

**Religious Affiliation and Philosophical and Moral Beliefs about Vaccines:  
A Longitudinal Study**

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**Abstract**

How do religious affiliation and beliefs shape vaccine attitudes and behaviors? This study examined the associations of attitudes and behaviors relevant to the flu, measles-mumps-rubella (MMR), and human-papillomavirus (HPV) vaccines with religious affiliations, as well as philosophical, spiritual, and moral beliefs. Respondents were 3,005 adults from a probability-based, 4-wave panel survey in the United States. Longitudinal structural equation modeling examined how religious affiliations and philosophical/moral beliefs shaped attitudes toward vaccines and actual vaccination. Stronger philosophical beliefs predicted more negative attitudes toward each vaccine and stronger moral beliefs more negative attitudes toward the HPV vaccine. Negative vaccine attitudes then predicted weaker intentions to encourage others to vaccinate and lower probability of receiving a vaccine. Theoretical and public health messaging implications are discussed.

**Keywords:** *religious affiliations, religious beliefs, vaccine attitudes, vaccine intentions and behavior, longitudinal survey*

70           Although the Church of the First Born advocates faith healing over medical care and  
71 Christian Scientists maintain that vaccines are unnecessary (Iannelli, 2019) and concerns with  
72 the use of gelatin in the vaccine itself (e.g., for Muslims) and the use of human fetus cell lineages  
73 in vaccine development (e.g. for Christians) vary across religions, Islam, Judaism, and  
74 Christianity are not explicitly against the idea of vaccination as well (Shurpin, 2015).  
75 Nonetheless, affiliation with specific denominations has in recent years been associated with  
76 outbreaks of flu and measles. For example, recent measles outbreaks in the United States (U.S.)  
77 emerged primarily in tightly-knit religious communities such as the Amish in Ohio and Orthodox  
78 Jews in New York (Belluz, 2019) and a fatwa by Muslim clerics plummeted the measles-  
79 mumps-rubella (MMR) vaccination rates in Indonesia (Rochmyaningsih, 2018). These  
80 developments raise questions about (a) the degree to which identification with certain religious  
81 groups predicts vaccine attitudes and behaviors and (b) the underlying beliefs that religious  
82 socialization might cultivate. This understanding is key to the design of health communication  
83 campaigns, and relevant to public health as the world embarks on massive vaccination efforts  
84 against the novel coronavirus disease (COVID-19).

85           To begin, although news accounts have chronicled a reluctance to vaccinate among those  
86 in some religious groups (Belluz, 2019; Otterman, 2019), scientific studies have generally  
87 ignored the link between religion and attitudes toward vaccines in the general population of  
88 countries studied. Most studies have been conducted with specific religious/ethnic communities  
89 including Gypsy communities in London or the Apostolic Church in Zimbabwe (Feder et al.,  
90 1993; Gerede et al., 2017). Empirical studies conducted have been generally restricted to specific  
91 regional and demographic groups for which religiosity is salient (e.g. 18-26 years-old insured  
92 women in Utah and religious leaders in Denver; Bodson et al., 2017; Williams and O’Leary,

93 2019), or focused on the human-papillomavirus (HPV) vaccine due to commonly cited religious  
94 concerns about the potential for these vaccines to promote teenage sexual activity. Yet, a review  
95 of the role of religious and philosophical beliefs in major religious affiliations in the U.S. has  
96 revealed common religious concerns with vaccines, such as the use of fetal tissue in vaccine  
97 development (Wombwell et al., 2015). However, to the best of our knowledge no prior research  
98 has simultaneously investigated the relations between religious affiliations, specific religious  
99 beliefs about vaccines, and attitudes toward vaccines and self-declared vaccination rates in a  
100 large-scale population-level approach. These relations, although potentially incomplete and  
101 simplified (Ammerman, 2013), are important to investigate because religious affiliation  
102 (institutional practice) and religious beliefs (as opposed to institutional practice of religion) are  
103 entirely distinct dimensions of religiosity (Versteeg & Roeland, 2011).

104         Against this background, this study contributes to this line of work by examining  
105 philosophical and moral beliefs about vaccines in the general U.S. population through a formal  
106 exploration of the processes leading from religious affiliation to attitudes and actual vaccination  
107 conducted with longitudinal causal analysis. Specifically, the current study investigated how  
108 religious affiliations might be associated with differing levels of two religious, philosophical and  
109 moral, which have been established as important predictors of vaccine hesitancy, thus  
110 interlinking the pathways between affiliation differences to cognitive predictors of both  
111 attitudinal and behavioral manifestations of vaccine hesitancy (Ajzen et al., 2019; Albarracin,  
112 2020; Albarracín et al., 2001). In the following sections, we first review the existing research on  
113 religious affiliations and beliefs in conjunction with health beliefs and behaviors, particularly  
114 vaccination, before integrating their connections and predictive paths to attitudes and behaviors  
115 in the area of vaccination.

**116 Religious Affiliations**

117           How institutionalized religion influences vaccine attitudes and actual vaccination is an  
118 important question. Religious considerations play an important role in vaccine attitudes, beliefs,  
119 and decisions (Natan et al., 2011; Rutjens et al., 2021). Prior research on vaccination intentions  
120 and behaviors has documented noteworthy associations with affiliation with an organized  
121 religion and level of religiosity (i.e., individual differences in how people interpret and practice  
122 their religion) particularly in the area of the HPV vaccine. For example, mothers who report  
123 being more religious are more reluctant to vaccinate their daughters against HPV than less  
124 religious ones (Natan et al., 2011; Shelton et al., 2013). Furthermore, according to an analysis of  
125 the U.S. Centers for Disease Control and Prevention (C.D.C.) National Teen Immunization  
126 Survey, across all religious affiliations, adolescents from non-orthodox households are more  
127 likely to get the HPV vaccine than are those from orthodox households (Sriram and  
128 Ranganathan, 2019). Also, people who frequently attend religious services tend to have lower  
129 HPV vaccination intentions (Barnack et al., 2010; Bernat et al., 2009) than do those who attend  
130 less frequently, and highly religious people in the U.S. are more likely to incorrectly believe that  
131 vaccines caused autism than are nonreligious (Rutjens et al., 2018). Recent research has shown  
132 that religiosity predicts lower intentions to get a potential COVID-19 vaccine as well (Olagoke et  
133 al., 2020). However, none of this work has looked at how affiliations and philosophical and  
134 moral beliefs may operate together to shape vaccination attitudes and behaviors.

135           With respect to specific religious affiliation, although some studies have found no  
136 associations with vaccination practices (Reynolds, 2014; Thomas et al., 2012; Williams et al.,  
137 2021), some of these null findings could be due to the reliance on specific samples, such as  
138 parents in a low income Latino community (e.g. Williams et al., 2021). Furthermore, even

139 studies documenting differences among religious affiliations have also focused on specific  
140 communities. A comparison of multiple U.S. affiliations found that Jewish respondents had the  
141 lowest intentions to vaccinate against HPV (Fogel and Ebadi, 2011). A cross-national study  
142 found that Roman Catholics had more negative attitudes toward vaccines than did  
143 Russian/Eastern Orthodox adherents, atheists, and agnostics (Larson et al., 2016). Moreover,  
144 Muslim, Jewish, and people who identify as “Other Christians” appear to not differ from Roman  
145 Catholics (Larson et al., 2016), implying that affiliation with any Abrahamic religions (those  
146 referring to the Prophet Abraham as a common forefather: i.e., Judaism, Christianity, and Islam,  
147 (Encyclopedia, 2009)) may be associated with more negative vaccine attitudes.<sup>1</sup> Hence, in this  
148 study, we were interested in estimating differences in vaccine attitudes and behaviors (i.e.,  
149 getting vaccinated and intentions to encourage others to get the vaccine) across religious  
150 affiliations in the general U.S. population through a large nationally representative survey  
151 focusing on how religious affiliations predict vaccine related attitudes and behaviors through two  
152 philosophical and moral religious beliefs about vaccination.

