



# Intention to Vaccinate Against the Novel 2019 Coronavirus Disease: The Role of Health Locus of Control and Religiosity

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## Abstract

The urgency to develop a vaccine against the 2019 coronavirus (COVID-19) has waxed stronger in speed, scale, and scope. However, wisdom dictates that we take a vantage position and start to examine the demographic predictors of COVID-19 vaccine hesitancy. The objective of this study was to examine the role of health locus of control (HLOC) in the relationship between religiosity and COVID-19 vaccination intention. In a cross-sectional survey (N = 501), we found a significantly negative association between religiosity and COVID-19 vaccination intention. This relationship was partially mediated by external HLOC. Collaborative efforts with religious institutions may influence COVID-19 vaccine uptake.

**Keywords** Religiosity · Health Locus of Control · COVID-19 · Vaccination

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## Introduction

The novel 2019 coronavirus (COVID-19) has expanded to over 170 countries (WHO 2020). As of April 13, 2020, there has been a report of 1,773,084 cases and 111,652 deaths globally, with the USA leading in the number of cases (CDC 2020). The devastating impacts of this pandemic on lives, healthcare systems, social wellbeing, and the economy have led to the introduction of several mitigating measures such as regional lockdown, hygiene promotion, social distancing, travel restrictions, and vaccine development research (Wilder-Smith and Freedman 2020). Although containment measures and prevalence estimations are necessary to mitigate the impact of the virus and calibrate epidemiological responses, wisdom dictates that we take a vantage position, and start to examine the predictors of the COVID-19 vaccine hesitancy. This approach will stir up proactive measures and mobilize collaborative action among key stakeholders.

Researchers across various settings (academia, biotech, pharmaceuticals, and military) fervently work toward developing a vaccine against COVID-19. As the death toll rises, these efforts are likely to increase in intensity and speed (Lurie et al. 2020). More than \$1 billion has been committed to its actualization, and at least two companies have already launched clinical trials (Amanat and Krammer 2020). While the progress and dedication pose promise for swiftly developing a vaccine, the news of vaccination against COVID-19 has already received mixed reactions from the general public. Recent findings suggest that vaccine misinformation has been communicated through conspiracy stories and myths (Singh et al. 2020). For instance, a famous COVID-19 vaccine conspiracy story that has been actively propagated through social media is about the 5G network (Lee 2020). This widely spread story speculates that the COVID-19 vaccine is an attempt by some powerful US corporations to insert a nanotechnology microchip that will allow humans to be controlled. This myth has been further adapted by some religious leaders to represent the end time sign of the mark of the anti-Christ (Pulpit and Pen 2020; Robins and Baxter 2020). Also, in the Muslim community, the COVID-19 vaccine has been portrayed as a “Western plot” to sterilize Muslim women (Ali 2020). It is therefore important to proactively investigate the likely predictors of COVID-19 hesitancy among religious groups and start to mobilize key actors within existing religious, scientific, and political structures toward a common goal of vaccination.

## Religious Coping During Stressful Events

During stressful life events, adversities, and uncertainties, religion offers a source of relief as a means for coping with uncertainty (Koenig et al. 1997). Religious coping involves relying on one’s faith, not just for refuge and comfort, but also for possible explanations. Empirical evidence suggests that during tragic events, much emphasis is placed on prayer, scripture readings, and closeness to God as the way out of the crisis (Pargament 2001; Tix and Frazier 1998). For instance, in

March 2020, an analysis of Google searches showed that for each 80,000 reported COVID-19 case, the Google search for “prayer” doubled (Bentzen 2020).

While religion assists in coping with life stressors, studies have also demonstrated religiosity to be strongly and positively correlated with trust in informal sources of information such as religious organization’s website, spiritual leaders, and family/friends (Cacciatore et al. 2018; Scheitle et al. 2018). However, the content of these informal sources may be contradictory to scientific evidence. In the USA, the tensions between science and religion are evident. Scientifically, individuals with high levels of religiosity are more likely to hold negative views toward scientific innovations and nanotechnology (Cacciatore et al. 2018; McPhetres and Zuckerman 2018; Scheufele et al. 2009). Therefore, while religion offers a source of comfort, higher levels of engagement in religious practices may unintentionally spread misinformation, yielding unsafe practices. During the era of COVID-19, misinformation regarding the disease and religious activities (e.g., “it is safe to gather for religious ceremonies because God will protect us”) may uniquely position highly religious individuals to engage in behaviors which risk greater community spread and death (Pereira 2020). Taken together, it is imperative to examine the role that religiosity plays during the COVID-19 pandemic such that information regarding COVID-19 vaccines (once available) is received positively by all communities, including those high in religiosity.

