

RESEARCH

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cases exceeded 676 million, with at least 6.8 million deaths worldwide [4]. It is noted that additional analyses and modeling have shown a significant excess mor-

Consequently, the total sample of 2,303 respondents may not be fully representative of the populations in Zimbabwe and Sierra Leone.

Procedure

Participants were recruited from the communities within the catchment areas of ZACH and CHASL member facilities. Participants were invited to participate in the face-to-face questionnaire. They were asked to acknowledge their interest and willingness by providing their contact information and scheduling a meeting date with the data collection team. Enumerators contracted by ZACH in Zimbabwe and CHASL in Sierra Leone collected the data. Enumerators traveled to respondents' homes, obtained written informed consent, and completed the 20-min questionnaire. Respondents were assured that their participation was voluntary. Inclusion criteria included being 18 years of age or older and the ability to speak English. Enumerators entered data into smartphones and uploaded the data into a central database. Ethical clearance for publication of study's data was approved by the Brigham Young University Institutional Review Board (IRB2023-026). Researchers adhered to the ethical principles outlined in the Declaration of Helsinki by ensuring their autonomy and collecting informed consent from all participants, safeguarding their confidentiality by securing all data on password protected devices, and prioritizing their well-being throughout the research process.

Measurement

The questionnaire instrument used in this study was constructed collaboratively and included inputs from ACHAP, IMA World Health, Internews, and in-country partners ZACH and CHASL. The instrument was adapted from the US Centers for Disease Control and Prevention's Rapid Community Assessment guidelines for community surveys. The instrument was constructed in English, and specific items were pilot-tested in focus groups conducted in Zimbabwe and Sierra Leone. The instrument was then revised in accordance with the feedback, and all partners agreed upon a final version. The questionnaire included five sections, including demographics, items measuring COVID-19 vaccination (e.g., vaccination status, vaccine refusal, etc.), and key theoretical constructs from the HBM and TPB related to perceptions.

Demographic items included sex, age, level of education obtained, and information about pre-existing medical conditions. COVID-19 vaccination items included whether the respondent had been vaccinated and whether they have ever refused the COVID-19 vaccine.

A variable representing high vaccine uptake was constructed that included respondents who had been vaccinated and who never had at any point refused the vaccine. A separate variable was constructed to represent low vaccine uptake and consisted of respondents who had not been vaccinated and who had previously refused the vaccine. High vaccine uptake and low vaccine uptake were distinct categories. $\chi^2(1) = 9.856, p = .002, OR = 56.692, 95\% CI = 9.856, 311.453$ (d.f. = 1).

Results

Female respondents accounted for just over half of the sample (52.9%), with more female respondents in Zimbabwe (57.0%) than in Sierra Leone (48.9%) (see Table 1). Approximately half (50.3%) of all respondents were between 25 and 49 years of age, with Zimbabwe's age distribution trending slightly older and Sierra Leone's slightly younger. Most respondents in Zimbabwe (67.0%) and Sierra Leone (51.9%) had a secondary education, with Sierra Leone having a higher percentage of respondents having completed tertiary education, 27.6%, compared to 7.8% in Zimbabwe. Most respondents identified themselves as community members (68.2%), followed by "other" (13.9%) and community leaders (8.5%). A total of 43.8% of participants had received at least one dose of a COVID-19 vaccine, including more than half of Zimbabweans (55.6%) and 32% of Sierra Leonians.

High vaccine uptake was greater among Zimbabwe respondents, at 45.6%, compared to 19.5% in Sierra Leone (Table 2), where they also reported a greater percentage of low vaccine uptake at 48.7% (27.0% in Zimbabwe). When comparing theory variables across the two countries, there are noticeable differences. Perceived susceptibility and perceived severity combine to form a variable called perceived threat (to one's health). Perceived threat is significantly lower in Sierra Leone compared to

Zimbabwe. Respondents in Sierra Leone reported higher perceived barriers to vaccination (41.0% to 20.1%). By contrast, in Zimbabwe, respondents reported higher perceptions of the benefits of vaccination (50.8% to 35.8%). Zimbabwe respondents also reported higher perceived behavior control, 60.2%, compared to 38.6% in Sierra Leone.

Adjusted regression models explored the HBM and TPB variables and the association with high and low vaccine uptake. Each model controlled for sex, age, education, and the respondent's country. In the model considering high vaccine uptake (Table 3), all theory variables were significant and in the expected direction. Compared to a low perceived threat, both medium (OR 2.142; $p < 0.001$) and high perceived threat were positively related to high vaccine uptake (OR 2.674; $p < 0.001$). Perceived barriers was negatively associated with high vaccine uptake (OR 0.173; $p < 0.001$), such that higher perceived barriers was associated with decreased odds of vaccine uptake. Perceived benefits

Table 1 Demographics of study participants in Zimbabwe and Sierra Leone

Indicator	Zimbabwe	Sierra Leone	Total
	<i>N</i> = 1154	<i>N</i> = 1158	<i>N</i> = 2312
Gender			
Female	57.0	48.9	52.9
Male	43.0	51.1	47.1
Age (years)			
10–19	9.8	9.6	9.7
20–24	13.2	23.2	18.2
25–49	48.1	52.4	50.3
50+			

(OR 1.482; $p < 0.001$) of getting vaccinated and perceived behavior control (OR 2.189; $p < 0.001$) were both associated with increased odds of high vaccine uptake.