### 153 **Philosophical and Moral Beliefs and their Likely Contributions to Attitudes toward and** 154 **Actual Vaccination**

155 Differences among affiliations alone offer limited insights into the role of religion  
156 because individual adherents interpret their faith and form beliefs about vaccination in different  
157 ways (Wombwell et al., 2015). In this study, we are interested in the mediating role of two key  
158 and commonly discussed cognitions: (a) philosophical beliefs and (b) moral beliefs. These  
159 beliefs dovetail with two of Smart’s doctrinal and ethical dimensions of religiosity and are most  
160 relevant to the flu, MMR, and HPV vaccines (Smart, 1996). Our theoretical model illustrates  
161 how these beliefs, which may differ in intensity but are common to many religious affiliations,

162 may subsequently influence vaccination attitudes and behaviors. By so doing, the model (See  
163 Figure 1A and B) provides a framework through which to understand the individual impact of  
164 religious affiliations on the philosophical and moral beliefs that may shape subsequent vaccine  
165 attitudes and behavior (Ajzen et al., 2019; Albarracin, 2020; Albarracín et al., 2001; Glasman  
166 and Albarracín, 2006). Next, we discuss these two beliefs in more detail.

167       **Philosophical beliefs** entail judgments about the natural order and can include fatalistic  
168 ideas about God controlling health outcomes (Shen et al., 2009). A study of qualitative  
169 interviews in the UK has shown that some people oppose vaccination out of a belief that “God  
170 would protect against childhood diseases” (Sporton and Francis, 2001). Likewise, philosophical  
171 beliefs that God will intervene are positively associated with lower vaccination rates. For  
172 example, parents may conclude that fighting HPV and MMR does not require medical  
173 intervention because of their faith in divine protection (Browne et al., 2015; Thomas et al.,  
174 2012). Similarly, a recent study found that self-reported spirituality has been shown to be  
175 strongest positive predictor of vaccine hesitancy in Greece, although the survey measure in this  
176 study did define “spirituality” to respondents (Rutjens et al., 2021; Rutjens and van der Lee,  
177 2020). Research in other health domains such as physical activity and alcohol use found mixed  
178 findings about the influence of such beliefs about God intervening to protect one’s health  
179 (Karvinen and Carr, 2013). Hence, given the differences in religiosity and health behavior shown  
180 in the prior literature on religious affiliations and people citing their religious affiliation as a  
181 reason for their health decisions (Holt et al., 2016), we expected that (1) individuals from  
182 different affiliations would differ in their degree of endorsing philosophical beliefs and (2) those  
183 having stronger philosophical beliefs would exhibit more negative vaccine attitudes and less  
184 vaccination.

185           **Moral beliefs** relevant to vaccination are associated with judgments about sex and,  
186 particularly, sex outside of a marital union and sex during the early teenage years (Krakow et al.,  
187 2015). This type of belief has been widely studied, particularly when it comes to the HPV  
188 vaccine. For example, some parents believe that the HPV vaccine may mistakenly signal their  
189 permission for sexual activity to teenagers (Brewer and Fazekas, 2007) or remove the “penalties”  
190 otherwise associated with the natural consequences of sexual activity (Holman et al., 2014;  
191 Krakow et al., 2015). Hence, like philosophical beliefs, we expected that (1) individuals from  
192 different affiliations would differ in endorsement of moral beliefs and (2) those with stronger  
193 moral beliefs would exhibit more negative vaccine attitudes and less vaccination.

194           To reiterate the expectations in our theoretical model, we tested the relations between  
195 religious beliefs (philosophical and moral) and vaccination following the theoretical model  
196 proposed, in the context of three different vaccines, two childhood/adolescence vaccines (MMR  
197 and HPV) and one seasonal adult vaccine. We predicted that religious affiliations may be  
198 associated with different endorsement of philosophical and moral beliefs. In turn, stronger  
199 religious beliefs may predict less positive attitudes toward vaccines over time, and these less  
200 favorable vaccine attitudes may predict weaker intentions to encourage others to vaccinate and  
201 lower vaccination rates.<sup>2</sup> However, the degree to which different affiliations would correlate with  
202 stronger religious or moral beliefs was an empirical question, as was the overall fit of our model  
203 to the data from our sample, the relative influence of each type of belief on attitudes and actual  
204 vaccination, and possible differences across vaccines.<sup>3</sup> We tested this conceptual model via path  
205 analysis with three different vaccines.<sup>4</sup>

206   **Empirical Context: Three Distinct Vaccines in the United States, 2018-2019**



207 In this section, we contextualize the empirical context by focusing on the country of data  
208 collection, the three distinct vaccines examined, and the longitudinal nature of the empirical  
209 evidence.

210 The current study concentrated on the United States, where 70% of adults report being  
211 Christian (45% Protestant, 21% Catholic), 2% being Jewish, 1% being Muslim, 1% being  
212 Buddhist, 1% being Hindu, 3% being Atheist, 4% being Agnostic, and 16% being “nothing in  
213 particular” (Pew Research Center, 2014a).<sup>5</sup> Comparing across countries, the U.S. ranks  
214 moderately on the religious diversity index, being the 68<sup>th</sup> most diverse country out of the 233  
215 (Pew Research Center, 2014b). In the public health domain, religious affiliations, communities,  
216 and beliefs usually are most commonly discussed in relation to policymaking about abortion,  
217 sexual identities, and religion-based exemptions from mandatory school vaccinations (Stecula et  
218 al., 2020). Hence, a large-scale study of the U.S. population offers important empirical evidence  
219 that could generalize to other important contexts, although demographic, sociocultural, and  
220 political differences across societies should be very carefully considered when extrapolating  
221 these findings to other countries.

222 Studying three different vaccines provided a strong framework to assess whether attitudes  
223 toward them have a similar belief basis. Vaccines differed on numerous attributes (typical age  
224 given, nature of the viruses targeted, nature of the associated health outcomes, seasonality, etc.).  
225 The HPV vaccine is known to fuel moral concerns about adolescent sexual activity, whereas the  
226 flu and MMR vaccines are not. As mentioned previously, the MMR and HPV vaccines are either  
227 one time or composed of a few doses in a lifetime, whereas the flu vaccine is seasonal. The  
228 MMR vaccine had more prominence surrounding the emergence of a measles outbreak in the  
229 U.S. in late 2018 and early 2019 and the flu vaccine was relevant because of the season, whereas

230 the HPV vaccine was not particularly salient. Investigating patterns for such different vaccines,  
231 combined with a large probability sample, should inform theory and practice in the area of  
232 religion and vaccine promotion.