### **Religiosity and COVID-19 Vaccination**

Previous studies have shown that religiosity is a strong predictor of anti-vaccine beliefs. For example, in a study among American Muslim physicians, respondents who sought bioethical guidance from Islamic juridical authorities had lower odds of recommending porcine-based flu vaccination to their patients (Mahdi et al. 2016). Also, Utah, where Mormon religion is dominant, and 74% of the residents rated themselves as being “highly religious” is ranked 46th in the nation as up to date with Human papillomavirus vaccination (Walker et al. 2017; Wormald 2015). A common determinant of vaccine acceptance among religious people is health locus of control-HLOC (Amit Aharon et al. 2018; Sinding Bentzen 2019; Wilson et al. 2016). HLOC is the extent of perception that each person has about the important factors that govern their health or illness (Wallston et al. 1978). Two domains of locus of health control (LOC) have been identified as internal and external LOC (Wallston 2005). Individuals who believe that they can positively influence their health outcomes (internal LOC) may actively seek preventive services such as vaccination. However, external LOC is the belief that a person’s health depends on external factors such as God, chance, or Powerful others. In a recent path analysis model among Jewish and Muslim parents, external HLOC was shown to be positively associated with low childhood vaccine uptake through parents’ attitudes (Amit Aharon et al. 2018). Nevertheless, weighing the virulent nature of COVID-19 against the existing evidence that religious individuals may offer explanations to a crisis by referencing it as “an Act of God of which humans have no control over” (Sinding Bentzen

2019), it is uncertain how HLOC will mediate the relationship between religiosity and COVID-19 vaccination intention.

## Current Study

This current study seeks to take an anticipatory perspective in the ongoing efforts toward the management of COVID-19 by (i) examining the relationship between religiosity and intention to receive the COVID-19 vaccine if/when there is one, and (ii) assessing the mediating role of health locus of control in the relationship between religiosity and COVID-19 vaccination intention. We hope to provide highly informative empirical evidence that will stir up conversations, proactive preparation, and mobilization among religious leaders, clinicians, healthcare workers, and communication experts toward the likelihood of COVID-19 vaccine hesitancy.

## Methods

To satisfy our study objectives, we deployed a survey tool with validated screening techniques for a rapid assessment of the relationship between religiosity and COVID-19 vaccination intention. This study was approved by the Institution Review Board of the University of Illinois at Chicago. All participants signed the online informed consent form before proceeding with the survey.

## Study Sample

We recruited study participants via Prolific, an online crowdsourcing platform for researchers (Peer et al. 2017). Prolific has been shown to have a reputable and reliable track record of diverse participant pool and high data quality. Compared to other online recruitment platforms, participants from Prolific scored higher on attention-checks, engaged in lesser dishonest behavior, and reproduced existing results (Palan and Schitter 2018; Peer et al. 2017). We had 2 eligibility criteria for participation (i) residence in the USA and (ii) being 18 years or older. Cross-sectional data were collected from 502 participants on March 22, 2020, through the Qualtrics online survey link. Each participant received an incentive of \$0.55 after survey completion.

## Measures

### Assessment of Religiosity

*Religiosity* was measured using the *Duke University Religion Index (DUREL)*, which has been used in over 100 studies (Koenig and Büssing 2010). This 5-item scale captures three major domains of religiosity—the *organizational*, *non-organizational*, and *intrinsic* religiosity. This measure has demonstrated a high 2-week test–retest reliability of 0.91, reliable internal consistency ( $\alpha=0.78–0.91$ ), and a convergent

validity with other established measures of religiosity ( $r$ 's = 0.71–0.86). An example of an item on the scale is “My religious beliefs are what really lie behind my whole approach to life.” Response options ranged from *definitely yes* [1] to *definitely not* [5]. A reverse coding was performed such that higher values represented higher religiosity.

