analyze quantitative and qualitative data using biostatistics, informatics, computer-based programming and software, as appropriate	Used R to clean, manage, and analyze the BWS survey dataset through descriptive statistics, regression modeling, and data visualization. Qualitative data from the literature search was synthesized through a structured matrix that informed interpretation of vaccine concerns and patterns of intention.

Interpret results of data analysis for public health research, policy or practice	Translated analytical findings into clear conclusions about vaccine concerns and their implications for public health communication and intervention planning.
Ability to evaluate the epidemiologic literature critically with regard to design, potential biases, assessment of adequacy of analytic approach, and interpretation of results given limitations	Reported findings from the literature matrix, which evaluated study designs, sources of bias, key results, and limitations. Preprints that used the same dataset were reviewed to understand their analytic approach and identify unanswered questions. Insights from these studies informed the development of the research question.
Ability to assess confounding and effect modification in epidemiologic studies	During model building in R, confounders were identified using a directed acyclic graph and evaluated through bivariate and regression analyses. Examination of difference in effect estimates across models supported assessment of confounding and potential effect modification.
Critically analyze health literature when discussing health disparities	Assessed how structural, social, and contextual factors shape vaccine concerns in Zambia. The literature review highlighted disparities in trust, communication, and health system reach.
Synthesize and present health disparities research to a group	Organized quantitative results and literature-based insights into a clear narrative about vaccine disparities. The presentation communicated findings in an accessible format for stakeholders and researchers.

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Appendix C

Table 2a: Unadjusted bivariate prevalence ratios for Profile 1 (n = 100)				
Covariate	*Level*	*PR*	*95% CI*	*p-value*
Gender	Male	1.00 (ref)	ref	ref
	Female	1.05	(0.70, 1.55)	0.827
Age	18-24 years	1.13	(0.63, 2.05)	0.676
	25-29 years	1.05	(0.55, 1.98)	0.885
	30-34 years	1.00 (ref)	ref	ref
	35-44 years	0.67	(0.32, 1.36)	0.266
	45+ years	0.50	(0.23, 1.05)	0.066
Marital status	Single	1.06	(0.71, 1.58)	0.786
	Stable relationship, not married	0.59	(0.18, 1.88)	0.368
	Co-cohabiting/Married	1.00 (ref)	ref	ref
	Divorced/Separated	NA	NA	NA
	Widowed	0.54	(0.17, 1.74)	0.301
	Prefer not to answer	NA	NA	NA
Educational attainment	Less than secondary school	0.81	(0.42, 1.54)	0.516
	Some secondary school	0.63	(0.36, 1.12)	0.113
	Completed secondary school	1.00 (ref)	ref	ref
	Post-secondary education	1.13	(0.71, 1.81)	0.598
Religion	Evangelical/Protestant/Other Christian	1.00 (ref)	ref	ref
	Catholic	1.13	(0.63, 2.04)	0.682
	SDA	0.64	(0.29, 1.40)	0.263
	JW	1.19	(0.48, 2.96)	0.712
	Pentecostal	0.85	(0.47, 1.54)	0.593
	Other religion	1.09	(0.56, 2.10)	0.806
	Not religious	NA	NA	NA
Community role	Community member	1.00 (ref)	ref	ref
	Healthcare worker	1.48	(0.95, 2.29)	0.080
HIV status	HIV negative	1.00 (ref)	ref	ref
	PLHIV	0.93	(0.48, 1.79)	0.831
	HIV status unknown	0.48	(0.23, 0.99)	0.048
COVID Vaccine	3+ doses	0.73	(0.29, 1.86)	0.510
	2 doses	1.00 (ref)	ref	ref
	1 dose	0.78	(0.47, 1.32)	0.362
	No doses	1.04	(0.66, 1.65)	0.860
Logistic concern	No concern	1.00 (ref)	ref	ref
	Concern	6.62	(4.05, 10.80)	<0.001
Health concern	No concern	1.00 (ref)	ref	ref
	Concern	8.19	(4.38, 15.32)	<0.001
Community concern	No concern	1.00 (ref)	ref	ref
	Concern	16.58	(9.07, 30.31)	<0.001
Experience concern	No concern	1.00 (ref)	ref	ref
	Concern	14.99	(8.37, 26.85)	<0.001
Personal concern	No concern	1.00 (ref)	ref	ref
	Concern	4.73	(2.53, 8.84)	<0.001
Note: CI - confidence interval, PR - prevalence ratio, NA - not applicable, variables examined include demographic characteristics, COVID-19 vaccination status, and concern domains.				