233 Finally, the current study investigated this model with three different vaccines through a  
234 longitudinal design. Through a nationally representative probability-based panel survey, the  
235 same respondents were tracked over a six-months long period through a total of four re-contacts.  
236 This strategy provided an opportunity to capture within-individual changes and stability across  
237 time, thereby providing stronger causal associations in predicting vaccine attitudes and behavior  
238 (Ajzen et al., 2019).

## 239 METHODS

### 240 Sample

241 The study was approved by the Institutional Review Board of [REDACTED] and  
242 included written consent. It shared time and was administered within a larger panel study on  
243 perceptions of infectious diseases and vaccination predictors during 2018-2019. The survey  
244 consisted of a probability-based nationally representative panel sample of adults living in the  
245 U.S. who were randomly selected from the AmeriSpeak panel of National Opinion Research  
246 Center (NORC) at the University of Chicago. The sampling frame covered 97% of U.S.  
247 households via a two-stage stratified sampling (Supplementary Information – SI-1). In this study,  
248 we utilized data from four different waves of the panel based on available space for questions.  
249 Four waves of data collection were implemented between September 21, 2018 and March 18,  
250 2019, thus covering the 2018-2019 flu season; further details on waves are in the upper panel in  
251 Table 1.

252 [Table 1 INSERT HERE]

253 Both the average and the median sample age was 48 years. Males (48%) and females  
254 (52%) were represented in balanced way. Racial groups were proportionally represented,  
255 although not perfectly, with Whites constituting 62% of the sample. The median income ranged  
256 from \$50,000 to \$59,999. Weighted distributions of key demographic variables (i.e., age, sex,  
257 race, and income) did not differ greatly from unweighted results and closely matched the census  
258 estimates (SI-1). The one exception was an inexact match between our sample and the latest  
259 census estimates for education. Among respondents of 25 years of age or older (excluding most  
260 college students), 49% had at least a college degree.<sup>6</sup>

## 261 **Measures**

262 All questions and operationalization details about question wording, response options,  
263 coding, and reliability scores, are provided in second section in Table 1. Frequency distributions  
264 and other summary statistics appear in SI-1. We formulated most of the questions after extensive  
265 piloting, and relied on and adopted validated measures of philosophical beliefs (Shen et al.,  
266 2009) and moral beliefs obtained from prior research (Poushter, 2014). We asked respondents  
267 questions about the vaccines against the flu, MMR, and HPV.<sup>7</sup> These questions concerned  
268 attitudes toward the vaccines with two classic (i.e., perceived vaccine risk and positive  
269 evaluation of the vaccine) items that had good item-total correlations (Ajzen and Fishbein, 1980;  
270 Albarracin, 2020). These two items provide a comprehensive account of vaccine attitudes by  
271 tapping both cognitive and affective components, respectively. In the case of the flu vaccine, we  
272 also measured intentions to encourage others to get the vaccines and whether the respondent  
273 received the vaccine.<sup>8</sup> Additionally, we asked a series of demographic questions including  
274 whether respondents were parents of children and political ideology (Table 1). Finally, we asked

275 whether respondents' religion had an explicit mandate against vaccination and if so, whether  
276 they followed it, although these were not included in the theoretical model.<sup>9</sup>

### 277 **Panel Attrition**

278 Attrition analyses were conducted to compare sample composition across the four waves  
279 of the study with a focus on both demographic variables and the theoretical variables in our  
280 model (Figure 1). The demographic composition of different waves was similar as judged by  
281 nonsignificant differences in age, gender, education, income and race. For other variables, the  
282 great majority did not display any significant differences between those who dropped out and  
283 remained in the panel. Only two differences emerged. First, those who dropped out at Wave 3  
284 had relatively lower HPV positive attitude (i.e., positivity towards the vaccine item) scores in  
285 Wave 2 than those who remained. Specifically, among Wave 2, 23% of those who returned to  
286 Wave 3 and 29% of those who did not stated that they felt somewhat or very negative towards  
287 the HPV vaccine,  $F(1, 2432) = 11.01, p = .001$ . Second, those who dropped out at Wave 2 had  
288 higher flu vaccine risk perceptions in Wave 1 than those who remained. That is, among Wave 1  
289 respondents 30% of those who returned but 36% of those who dropped out at Wave 2 stated that  
290 the flu vaccine is somewhat or very risky,  $F(1, 2996) = 4.36, p = .04$ . However, these two  
291 differences were not paralleled by differences in the overall attitude index, intentions, behavior,  
292 or religious beliefs, leading to our conclusion that attrition was mostly random (SI-5).

### 293 **Analytical Strategy**

294 Using the *lavaan* package in R (Rosseel et al., 2021), we conducted longitudinal  
295 Structural Equation Models (SEM) with latent factors and autoregressive effects to test our  
296 theoretical model. The SEM approach allowed us to gauge the manner in which affiliations and  
297 philosophical and moral beliefs might predict vaccine attitudes and behaviors over time. In these

298 models, religious affiliations were positioned as exogeneous predictors of moral and  
299 philosophical views. The moral belief latent factor had three indicators and the philosophical  
300 beliefs latent factor had two indicators.<sup>10</sup> These two latent factors then predict vaccine attitudes,  
301 which is itself a latent factor with two indicators (perceived risk of the vaccine and positive  
302 evaluation of the vaccine). This vaccine attitude factor in turn predicts the respondents' (a)  
303 intentions to encourage others to vaccinate against the flu and (b) their actual flu vaccine  
304 behavior. Because intention and behaviors were only measured for the flu vaccine, we tested the  
305 analytical model in Figure 1A for the flu vaccine and the model in Figure 1B for the MMR and  
306 HPV vaccines. Each model controlled for the demographics and political ideology. The  
307 correlation matrix is in SI-2.

308         We ran the models with all religious affiliations entered as separate dummy variables (1  
309 indicates that the participant was affiliated with that group and 0 that they were not). Because we  
310 had numerous religious groups with small representations, to maximize model fit, we combined  
311 a few of the affiliations based on similarity in their philosophical and moral beliefs and the  
312 broader religious categories they were part of: Catholics and Orthodox were combined into  
313 single category and Buddhists and Hindu were combined into another single category. Hence,  
314 the following groups were coded with dummy variables and each of them entered as exogeneous  
315 variable into the SEM: (1) Protestants, (2) Roman Catholics and Orthodox Catholics, (3)  
316 Mormon, (4) Just Christians, (5) Muslim, (6) Jewish, (7) Buddhists and Hindus, (8) Unitarian,  
317 (9) Other, (10) Agnostic, (11) Nothing in particular. Atheist respondents constituted a fairly large  
318 portion of our respondents (16%); although they were not the normative category their size was  
319 higher than numerous other groups, such as Muslims, Buddhists, and Hindus.<sup>11</sup> Atheist was

320 chosen as the reference category because atheists may differ from other respondents both  
321 theoretically and empirically (Shimron, 2021).