### Assessment of Religious Affiliation

*Religious affiliation* was measured with a single item asking participants, “What is your religious affiliation?” Possible response categories were Catholic, Protestant, Adventist, Mormon, Islam, Buddhism, Hinduism, Agnostic, Atheist, and others (Dollinger 2001).

### Assessment of Trust in Informal Sources of Information

Three items were used to assess *trust in informal sources of information* (Liao et al. 2011). The items were (i) *Social media reports can be trusted*, (ii) *The best source of information about coronavirus is to watch and listen to what others say*, and (iii) *I tend to believe what my friends, colleagues, or neighbors say about coronavirus*. Responses were reversely coded such that they ranged from *strongly disagree* [1] to *strongly agree* [5].

### Assessment of Perceived Effectiveness of Religious Practices

The *perceived effectiveness of prayer and scripture reading* in protecting against COVID-19 were each assessed with a single item. Participants were asked, “What are your beliefs about the effectiveness or ineffectiveness of the following in preventing coronavirus?” (i) *Prayer*, and (ii) *Scripture reading*. Responses ranged from *completely effective* [1] to *completely ineffective* [5].

### Assessment of Health Locus of Control

The measure of HLOC was based on the *Multidimensional Health Locus of Control* (MHLC) scale ( $\alpha$  = 0.70; Wallston et al. 1978). Specifically, we measured the external LOC by adopting the following (i) *No matter what I do, if I am going to get sick, I will get sick* (ii) *God controls whether one falls sick or not* (iii) *If it is meant to be, I will stay healthy*. Responses were assessed on a 5-point Likert scale *strongly agree* [1] to *strongly disagree* [5]. Responses were reversely coded and averaged to range from 1 to 5 with low numbers indicating low external HLOC.

### Assessment of Personal Beliefs Against Vaccination in General

Participants were asked if they had personal beliefs against vaccination in general. Response categories were *Yes* and *No*.

## Assessment of COVID-19 Vaccination Intention

*COVID-19 vaccination intention* was assessed with a single item that asked participants, “If there is a preventive vaccine against COVID-19, how likely are you receive the vaccine?” Responses were assessed on a 5-point Likert scale ranging from *extremely unlikely* [1] to *extremely likely* [5].

## Demographics

Since COVID-19 vaccination intention and religiosity are likely to be influenced by key demographics (e.g., age, household income), we collected key demographic variables for statistical control (Amit Aharon et al. 2018; Pashak et al. 2020). More specifically, participants reported on the following important demographic characteristics: age (continuous variable), sex (female, male) race (White, African American, Asian, Hispanic, American Indian, Middle East and North Africa (MENA) and others), and marital status. For marital status, categories included married, divorced, separated, widowed, and single/never married. Socioeconomic status (SES) factors included household income (< \$20,000, \$20,000 to < \$35,000, \$35,000 to < \$50,000, \$50,000 to < \$75,000, and \$75,000 or more); employment status, and education (less than high school, high school graduate, some college, college graduate or more).

## Data Analysis

Participants’ characteristics were analyzed using descriptive statistics such as frequencies (and their proportions) and means (and their standard deviations). The one-way analysis of variance (ANOVA) was performed to investigate the mean differences in religiosity and COVID-19 vaccination intention by participants’ characteristics. Pearson correlations were calculated to test bivariate associations between the continuous variables. To further investigate the relationship between religiosity and COVID-19 vaccination intention, multivariable analysis was conducted. Model 1 tested the unadjusted relationships, Model 2 controlled for sociodemographic factors, and Model 3 added the SES variables. Statistical tests were 2-sided, and a  $P < .05$  was considered statistically significant. Effect sizes and their confidence intervals, as suggested by Cumming (2014), were reported to interpret findings (Cumming 2014). Statistical analyses were performed using SAS version 9.4 (SAS Institute Inc., Cary, NC).