In the adjusted model exploring the relationship between the theory variables and low vaccine uptake (Table 4), medium perceived threat (OR 0.439; $p < 0.001$) and high perceived threat (OR 0.54; $p < 0.001$) were both negatively associated with low vaccine uptake; increases in perceived threat was related to decreased odds that respondents reported low vaccine uptake. Perceived barriers was positively related to increased odds of reporting low vaccine uptake (OR 2.001; $p < 0.001$). Perceived benefits of vaccination and perceived behavior control were both negatively related (OR 0.762; $p < 0.001$; OR 0.429; $p < 0.001$, respectively), such that increases in both were related to decreased odds of also reporting low vaccine uptake.

Discussion

The purpose of this study was to use HBM and TPB con-

from Zimbabwe reporting that they had received at least one dose of a COVID-19 vaccine. These findings are remarkably consistent with the reporting from Mundagowa et al. [14] who noted that prior to COVID-19 vaccine availability, exactly half (50%) of Zimbabweans surveyed indicated they would accept the vaccine. It should again be noted that while vaccine uptake and receiving at least one dose of a COVID-19 vaccine were both higher among Zimbabweans in the current study, national COVID-19 vaccination rates are nearly 35% higher in Sierra Leone (94.3% of those eligible) than in Zimbabwe (65.2% of those eligible) [2]. In this case, the current study sample may not be representative of either country as a whole.

The logistic regression analysis, which accounted for within-country variations, provided strong support for the theoretical framework, with all variables from the HBM and the TPB being statistically significant and aligned with expected outcomes. These findings are consistent with previous global studies on COVID-19 vaccine uptake and intentions, reinforcing the validity of these theoretical constructs in understanding vaccine behavior. The perceived threat of COVID-19 morbidity and mortality, a combination of perceived susceptibility and perceived severity, has been the focus of many such studies. In their study of adults in France, Schwarzinger et al. [17] found a strong association between the refusal of COVID-19 vaccines and lower perceived severity of the disease if infected. The authors noted that the benefit-risk assessment of COVID-19 vaccination was perceived as unfavorable, particularly among younger working adults. Relatedly, a heightened perception of COVID-19 severity, when compared to the seasonal flu, was associated with an increased acceptance of COVID-19 vaccines amongst adults in Italy [3]. Hilverda and Vollmann [8] studied perceptions of COVID-19 among Dutch university students and concluded that heightened perceived severity of COVID-19 was associated with increased concern about the disease and both stronger vaccine intentions and vaccine uptake. Perceived risk of COVID-19 infection among study participants in South Africa, mediated by perceived vaccine efficacy, was found to be associated with intentions to receive the COVID-19 vaccines [12]. Like the current study, Shmueli and colleagues (2021) combined HBM and TPB constructs in their study of Israeli adults. The authors noted perceived severity, perceived benefits, and perceived behavioral control as significant determinants of participants' intention to receive COVID-19 vaccines. These findings from around the globe provide strong support for the use of HBM and

TPB constructs in the development of interventions to promote uptake in, and acceptance of, COVID-19 vaccines.

The current study's findings should be interpreted with several key limitations in mind. First, all study data were gathered via self-report with no inspection of vaccination records. Second, this study used data from, and made comparisons between, two countries with many differences and unique experiences related to disease. Country-specific contextual factors related to recent disease outbreaks and past performance of health systems may help explain the difference in perceptions of COVID-19 among the two countries in the current study. Furthermore, despite the current study's large sample size, results are not generalizable to all of Zimbabwe or Sierra Leone and should thus be interpreted with caution. Namely, vaccination percentages found in the current study vary from national vaccine uptake percentages reported elsewhere. Lastly, participants may represent a biased sample as a result of coming from a CoV-FaB catchment area where numerous efforts had been made to engage with the population and where respondents were not actively sought out, but instead willingly volunteered. This could limit the finding's generalizability. Despite these limitations, the current study adds to the literature supporting established theoretical constructs from the HBM and TPB while building support for adherence to theory in the development and implementation of public health programming.

Conclusion

This study identified theoretical constructs from both the HBM and the TPB as significant predictors of vaccine uptake among participants in Zimbabwe and Sierra Leone. The findings from this study may inform the design of future public health interventions focused on increasing vaccine uptake generally. More specifically, future efforts to increase the perceived threat of disease outbreaks like COVID-19 and the perceived benefit of accessing appropriate preventative care like COVID vaccines while also increasing an individual's perceived behavior control in assuaging such threats through preventative action and minimizing perceived barriers to care or other health-enhancing actions should be public health priorities. Proven theoretical frameworks such as the HBM and TPB can increase public health's understanding of both a population's response to disease outbreaks as well as inform effective program planning and public health messaging.

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Authors' contributions

JW and BC did the analysis. RW, SS, JW, BC, ML, and CH contributed to the survey design. SS, AM, and RW contributed to the data collection. SS, AM, MM,

RG, JW, BC, CH, RW, ML, HB, and DC all contributed to the manuscript design and preparation.

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Data availability

Data and materials requests can be considered through an inquiry to the corresponding author who will in turn seek approval from the Africa Christian Health Associations Platform and CORUS International.

Declarations

Ethics approval and consent to participate

Ethical clearance for publication of study's data was approved by the Brigham Young University Institutional Review Board (IRB#: IRB2023-026).

Competing interests

The authors declare no competing interests.

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