322 For the flu vaccine model, we tested our models fully longitudinally over four waves:  
323 demographics and religious affiliations (Wave 1), philosophical and moral beliefs (Wave 2),  
324 vaccine attitudes (Wave 3), and intentions/behaviors (to encourage flu vaccination and to receive  
325 the flu vaccine) (Wave 4). All attitudes and behavior variables were fitted across all times and  
326 wave number was included to properly incorporate time, which was an important goal of the  
327 longitudinal design to capture changes in attitudes toward vaccines and actual flu vaccination.  
328 For MMR and HPV as well, we longitudinally tested vaccine attitudes in Wave 2 and 3 and the  
329 coding was done in the same manner as for the flu vaccine analyses.

330 The models in Figure 1A (flu) and 1B (MMR and HPV) were fit to the variance-  
331 covariance matrices. We reported four model fit indices (the chi-square goodness of fit test, root  
332 mean square error of approximation - RMSEA, comparative fit index - CFI, standardized version  
333 of root mean square residuals - SRMS) (Kline, 2016).<sup>12</sup> Given our categorical outcome variable  
334 (vaccine behavior), to be consistent across models, we employed diagonally weighted least  
335 squares estimation but also replicated the analyses with maximum likelihood estimation.

336 [Figure 1A and B INSERT HERE]

337 Additionally, we also used analysis of covariance (ANCOVA) to cross-sectionally  
338 compare beliefs, attitudes, intentions, and behaviors as a function of religious affiliations (all  
339 pairwise differences) while controlling for demographic differences and political ideology.<sup>13</sup>  
340 These analyses reported in SI-6 provide supplementary evidence for all pairwise religious  
341 affiliation differences.

342 The data, code, and Supporting Information Files (Online Appendices) are provided in  
 343 anonymized Open Science Framework (OSF) depository.<sup>14</sup>

## 344 RESULTS

345 The sample included a variety of religious groups that represent the religious diversity of  
 346 the U.S, specifically 877 Protestants (29 %), 574 Roman Catholics (19 %), 515 Just Christian  
 347 (Nondenominational Christian, 17 %), 343 Nothing in Particular (11 %), 192 Agnostics (6 %),  
 348 189 Atheists (6 %), 71 Other (2 %), 64 Jews (2 %), 45 Buddhists (2 %), 40 Mormons (1 %), 32  
 349 Muslims (1 %), 25 Unitarians (1 %) and 15 Orthodox Catholics (less than 1 %). When asked  
 350 directly (see Table 1), only 3% ( $N = 67$ ) of respondents reported that their religion forbids  
 351 vaccination (mostly Roman Catholic and Protestant respondents), and only half of those 67  
 352 respondents ( $N = 30$ , 2% of the total sample) reported that they followed that mandate.

353 SEM solutions in Figure 1A and 1B had an acceptable model fit for all three vaccines.  
 354 The model fits were acceptable for all flu (Chi-square,  $\chi^2(364) = 1048.305$ ,  $p < .001$ ; RMSEA =  
 355 .033 [.031, .035]; CFI = 0.989; SRMS = 0.031), MMR (Chi-square,  $\chi^2(147) = 345.992$ ,  $p < .001$ ;  
 356 RMSEA = .026 [.022, .029]; CFI = 0.978; SRMS = 0.022) and HPV models (Chi-square,  $\chi^2$   
 357 (147) = 296.350,  $p < .001$ ; RMSEA = .023 [.019, .026]; CFI = 0.985; SRMS = 0.020). The chi-  
 358 square indexes were significant, which is common with large samples, but, more importantly, the  
 359 RMSEA and the SRMR indicated good fit. All latent factors (moral beliefs, philosophical  
 360 beliefs, and vaccine attitudes) in all three vaccines had moderate to strong factor loadings, with  
 361 majority of standardized coefficients ranging from .50 to .92, only one loading being .44 (top  
 362 panel in Table 2), and all loadings being significant. Moral and philosophical beliefs covaried  
 363 significantly and strongly for the flu vaccine model ( $r = .76$ , Table 2) and weakly for MMR and  
 364 HPV vaccine ( $r = .33$  and  $r = .09$ , Table 2). In addition, according to simple correlations, all of

365 the items comprising philosophical and moral beliefs were positively correlated with each other,  
 366 and philosophical and moral beliefs indexes were positively correlated as well ( $r = .28, p < .01$ ,  
 367 see Table B1 in Supporting Information 2). These results suggest that, generally, the direction of  
 368 association of vaccine beliefs and behaviors with philosophical and moral beliefs is the same.

369 Across the models, the variance in vaccine attitudes explained by philosophical and  
 370 moral beliefs was .99 for the flu vaccine, .43 for the MMR vaccine, and .27 for the HPV vaccine  
 371 at Wave 2, and .97 for the flu vaccine, .93 for the MMR vaccine, and .89 for the HPV vaccine at  
 372 Wave 3, and .92 for the flu vaccine at Wave 4. Also, the variance in flu vaccine behavior  
 373 explained by attitudes was .40, .77 and .93 for the Waves 2, 3 and 4, respectively (SI-7). The  
 374 results of the models are not shown in a figure due to large number of coefficients, but are  
 375 provided in Table 2, and indirect effects are provided in SI-3. These analyses led to the following  
 376 results.

377 [Table 2 INSERT HERE]

378 First, we found that religious affiliations predicted moral and philosophical beliefs and  
 379 these results were consistent across the three vaccines (see center panel in *Paths* section in Table  
 380 2). For philosophical views (e.g., that health is controlled by God), we found that identifying as  
 381 Protestant, Just Christian, and Muslim had consistently stronger beliefs, and Mormons tended  
 382 have stronger beliefs in the case of the flu vaccine. Particularly, identifying as Just Christian had  
 383 the stronger positive association with philosophical views (e.g., for flu,  $\beta = .33, se = .15, p < .05$ ,  
 384 Table 2, row 22). For moral beliefs (e.g., premarital sex is immoral), we observed a very similar  
 385 pattern. Identifying as Protestant (e.g., for HPV,  $\beta = .36, se = .10, p < .05$ , Table 2, row 37), and  
 386 to a lesser extent Just Christian, Muslim, and Mormon had consistently positive and significant  
 387 associations with moral beliefs. We also note that these effects were stronger and more of them



388 were positive when political ideology was not controlled for, showing the importance of  
389 ideology in association with religion.<sup>15</sup> Additionally, having a higher income, being a parent, and  
390 being more conservative predicted stronger philosophical and moral beliefs.

391         Second, we found that philosophical and moral beliefs had different contributions to  
392 vaccine attitudes and intention/behaviors, and this differed across vaccine types. On the one  
393 hand, stronger philosophical beliefs (e.g., that health is controlled by God) predicted more  
394 negative vaccine attitudes consistently across the models (Table 2, row 48). On the other hand,  
395 moral beliefs (e.g., that premarital sex is immoral) were negatively associated with attitudes  
396 toward the HPV vaccine ( $\beta = -.15$ ,  $se = .03$ ,  $p < .001$ , Table 2, row 49) but positively with  
397 attitudes towards the flu and MMR vaccines. For the flu vaccine, this association was similar for  
398 intentions to encourage vaccination and actual vaccination as well. Stronger philosophical beliefs  
399 predicted weaker intention to encourage others to vaccinate as well as less actual vaccination,  
400 whereas stronger moral beliefs predicted stronger intention to encourage vaccination as well as  
401 more vaccination (e.g., for Moral Belief – Vaccine Behavior,  $\beta = 1.08$ ,  $se = .13$ ,  $p < .001$ , Table  
402 2, row 53).