## Mediation Analysis

Mediation analysis with 1000 bootstrap resamples was conducted to test the possible mediating role of external HLOC in the relationship between religiosity and COVID-19 vaccination intention. Regression models were fitted in four steps according to the procedures outlined by Sobel to assess the mediating role of

external HLOC (Sobel 1982). The purpose of steps 1–3 was to examine the zero-order relationships among the variables. However, as recommended by Hayes, religiosity was not required to demonstrate a significant overall zero-order association with the COVID-19 vaccination intention (Hayes 2009) in testing for mediation. This contemporary approach was chosen because of the possibility of the direct and indirect (meditational) paths operating in opposite directions, which can result in a nonsignificant total exposure-outcome association (Erdem et al. 2016).

### Sensitivity Analysis

We conducted a sensitivity analysis to further test the robustness of our model under varying methodological conditions. One of the three items that assessed external HLOC was found to overlap with our measure of religiosity (DUREL) conceptually; hence, we conducted our analysis with the three items and with 2 of the three items to probe its impact on the effect size estimates. Sensitivity analysis was not used to choose an alternate conclusion to our study. Instead, our conclusions were based on the primary analysis, and the sensitivity analysis finding was presented to demonstrate the consistency of the primary findings (Thabane et al. 2013).

### Results

After excluding one participant who failed the attention check (Table 1), the remaining participants ( $N=501$ ) reported a mean age of  $32.44 \pm 11.94$  years, being females (55.29%), White (67.86%), single/never married (68.46%), college graduate or more (53.71%), and employed (54.89%). Participants reported a household income of over \$75,000 (35.67%), personal belief against vaccines in general (3.79%), and religious affiliation as protestant (20.16%) and Agnostic (21.96%).

We recorded means (Table 2) of religiosity ( $2.09 \pm 1.17$ ), external HLOC ( $3.73 \pm 0.97$ ) and COVID-19 vaccination intention ( $4.24 \pm 1.04$ ), trust in informal sources of information ( $2.57 \pm 0.76$ ), effectiveness of prayer in protecting against COVID-19 was  $1.98 \pm 1.36$ . Mean vaccination intention by participants' characteristics (Table 1) showed that participants who were Black/African American ( $3.53 \pm 1.43$ ), unemployed/retired/disabled/others ( $4.10 \pm 1.15$ ), with personal belief against vaccines in general ( $2.63 \pm 1.57$ ) had lower COVID-19 vaccination intention. Pearson's correlation analysis (Table 2) showed that religiosity was positively correlated with external HLOC ( $r=0.47$ ;  $P<0.001$ ) and negatively correlated with COVID-19 vaccination intention ( $r=-0.17$ ;  $P<0.001$ ).

In Model 1 (Table 3), we found a significantly negative association between COVID-19 vaccination intention and (i) religiosity ( $\beta=-0.15$ ; 95% Confidence Interval (CI)=-0.23 to -0.08;  $P<0.0001$ ) and (ii) external HLOC ( $\beta=-0.24$ ; 95% CI=-0.33 to -0.15;  $P<0.0001$ ). These relationships remained significant in Model 2 for religiosity ( $\beta=-0.13$ ; 95% CI=-0.21 to -0.05;  $P=0.0009$ ) and external HLOC ( $\beta=-0.20$ ; 95% CI=-0.30 to -0.11;  $P<0.0001$ ). In Model 3 COVID-19 vaccination intention was also significantly and negatively associated

**Table 1** Mean distribution of religiosity and COVID-19 vaccination intention by participants' characteristics ( $N=501$ )<sup>a</sup>