Table 2b: Unadjusted bivariate prevalence ratios for Profile 2 (n = 170)				
Covariate	*Level*	*PR*	*95% CI*	*p-value*
Gender	Male	1.00 (ref)	ref	ref
	Female	1.14	(0.84, 1.54)	0.410
Age	18-24 years	1.19	(0.67, 2.10)	0.550
	25-29 years	1.33	(0.74, 2.40)	0.345
	30-34 years	1.00 (ref)	ref	ref
	35-44 years	1.34	(0.74, 2.43)	0.332
	45+ years	2.06	(1.19, 3.56)	0.010
Marital status	Single	0.95	(0.68, 1.34)	0.782
	Stable relationship, not married	1.03	(0.50, 2.15)	0.931
	Co-cohabiting/Married	1.00 (ref)	ref	ref
	Divorced/Separated	1.70	(0.90, 3.22)	0.100
	Widowed	1.79	(1.02, 3.12)	0.041
	Prefer not to answer	3.10	(0.43, 22.30)	0.261
Educational attainment	Less than secondary school	0.94	(0.59, 1.49)	0.780
	Some secondary school	0.86	(0.58, 1.27)	0.457
	Completed secondary school	1.00 (ref)	ref	ref
	Post-secondary education	0.79	(0.53, 1.17)	0.235
Religion	Evangelical/Protestant/Other Christian	1.00 (ref)	ref	ref
	Catholic	1.27	(0.78, 2.09)	0.337
	SDA	1.31	(0.76, 2.26)	0.327
	JW	1.61	(0.80, 3.25)	0.182
	Pentecostal	1.26	(0.79, 2.02)	0.336
	Other religion	1.01	(0.56, 1.79)	0.986
	Not religious	0.88	(0.12, 6.47)	0.900
Community role	Community member	1.00 (ref)	ref	ref
	Healthcare worker	0.75	(0.50, 1.12)	0.162
HIV status	HIV negative	1.00 (ref)	ref	ref
	PLHIV	1.16	(0.71, 1.91)	0.548
	HIV status unknown	1.42	(0.97, 2.08)	0.073
COVID Vaccine	3+ doses	1.29	(0.73, 2.26)	0.380
	2 doses	1.00 (ref)	ref	ref
	1 dose	0.84	(0.57, 1.24)	0.387
	No doses	0.87	(0.60, 1.27)	0.479
Logistic concern	No concern	1.00 (ref)	ref	ref
	Concern	NA	NA	NA
Health concern	No concern	1.00 (ref)	ref	ref
	Concern	NA	NA	NA
Community concern	No concern	1.00 (ref)	ref	ref
	Concern	0.28	(0.18, 0.46)	<0.001
Experience concern	No concern	1.00 (ref)	ref	ref
	Concern	0.35	(0.23, 0.54)	<0.001
Personal concern	No concern	1.00 (ref)	ref	ref
	Concern	1.22	(0.89, 1.68)	0.223

Note: CI - confidence interval, PR - prevalence ratio, NA - not applicable, variables examined include demographic characteristics, COVID-19 vaccination status, and concern domains.