403         Third, we found a positive association between attitude toward the flu vaccine and actual  
404 vaccination. Vaccine attitudes at Waves 2 and 3 predicted vaccination behavior at Waves 3 and  
405 4, respectively (e.g., Vaccine Attitude W2 – Vaccine Behavior W3,  $\beta = .19$ ,  $se = .02$ ,  $p < .001$ ,  
406 Table 2, row 56). The association between attitudes and intention to encourage vaccination was  
407 only positive and significant going from Wave 2 to 3 but not from Wave 3 to 4.<sup>16</sup>

408         There were also numerous albeit small indirect effects for which the full results are  
409 provided in SI-3. Most of the indirect effects were observed only for the affiliation – religious  
410 belief – vaccine attitude path.

411

**DISCUSSION**

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Vaccine mandates and religious exemptions generate extensive policy discussion all over the world. In the U.S., where state level policies determine vaccination requirements, forty five states permit for some form of religious, personal, or philosophical exemption from vaccination (National Conference on State Legislatures, 2019). In the midst of the COVID-19 pandemic and conflicts between respect for religious freedom and public health (Silverman and May, 2001; Stecula et al., 2020), it is important to understand the role that religion plays in vaccine attitudes and related behaviors. Although longstanding research has documented that, overall, religion plays an important role in vaccine attitudes and behaviors (Feder et al., 1993; Rutjens et al., 2021; Williams and O’Leary, 2019; Wombwell et al., 2015), how institutional (religious affiliations) and personal interpretations (religious beliefs) may interact to shape vaccine confidence remains poorly understood. This study contributes to this literature by probing the pathways from affiliations to beliefs to attitudes to behaviors in the contexts of three vaccines and with a nationally representative sample of U.S. adults.

Our findings indicate that although a negligible percentage of respondents stated that their religion opposed vaccination, and only half of those stated that they followed that mandate, religious affiliation was correlated with vaccination attitudes and behavior. In this paper, we both identified religious affiliation differences and explained those associations by examining the mediating role of philosophical and moral beliefs across a four waves of survey data over a period of six months. This process allowed us to both empirically control for and test the influence of religious affiliations and religious beliefs on multiple vaccine confidence indicators simultaneously. Some of our findings were in line with previous studies on perceptions of the

433 HPV vaccine (Barnack et al., 2010; Bernat et al., 2009) but described patterns that could  
434 generalize to other vaccines (i.e. the flu vaccine and the MMR vaccine).

435 Other findings were novel. We showed that there are notable differences among religious  
436 and non-religious groups such as Atheists, Unitarians and Agnostics and some among religious  
437 groups as well: SEM results showed that Protestant, Just Christian (Nondenominational  
438 Christian), and Muslim had both stronger philosophical and moral beliefs, while additionally,  
439 Mormons had also stronger moral beliefs.<sup>17</sup> We also showed that stronger philosophical views  
440 predicted greater vaccine hesitancy, both in terms of attitudes toward vaccines as well as  
441 behavior. These results contribute to the prior evidence showing a positive association between  
442 philosophical beliefs and vaccine hesitancy (Browne et al., 2015; Rutjens et al., 2021; Thomas et  
443 al., 2012) and indicating important affiliation differences when it comes to philosophical beliefs.

444 However, the association between moral beliefs and vaccine attitudes differed across  
445 vaccines. As might be expected, moral beliefs, which in this case concern premarital sex,  
446 consistently predicted negative vaccine attitudes toward the HPV vaccine (Shelton et al., 2013;  
447 Thomas et al., 2012). Yet, moral beliefs were associated with positive attitudes toward the flu  
448 and MMR vaccines as well as greater vaccination against the flu. The way we measured moral  
449 beliefs could also partly explain this finding. The moral beliefs measure comprised a mixture of  
450 items that both tapped vaccine-relevant issues (e.g. premarital and teen sex in relation to HPV  
451 being sexually transmitted infection). They also provided a more generalizable moral beliefs  
452 measure given the breadth of moral issue dimensions, making the measure more applicable to  
453 vaccines outside of the HPV vaccine. Also, the differential weight of moral beliefs across  
454 vaccines reminds us that vaccines and populations are unique. At large, these variations  
455 underscore the complexity and multidimensionality of moral beliefs and how they might

456 contribute to vaccine hesitancy, something future research could investigate. One interesting area  
457 to understand is whether and how moral religious beliefs interact with the influence of perceived  
458 (religious) norms and altruism in religious communities, which could explain positive  
459 associations with positive attitudes toward some vaccines (Pessi, 2011).

460         We also demonstrated that vaccine attitudes subsequently shaped related intentions to  
461 encourage others to get the vaccine - and behaviors - actual vaccination against the flu (Ajzen et  
462 al., 2019; Albarracin, 2020; Albarracín et al., 2001; Glasman and Albarracín, 2006). Our study is  
463 the first to uncover differences in vaccine attitudes and behaviors among religious affiliations  
464 and to consider the (mediating) role of different religious beliefs in this process. This aspect  
465 furthers our understanding of both the identity-based (religious affiliation) and cognitive  
466 dimensions (religious beliefs) in the structure of attitudes toward vaccines (cf. Krosnick et al.,  
467 1993). Additionally, the longitudinal model in this study strengthens the inference about a casual  
468 element in the demonstrated effects. It shows religious cognitions as antecedents of religious  
469 affiliation and demographic variables, which then shape vaccine attitudes and behaviors.

470         Although many studies focused on the role of religion in vaccination decisions,  
471 particularly in the case of HPV, much less is known about the role of religious beliefs concerning  
472 vaccines in general. We hypothesized and found evidence that religious identity shapes vaccine  
473 attitudes and behaviors through philosophical and moral beliefs about health and disease  
474 management. These philosophical and moral beliefs were previously hypothesized to be in  
475 conflict with the premises of vaccine technology (Gargano et al., 2013; Reynolds, 2014; Sporton  
476 and Francis, 2001). Thus, these results also speak to the individual differences in how people  
477 perceive and practice their religious affiliations when they form beliefs about vaccines. Second,  
478 our finding calls for greater focus on the mediating role of philosophical and moral beliefs and

479 suggests a degree of interpretational malleability in religion-based attitudes. For example, health  
480 campaigns could focus on such beliefs instead of religious identity, as messages on identity may  
481 backfire more easily because of defensive psychological processes (Kahan, 2017). Messages  
482 could target religious beliefs more precisely and frame vaccination recommendations in ways  
483 that highlight compatibility with (or absence of direct antagonism toward) religious attitudes. It  
484 is also important to not essentialize religious identities or isolate them by pinpointing blame in  
485 the public discourse on vaccine hesitancy, a topic we discuss at greater length below. Moreover,  
486 our mixed findings pertaining to moral beliefs suggest the need for customized messages  
487 targeting vaccine attitudes versus uptake.