Variable	Religiosity			Vaccine intention	
	Frequency (%)	Mean (SD)	<i>P</i> value	Mean (SD)	<i>P</i> value
<i>Sex</i>			0.2862		0.0948
Female	277 (55.29)	2.14 (1.19)		4.17 (1.11)	
Male	224 (44.71)	2.03 (1.15)		4.32 (0.95)	
<i>Race</i> <sup>b</sup>			0.3610		<b>0.0002</b>
White	340 (67.86)	2.08 (1.19)		4.24 (1.02)	
Black/African American	30 (5.99)	2.40 (1.19)		3.53 (1.43)	
Asian	72 (14.37)	1.94 (1.05)		4.55 (0.82)	
Hispanic	41 (8.18)	2.10 (1.09)		4.24 (1.02)	
American Indian/MENA/others	18 (3.59)	2.38 (1.51)		4.0 (0.91)	
<i>Marital status</i> <sup>b</sup>			<b>0.0004</b>		0.4032
Single/Never married	343 (68.46)	1.95 (1.06)		4.26 (1.02)	
Married	128 (25.55)	2.43 (1.36)		4.23 (1.03)	
Widowed/Divorced/Separated	30 (5.99)	2.15 (1.23)		4.0 (1.34)	
<i>Highest education</i> <sup>b</sup>			0.3691		0.7417
Less than High school/High school	70 (14.03)	2.10 (1.17)		4.31 (0.92)	
Some college	161 (32.26)	1.99 (1.10)		4.20 (1.01)	
College or more	268 (53.71)	2.15 (1.22)		4.25 (1.09)	
<i>Household income</i> <sup>b</sup>			0.9987		0.2759
Less than \$15,000	50 (10.02)	2.10 (1.17)		4.16 (1.13)	
\$15,000–\$34,999	80 (16.03)	2.08 (1.15)		4.18 (1.10)	
\$35,000–\$49,999	82 (16.43)	2.07 (1.20)		4.24 (0.90)	
\$50,000–\$74,999	109 (21.84)	2.12 (1.21)		4.10 (1.11)	
Over \$75,000	178 (35.67)	2.08 (1.16)		4.37 (1.01)	
<i>Employment status</i>					<b>0.0327</b>
Employed	275 (54.89)	2.05 (1.18)	0.7650	4.21 (1.04)	
Student	102 (20.36)	2.05 (1.08)		4.46 (0.86)	
Unemployed/retired/disabled/others	110 (22.59)	2.14 (1.21)		4.10 (1.15)	
<i>Personal belief against vaccines in general</i> <sup>b</sup>			<b>&lt;0.0001</b>		<b>&lt;0.0001</b>
Yes	19 (3.79)	3.12 (1.29)		2.63 (1.57)	
No	482 (96.21)	2.05 (1.15)		4.30 (0.96)	
<i>Religious Affiliation</i> <sup>b</sup>			<b>&lt;0.0001</b>		0.0763
Catholic	61 (12.18)	2.55 (0.95)		4.15 (1.03)	
Hindu/Buddhist/Adventist/Mormon/Islam	41 (8.18)	2.70 (1.05)		4.49 (0.98)	
Protestant	101 (20.16)	3.22 (1.15)		4.10 (1.14)	
Agnostic	110 (21.96)	1.30 (0.42)		4.26 (1.01)	
Atheist	105 (20.96)	1.12 (0.34)		4.43 (0.79)	
Others	83 (16.57)	2.34 (1.09)		4.08 (1.21)	

MENA Middle East and North Africa

<sup>a</sup>*n* may vary due to missing responses. <sup>b</sup>Results from this group should be interpreted with caution due to the small *n*



**Table 2** Mean descriptions and correlation matrix between variables

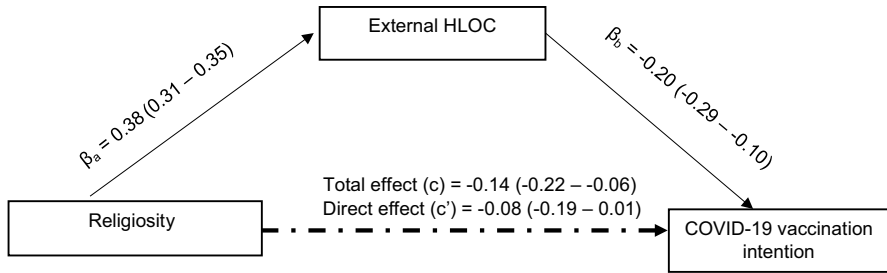
Variables	Mean (SD)	Pearson correlation						
		1	2	3	4	5	6	7
1 Age	32.44 (11.94)	–	0.17***	–0.07	0.27***	0.23***	0.14**	–0.11*
2 Religiosity	2.09 (1.17)	–	–	0.11*	0.68***	0.63***	0.47***	–0.17***
3 Trust in informal information sources	2.57 (0.76)	–	–	–	0.18***	0.16***	0.20***	–0.08
4 Effectiveness of prayer against COVID-19	1.98 (1.36)	–	–	–	–	0.91***	0.51***	–0.19***
5 Effectiveness of scripture against COVID-19	1.80 (1.21)	–	–	–	–	–	0.47***	–0.22***
6 External HLOC	3.73 (0.97)	–	–	–	–	–	–	–0.23***
7 COVID-19 vaccination intention	4.24 (1.04)	–	–	–	–	–	–	–

\* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$  (two-tailed test)

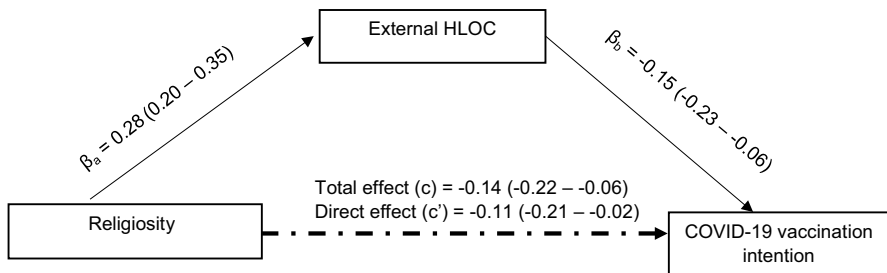
**Table 3** Multivariable linear regression of COVID-19 vaccination intention on religiosity and HLOC

Variables	Model 1		Model 2		Model 3	
	Estimates $\beta$ (95% CI)	P value	Estimates $\beta$ (95% CI)	P value	Estimates $\beta$ (95% CI)	P value
Religiosity	-0.15 (-0.23 to -0.08)	<.0001	-0.13 (-0.21 to -0.05)	0.0009	-0.14 (-0.22 to -0.06)	0.0003
External HLOC	-0.24 (-0.33 to -0.15)	<.0001	-0.20 (-0.30 to -0.11)	<.0001	-0.20 (-0.29 to -0.10)	<.0001

Model 1 is the unadjusted estimates. Model 2 adjusted for sociodemographic factors (age, race, sex, and marital status). Model 3 added SES factors (household income, employment status and education)



**Fig. 1** Mediation analysis: external health locus of control mediated 40.97% of the effect of religiosity on intention to vaccinate against COVID-19 with 1000 bootstrap resamples  $\beta = -0.06$ ,  $SE = 0.02$ . Bias-corrected 95% Confidence interval ( $-0.11$  to  $-0.02$ )



**Fig. 2** Mediation test from the sensitivity analysis: external health locus of control mediated 22.04% of the effect of religiosity on intention to vaccinate against COVID-19 with 1000 bootstrap resamples  $\beta = -0.03$ ,  $SE = 0.01$ . Bias-corrected 95% Confidence interval ( $-0.06$  to  $-0.01$ )

with religiosity ( $\beta = -0.14$ ; 95%  $CI = -0.22$  to  $-0.06$ ;  $P = 0.0003$ ) and external HLOC ( $\beta = -0.20$ ; 95%  $CI = -0.29$  to  $-0.10$ ;  $P < 0.0001$ ).

Standardized mediation tests showed that external HLOC mediated 40.97% of the relationship between religiosity and COVID-19 vaccination intention (Fig. 1) with an indirect effect of  $\beta = -0.06$ ; 95%  $CI = -0.11$  to  $-0.02$ ;  $P = 0.006$ . After conducting a sensitivity analysis (Fig. 2), external HLOC mediated 22.04% of the relationship with an indirect effect of  $\beta = -0.03$  ( $-0.06$  to  $-0.01$ ;  $P = 0.02$ ).

## Discussion

In this analysis, religiosity was significantly and negatively associated with intention to vaccinate against COVID-19. Our findings suggest that external HLOC can serve as a pathway through which this association exists. Notably, the non-significance of the indirect effect in our primary analysis and its significance in the sensitivity analysis suggests that there is a conceptual overlap between the measures of religiosity and the external locus of control. Hence, this association should be interpreted with caution when both measures are used. However, the

outcome of the sensitivity analysis (where the methodological, conceptual overlap is corrected) further lends credence to the possibility of a partial mediation of external locus of control in the relationship between religiosity and COVID-19 vaccine intention (Sjölander and Zetterqvist 2017). The results of this study confirm the principles of religious coping, which associates responses to stressful life events with external HLOC such that the crisis may be viewed as an Act of God that cannot be changed or prevented (Sinding Bentzen 2019). Furthermore, the novel coronavirus disease has been marked with rapid consumption of health information from informal sources (e.g., social media, religious website, family, friends and colleagues), which are prone to the dissemination of unclear, false or misleading health information and myths or conspiracy theories (Cuan-Baltazar et al. 2020; Kouzy et al. 2020). Hence, a possible explanation for our findings may be that highly religious individuals trust informal information sources (as evident in our result) whose contents may be dominated by anti-COVID-19 vaccination messages.