Table 2c: Unadjusted bivariate prevalence ratios for Profile 3 (n = 33)				
Covariate	*Level*	*PR*	*95% CI*	*p-value*
Gender	Male	1.00 (ref)	ref	ref
	Female	0.71	(0.36, 1.41)	0.332
Age	18-24 years	1.45	(0.52, 4.03)	0.474
	25-29 years	0.88	(0.27, 2.87)	0.825
	30-34 years	1.00 (ref)	ref	ref
	35-44 years	0.76	(0.22, 2.63)	0.666
	45+ years	0.40	(0.09, 1.66)	0.205
Marital status	Single	2.12	(1.03, 4.36)	0.042
	Stable relationship, not married	NA	NA	NA
	Co-cohabiting/Married	1.00 (ref)	ref	ref
	Divorced/Separated	NA	NA	NA
	Widowed	NA	NA	NA
	Prefer not to answer	NA	NA	NA
Educational attainment	Less than secondary school	0.81	(0.22, 2.93)	0.745
	Some secondary school	1.93	(0.85, 4.41)	0.117
	Completed secondary school	1.00 (ref)	ref	ref
	Post-secondary education	1.02	(0.39, 2.69)	0.960
Religion	Evangelical/Protestant/Other Christian	1.00 (ref)	ref	ref
	Catholic	0.70	(0.26, 1.89)	0.486
	SDA	0.63	(0.19, 2.05)	0.442
	JW	0.44	(0.06, 3.47)	0.436
	Pentecostal	0.32	(0.10, 1.02)	0.055
	Other religion	1.21	(0.47, 3.13)	0.699
	Not religious	NA	NA	0.989
Community role	Community member	1.00 (ref)	ref	ref
	Healthcare worker	0.84	(0.35, 2.04)	0.707
HIV status	HIV negative	1.00 (ref)	ref	ref
	PLHIV	1.39	(0.48, 4.03)	0.547
	HIV status unknown	1.57	(0.67, 3.67)	0.301
COVID Vaccine	3+ doses	0.54	(0.07, 4.22)	0.558
	2 doses	1.00 (ref)	ref	ref
	1 dose	0.76	(0.28, 2.08)	0.591
	No doses	1.76	(0.80, 3.89)	0.160
Logistic concern	No concern	1.00 (ref)	ref	ref
	Concern	7.44	(3.07, 18.03)	<0.001
Health concern	No concern	1.00 (ref)	ref	ref
	Concern	3.76	(1.63, 8.66)	0.002
Community concern	No concern	1.00 (ref)	ref	ref
	Concern	7.07	(3.19, 15.67)	<0.001
Experience concern	No concern	1.00 (ref)	ref	ref
	Concern	3.92	(1.93, 7.97)	<0.001
Personal concern	No concern	1.00 (ref)	ref	ref
	Concern	NA	NA	NA

Note: CI - confidence interval, PR - prevalence ratio, NA - not applicable, variables examined include demographic characteristics, COVID-19 vaccination status, and concern domains.

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Table 2d: Unadjusted bivariate prevalence ratios for Profile 4 (n = 81)				
Covariate	*Level*	*PR*	*95% CI*	*p-value*
Gender	Male	1.00 (ref)	ref	ref
	Female	0.79	(0.51, 1.23)	0.299
Age	18-24 years	1.21	(0.55, 2.64)	0.633
	25-29 years	1.46	(0.66, 3.25)	0.355
	30-34 years	1.00 (ref)	ref	ref
	35-44 years	1.27	(0.55, 2.90)	0.573
	45+ years	1.32	(0.59, 2.94)	0.496
Marital status	Single	1.35	(0.83, 2.19)	0.227
	Stable relationship, not married	1.90	(0.79, 4.57)	0.154
	Co-cohabiting/Married	1.00 (ref)	ref	ref
	Divorced/Separated	1.14	(0.35, 3.74)	0.831
	Widowed	1.75	(0.73, 4.22)	0.212
	Prefer not to answer	NA	NA	NA
Educational attainment	Less than secondary school	1.44	(0.77, 2.70)	0.253
	Some secondary school	0.90	(0.49, 1.65)	0.741
	Completed secondary school	1.00 (ref)	ref	ref
	Post-secondary education	1.10	(0.62, 1.93)	0.746
Religion	Evangelical/Protestant/Other Christian	1.00 (ref)	ref	ref
	Catholic	0.70	(0.35, 1.41)	0.324
	SDA	1.02	(0.50, 2.09)	0.948
	JW	0.44	(0.10, 1.90)	0.270
	Pentecostal	0.87	(0.46, 1.62)	0.652
	Other religion	0.90	(0.44, 1.88)	0.788
	Not religious	NA	NA	NA
Community role	Community member	1.00 (ref)	ref	ref
	Healthcare worker	0.93	(0.54, 1.62)	0.809
HIV status	HIV negative	1.00 (ref)	ref	ref
	PLHIV	0.95	(0.46, 1.99)	0.900
	HIV status unknown	0.69	(0.34, 1.39)	0.301
COVID Vaccine	3+ doses	0.80	(0.28, 2.29)	0.679
	2 doses	1.00 (ref)	ref	ref
	1 dose	1.40	(0.83, 2.36)	0.202
	No doses	0.82	(0.46, 1.46)	0.491
Logistic concern	No concern	1.00 (ref)	ref	ref
	Concern	NA	NA	NA
Health concern	No concern	1.00 (ref)	ref	ref
	Concern	0.29	(0.17, 0.49)	<0.001
Community concern	No concern	1.00 (ref)	ref	ref
	Concern	0.15	(0.06, 0.37)	<0.001
Experience concern	No concern	1.00 (ref)	ref	ref
	Concern	0.18	(0.08, 0.41)	<0.001
Personal concern	No concern	1.00 (ref)	ref	ref
	Concern	0.26	(0.16, 0.42)	<0.001
Note: CI - confidence interval, PR - prevalence ratio, NA - not applicable, variables examined include demographic characteristics, COVID-19 vaccination status, and concern domains.				