488         Our results also highlight the potential challenges for the acceptance of the COVID-19  
489 vaccines. Of relevance to this topic, religious ceremonies (e.g., funerals, holy days) attended  
490 during the COVID lockdowns and public gathering bans, have been cited as key early  
491 community transmission hotspots as seen with Orthodox Jews in New York, Liberty University  
492 in Virginia, Shia shrines in Iran, and Shincheonji Church of Jesus in South Korea (ABC News,  
493 2020). Moreover, because scientifically-unproven COVID-19 remedies touted by some religious  
494 and spiritual leaders potentially undercut the disposition to accept medicinal interventions among  
495 adherents, they deserve attention as well (Stewart, 2020; Yee, 2020). The generalizability of our  
496 results across three very different vaccines gives our findings relevance to efforts to vaccinate  
497 against COVID-19. If communities are to achieve and maintain community immunity against  
498 COVID-19, a process that will require periodic booster shots, reaching vaccine hesitant  
499 communities is important.

500         Finally, it is important to not essentialize demographic groups such as religious affiliation  
501 groups and race. These measurements are a snapshot of the U.S. population in time and might

502 not be generalizable across other geographies and time. For example, the impact of historical  
503 failures such as the U.S. Public Health System's Tuskegee Syphilis Study on marginalized  
504 groups is important to keep in mind (Quinn et al., 2016). Similarly, equitable access to vaccines  
505 for all sociodemographic groups should come first to avoid overattributing lack of vaccination to  
506 cultural values or specific religious, racial, or ethnic minorities (Dembosky, 2021). Countries  
507 differ widely in the role of religion in society, social and political culture, the influence of  
508 religious leaders, and the historical background of religion. The plummeting MMR vaccination  
509 rates in Indonesia in response to a fatwa by Muslim clerics (Rochmyaningsih, 2018) is an  
510 important example. A U.S. intelligence agency admitted to collecting DNA samples during  
511 vaccination campaigns in Pakistan, which led to religious fatwas opposing vaccination within a  
512 complex social and political context (Iqbal, 2021). Future research should consider religious  
513 factors in tandem with other social and political issues.

514 *Limitations and Future Research.* Specific beliefs about religion span a wide range of  
515 issues beyond those tapped by our questions. Our focus here was not exhaustive. Other specific  
516 religion-related concerns about vaccines include use (or prior use) of human fetuses and gelatin  
517 in the vaccine production process and its final contents (Wombwell et al., 2015). Second, our  
518 measures of philosophical and moral are imperfect. Our philosophical belief measure tapped into  
519 only fate-related beliefs. One of our moral beliefs items is about using drugs, which is about  
520 health but may be less relevant to vaccination. Still, because we prioritized more generalizable  
521 health-relevant religious concepts as opposed to vaccine-relevant concepts only, we retained this  
522 item in the analysis. Future research might build on our findings by examining a larger range of  
523 items and religious beliefs as well as probing their potential interactions.

524 With a large-scale survey, we were able to track national patterns, which is a strength of  
525 our design. However, we were able to model respondents' vaccine behavior only for the flu  
526 vaccine because decisions on the other two vaccines were likely not made by the adults in our  
527 study but by their parents. Finally, we combined some of the small-size religious and racial  
528 groups during the analysis for various statistical procedures. While there is ample research on  
529 specific religious communities and vaccination, studies should also oversample and focus on  
530 diverse race groups as well (Freimuth et al., 2017; Quinn et al., 2016) as these demographics  
531 predict important differences in COVID-19 related health protective behaviors (Breakwell et al.,  
532 2021). Future research should examine distinctions within affiliations too, such as between  
533 Orthodox Jews and other Jews.

## 534 **CONCLUSION**

535 Understanding the role of religious affiliations and beliefs in vaccine attitudes and  
536 behaviors is important both at the individual level but also at the macro level given the policy  
537 discussions on religious freedoms and exemptions. Since micro and macro level processes  
538 influence each other, greater vaccine hesitancy in the public could facilitate anti-vaccine policy-  
539 making that gives more weight to religious freedom in the public space at the expense of public  
540 health. Our findings suggest that some religious beliefs, particularly philosophical ones, are  
541 perceived to be in conflict with the premises of vaccines, which in turn fuels negative attitudes  
542 toward three different vaccines. These attitudes matter, as they predict both vaccination behavior  
543 and intention to encourage others to vaccinate (i.e., in the case of the flu vaccine) and they do so  
544 longitudinally over a span of six months. Findings suggest that the next generation of messages  
545 designed to increase vaccination should target religious beliefs more precisely. As the roll out of

546 COVID-19 vaccines and booster shots raises questions regarding vaccinate mandates and  
547 religious reservations, our findings can help inform the discussion.

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## Religious Affiliation and Beliefs about Vaccines

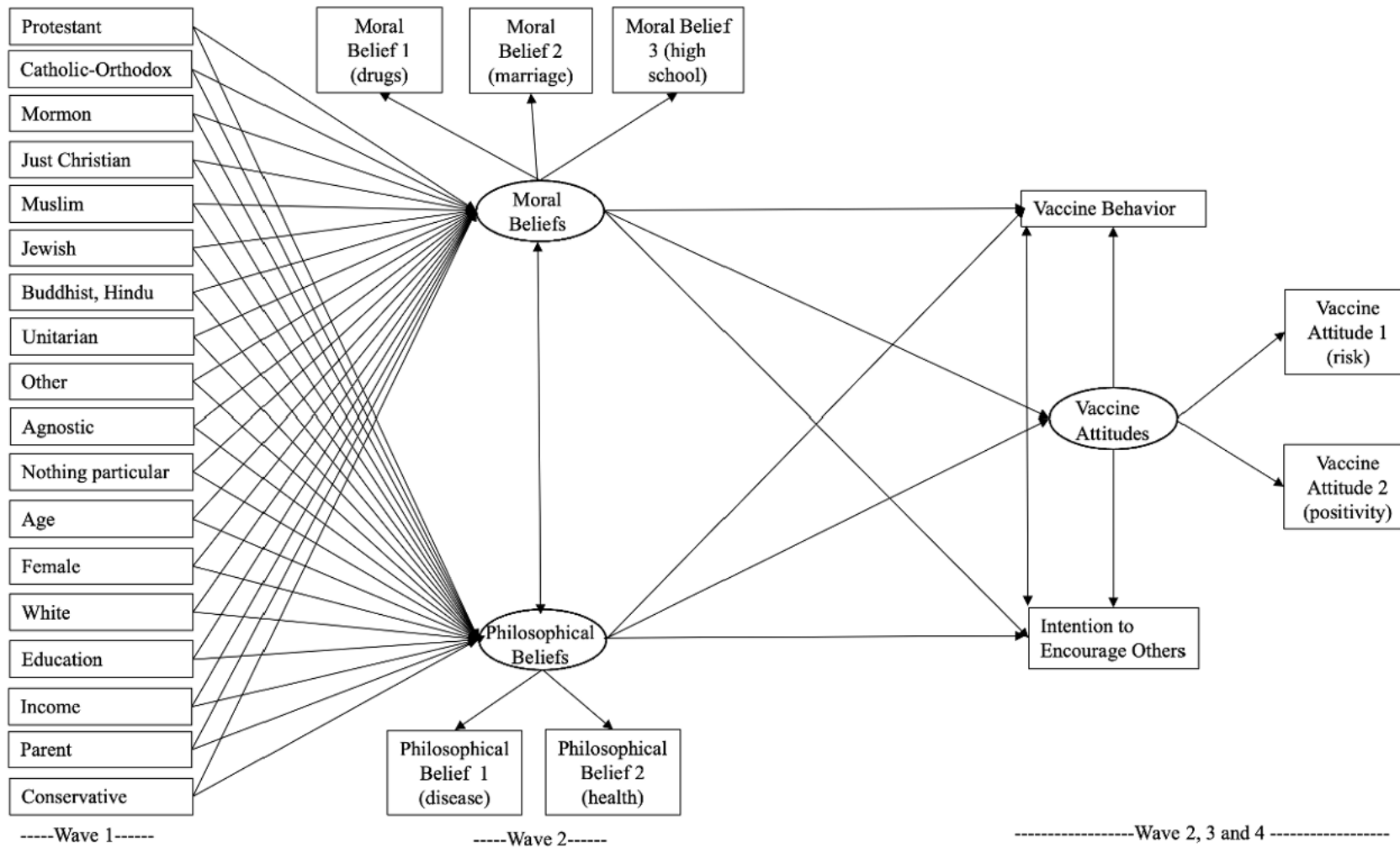
**Table 1.** Details for Sample Waves and Measures