We, therefore, offer the following recommendations: first, religious leaders should consider educating their members on the need to take responsibility for their health. One way of doing this is to find scriptural contents that emphasize that individuals have a role to play regarding their lives and health outcomes (Harris et al. 1999; Holt et al. 2009; Le et al. 2018). Drawing on such scriptural themes can provide a faith-based justification for strengthening the internal health locus of control rather than leave health outcomes to chance because, if people consider themselves to be responsible for their health outcome, they are more likely to take up preventive measures such as vaccine uptake (Wallston 2005).

Second, since previous studies have established that religious leaders have a strong influence on their followers (Cacciatore et al. 2018; McPhetres and Zuckerman 2018; Scheufele et al. 2009), we strongly propose that as scientists scramble for the development of a COVID-19 vaccine, they also establish a strong partnership with religious institutions through their leaders. This working relationship should be rooted in the transparency of the ongoing vaccine development processes. If religious leaders are familiar with and have strong confidence in the vaccine development processes, they may use informal informational platforms to communicate scientifically valid messages regarding COVID-19 vaccine.

Finally, it is important to note that our study included adults, and if parents have a negative disposition toward the COVID-19 vaccine, they may also prevent their children from taking the vaccine (Amit Aharon et al. 2018). This premise has an implication for policymakers who may further examine the likelihood of vaccine uptake among various demographic groups and offer policy recommendations for COVID-19 vaccine acceptance. For example, in our study, African American participants reported a significantly low COVID-19 vaccination intention. Hence, in the stimulation of public response toward COVID-19 vaccine uptake, there is a need for multi-stakeholder collaboration that will cut across religious groups, community organizations, healthcare practitioners, media organizations, and policymakers. This collaborative effort may ensure that people receive the right information that will strengthen their health locus of control and allow them to take responsibility regarding their protection.

## Limitations

Our study is not without its limitations. First, our sample consists mostly of young, educated adults and is therefore not generalizable across the USA; hence, it should be interpreted with caution. Second, the use of a cross-sectional study design makes it challenging to establish causality and requires a careful interpretation of our results. The novelty of the COVID-19 pandemic offers limited opportunity for comparing data at multiple data points. However, as more evidence emerges, further studies should longitudinally examine the pathways through which religiosity influences the likelihood of COVID-19 vaccine uptake.

## Conclusion

In this study of 501 participants, external health locus of control mediated the relationship between religiosity and COVID-19 vaccination intention. As scientists scramble for the development of a COVID-19 vaccine, it is important also to establish a strong partnership with religious institutions that may be very instrumental in positively shaping the narrative around health locus of control and vaccine uptake among their members.

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**Authors' Contributions** All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Ayokunle Olagoke and Ashley Hughes. The first draft of the manuscript was written by Ayokunle Olagoke and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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## Compliance with Ethical Standards

**Conflicts of interest** No conflict of interest pertinent to this research existed for the investigators.

**Human Participants and/or Animals Rights** This article does not contain any studies with animals performed by any of the authors. Ethical approval was obtained from the Institution review board of the University of Illinois at Chicago. The procedures used in this study, involving human participants, adhered to the tenets of the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

**Informed Consent** Standard procedures for obtaining consent and maintaining the confidentiality and anonymity of participants were instituted. Informed consent was obtained from all individual participants included in the study.

**Ethics Approval** Approval was obtained from the ethics committee of the University of Illinois at Chicago. The procedures used in this study adhere to the tenets of the Declaration of Helsinki.

**Consent to Participate** Informed consent was obtained from all individual participants included in the study.

**Consent to Publish** The participants consented to the dissemination of the study findings through scholarly publications.

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