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Table 2e: Unadjusted bivariate prevalence ratios for Profile 5 (n = 115)				
Covariate	*Level*	*PR*	*95% CI*	*p-value*
Gender	Male	1.00 (ref)	ref	ref
	Female	1.04	(0.72, 1.50)	0.851
Age	18-24 years	0.59	(0.33, 1.03)	0.062
	25-29 years	0.57	(0.31, 1.06)	0.075
	30-34 years	1.00 (ref)	ref	ref
	35-44 years	0.93	(0.53, 1.61)	0.786
	45+ years	0.57	(0.32, 1.05)	0.070
Marital status	Single	0.65	(0.43, 0.97)	0.035
	Stable relationship, not married	1.03	(0.47, 2.26)	0.931
	Co-cohabiting/Married	1.00 (ref)	ref	ref
	Divorced/Separated	1.06	(0.46, 2.46)	0.884
	Widowed	0.27	(0.07, 1.12)	0.071
	Prefer not to answer	NA	NA	NA
Educational attainment	Less than secondary school	1.05	(0.56, 1.94)	0.885
	Some secondary school	1.49	(0.94, 2.36	0.092
	Completed secondary school	1.00 (ref)	ref	ref
	Post-secondary education	1.18	(0.72, 1.92)	0.509
Religion	Evangelical/Protestant/Other Christian	1.00 (ref)	ref	ref
	Catholic	0.90	(0.49, 1.66)	0.746
	SDA	1.08	(0.56, 2.07)	0.816
	JW	0.75	(0.26, 2.20)	0.605
	Pentecostal	1.22	(0.71, 2.08)	0.478
	Other religion	0.90	(0.46, 1.78)	0.772
	Not religious	3.39	(1.01, 11.37)	0.048
Community role	Community member	1.00 (ref)	ref	ref
	Healthcare worker	1.11	(0.72, 1.72)	0.641
HIV status	HIV negative	1.00 (ref)	ref	ref
	PLHIV	0.78	(0.39, 1.55)	0.479
	HIV status unknown	1.01	(0.61, 1.67)	0.980
COVID Vaccine	3+ doses	1.05	(0.47, 2.36)	0.904
	2 doses	1.00 (ref)	ref	ref
	1 dose	1.26	(0.80, 2.00)	0.322
	No doses	1.10	(0.69, 1.75)	0.681
Logistic concern	No concern	1.00 (ref)	ref	ref
	Concern	NA	NA	NA
Health concern	No concern	1.00 (ref)	ref	ref
	Concern	NA	NA	NA
Community concern	No concern	1.00 (ref)	ref	ref
	Concern	0.37	(0.22, 0.62)	<0.001
Experience concern	No concern	1.00 (ref)	ref	ref
	Concern	0.39	(0.23, 0.65)	<0.001
Personal concern	No concern	1.00 (ref)	ref	ref
	Concern	0.50	(0.35, 0.72)	<0.001
Note: CI - confidence interval, PR - prevalence ratio, NA - not applicable, variables examined include demographic characteristics, COVID-19 vaccination status, and concern domains.				