Wave Number	Details
Wave 1	September 21, 2018 - October 6, 2018; N = 3,005; 2,725 Internet respondents and 280 phone respondents; Questions: demographics and religious affiliations
Wave 2	November 5, 2018 - November 27, 2018; N = 2, 470; 2,227 Internet respondents and 193 phone respondents; Retention rate from Wave 1: 82%; Questions: philosophical and moral beliefs, vaccine attitudes, intentions, and behaviors
Wave 3	January 1 <sup>5</sup> , 2019 - February 4, 2019; N = 2,091; 1,929 Internet respondents and 162 phone respondents; Retention rate from Wave 2: 79% and from Wave 1: 70%; Questions: vaccine attitudes, intentions, and behaviors
Wave 4	February 28, 2019- March 18, 2019; N = 1,803; 1,684 Internet respondents and 119 phone respondents; Retention rate from Wave 3: 86% and from Wave 1: 60%; Questions: vaccine attitudes, intentions, and behaviors
Variable name	Details
Age	Continuous, open-ended question (asked in Wave 1)
Sex	Two categories, male = 0, female = 1 (asked in Wave 1)
Race	Five categories, recoded into White = 1 vs Non-White = 0 dummy; original categories: White, non-Hispanic; Black, non-Hispanic; Other, non-Hispanic; Hispanic; Non-Hispanic; Asian, non-Hispanic (asked in Wave 1)
Educational attainment	Continuous, 14 response categories (coding range from 1 to 14): No formal education; 1 <sup>st</sup> , 2 <sup>nd</sup> , 3 <sup>rd</sup> , or 4 <sup>th</sup> grade; 5 <sup>th</sup> or 6 <sup>th</sup> grade; 7 <sup>th</sup> or 8 <sup>th</sup> grade; 9 <sup>th</sup> grade; 10 <sup>th</sup> grade; 11 <sup>th</sup> grade; 12 <sup>th</sup> grade NO DIPLOMA; High school graduate or equivalent; Some college, no degree; Associate degree; Bachelor's degree; Master's degree; Professional or Doctorate degree (asked in Wave 1)
Annual income	Last year total household income, continuous, 18 response categories (coding range from 1 to 18): Less than \$5,000; \$5,000 to \$9,999; \$10,000 to \$14,999; \$15,000 to \$19,999; \$20,000 to \$24,999; \$25,000 to \$29,999; \$30,000 to \$34,999; \$35,000 to \$39,999; \$40,000 to \$49,999; \$50,000 to \$59,999; \$60,000 to \$74,999; \$75,000 to \$84,999; \$85,000 to \$99,999; \$100,000 to \$124,999; \$125,000 to \$149,999; \$150,000 to \$174,999; \$175,000 to \$199,999; \$200,000 or more (asked in Wave 1)
Parent (9-12 years old)	Version 1: Are you a parent of a child between 9 and 12 years of age? Yes (1), No (0) (asked in Wave 2). This question is used in HPV and flu models. Version 2: Are you a parent of a child under 6 years of age? Yes (1), No (0) (asked in Wave 2). This question is used specifically for MMR models.
Religious affiliation	“What is your present religion, if any?”, 11 response options, “Protestant (Baptist, Methodist, Non-denominational, Lutheran, Presbyterian, Pentecostal, Episcopalian, Reformed, Church of Christ, Jehovah’s Witness, etc.),” “Roman Catholic (Catholic),” “Mormon (Church of Jesus Christ of Latter-day Saints/LDS),” “Orthodox (Greek, Russian, or some other orthodox church),” “Jewish (Judaism),” “Muslim (Islam),” “Buddhist,” “Hindu,” “Atheist (do not believe in God),” “Agnostic (not sure if there is a God),” “Nothing in particular,” “Just Christian,” “Unitarian (Universalist),” and “Other, please specify” (asked in Wave 1)
Religious mandate on vaccines	“Does your religion forbid its members from getting vaccines?”, Yes (1) / No (0), (asked in Wave 1)
Follow religion statement on vaccines	“Do you follow what your religion says about vaccines or not?”, Yes (1) / No (0), (asked in Wave 1)
Conservatism	Generally speaking, would you describe your political views as: (1) Very liberal (2) Somewhat liberal (3) Moderate (4) Somewhat conservative (5) Very conservative. (W1)
Philosophical beliefs	
Philosophical belief, item 1	“If someone is meant to get a serious disease, they will get it no matter what they do”, 4 categories, “Strongly disagree” (1), “Somewhat disagree” (2), “Somewhat agree” (3), and “Strongly agree” (4), (asked in Wave 2)

Philosophical belief, item 2	“My health is determined not by me but by a greater spiritual force”, 4 categories, “Strongly disagree” (1), “Somewhat disagree” (2), “Somewhat agree” (3), and “Strongly agree” (4), (asked in Wave 2)
Philosophical belief average of items 1 and 2	Average of the two items, (Pearson $r = .46$ , Cronbach’s alpha = $.63$ , Spearman-Brown = $.63$ ), continuous, (asked in Wave 2).
Moral beliefs	
Moral belief, item 1	“Using drugs (narcotics)”, 3 categories: “Morally acceptable,” “Morally wrong,” and “Not a moral issue”; 1 <sup>st</sup> and 3 <sup>rd</sup> categories combined* (0), 2 <sup>nd</sup> item (1) indicates bolder moral belief, (asked in Wave 2)
Moral belief, item 2	“Having sex before marriage”, 3 categories: “Morally acceptable,” “Morally wrong,” and “Not a moral issue”; 1 <sup>st</sup> and 3 <sup>rd</sup> categories combined* (0), 2 <sup>nd</sup> item (1) indicates bolder moral belief, (asked in Wave 2)
Moral belief, item 3	“Having sex in high school”, 3 categories: “Morally acceptable,” “Morally wrong,” and “Not a moral issue”; 1 <sup>st</sup> and 3 <sup>rd</sup> categories combined* (0), 2 <sup>nd</sup> item (1) indicates bolder moral belief, (asked in Wave 2) * These two response options combined for theoretical and empirical reasons. There is no meaningful theoretical difference between “not a moral issue” and “morally acceptable”; the question included both of these response options in order to prevent offending some respondents who might feel they are being forced to make a moral judgment. Empirically, as well, those respondents who chose “not a moral issue” and “morally acceptable” were indistinguishable in their responses to vaccine attitudes and other key measures. *Moral beliefs measure offers a mixture of items that both tap vaccine-relevant issues (e.g. premarital and teen sex in relation to HPV being sexually transmitted infection) and provides a more generalizable moral beliefs measure given the breadth of moral issue dimensions. This also makes the measure more applicable to distinct vaccines, not just the HPV vaccine.
Moral belief average of items 1-3	Average of items 1-3 (Pearson $r = .36$ for drugs and sex before marriage, $r = .46$ for drugs and high school sex, and $r = .65$ for sex before marriage and high school sex; Cronbach’s alpha = $.74$ , Spearman-Brown = $.80$ ).
Vaccine attitudes	
Flu/MMR/HPV vaccine risk perceptions	“Just your best guess, how risky, if at all, do you think the flu [the MMR; the HPV] vaccine is?”, 4 categories, “Not risky at all” (1), “Not too risky” (2), “Somewhat risky” (3), and “Very risky” (4), (Reversed), (asked in Wave 2, 3 and 4)
Flu/MMR/HPV vaccine positivity	“Based on what you know, how positive or negative do you feel about the flu [the MMR; the HPV] vaccine?”, 4 categories, “Very negative” (1), “Somewhat negative” (2), “Somewhat positive” (3), and “Very positive” (4), recoded so that higher scores indicate more vaccine positivity, (asked in Wave 2, 3 and 4)
Vaccine attitude index	Indexes are additive combination of vaccine risk and vaccine negativity. The Cronbach’s alpha for the flu, MMR, and HPV vaccines were $.76$ , $.62$ , and $.65$ , respectively. Greater scores represent more positive attitudes toward the vaccines.
Intention to encourage others to vaccinate against the flu	How likely, if at all, are you to encourage others to get the flu vaccine during this flu season? “Very likely” (1), “Somewhat likely” (2), “Not too likely” (3), “Not likely at all” (4). (reversed) Greater scores represent greater likelihood of encouraging vaccination. (asked in Wave 2, 3 and 4). Note that the question had an additional response option in Wave 4, which was “I already did”. For comparability, these respondents were imputed with the highest likelihood of encouraging others “Very likely” as they have already done it.
Actual vaccination behavior against the flu	Have you gotten the flu vaccine this season or not? Yes (1), No (0). Those who got the flu shot at Wave 1 were not asked this question at Wave 2, and so on with W3 and W4. Timing of vaccination across the waves was also accounted for in the analysis.

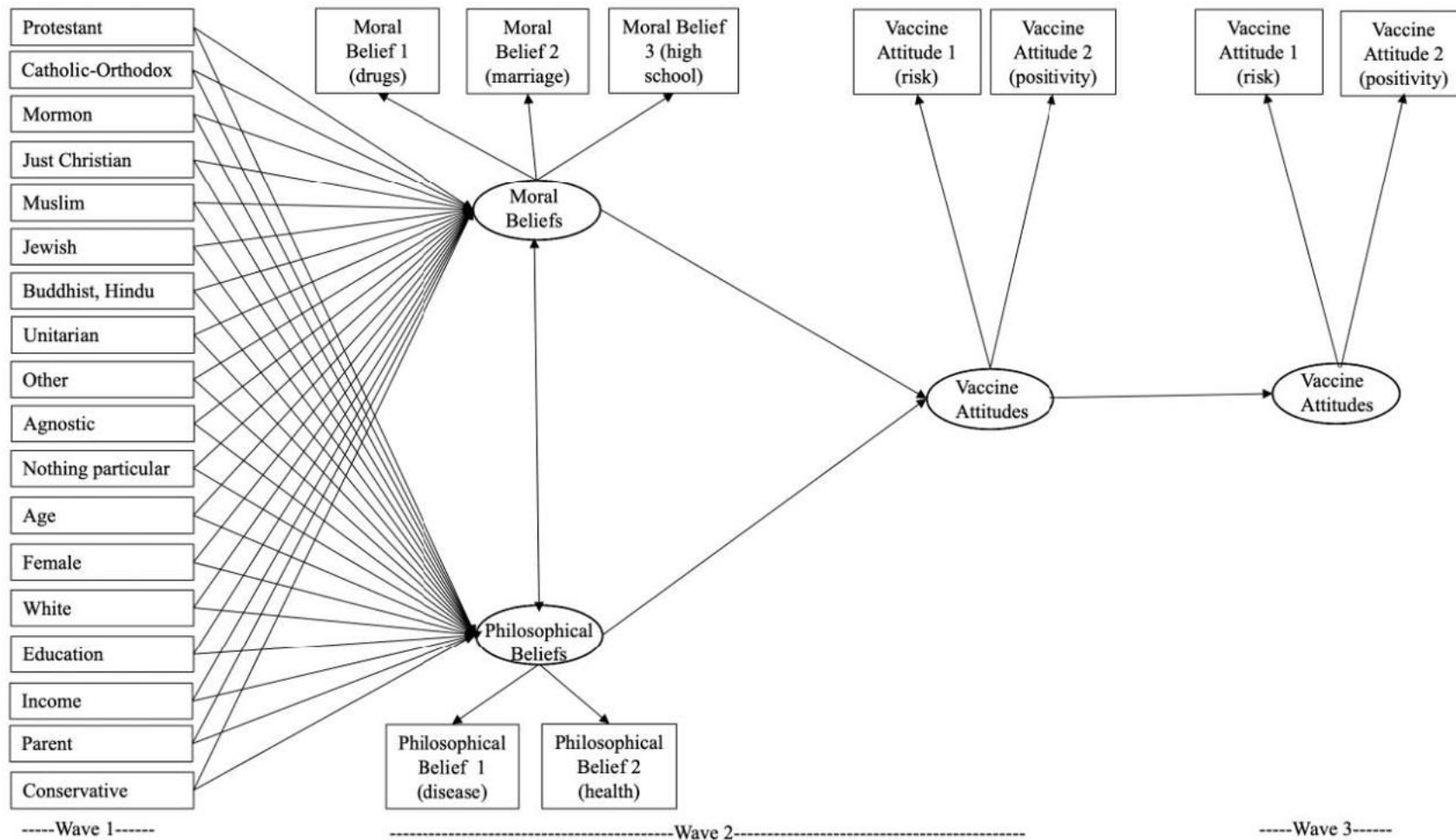
**Notes.** In questions with ordinal response options, the response options were randomized to be either in increasing or decreasing order to each half of the sample. Varying the presentation of the scales was a safeguard against response biases. Numbers in parentheses indicate the coding of each response option in the dataset.

**Figure 1A.** Analytical Model of the Structural Equation Model for Longitudinal Flu Vaccine Model



**Notes.** The wave in which variables are collected are shown at the bottom respectively. Exogeneous variables' covariances and error terms not shown. Reference category is Atheist.

**Figure 1B.** Analytical Model of the Structural Equation Model for Longitudinal MMR and HPV Vaccine Models



**Notes.** The wave in which variables are collected are shown at the bottom respectively. Exogeneous variables' covariances and error terms not shown. Reference category is Atheist.

Religious Affiliation and Beliefs about Vaccines

1 **Table 2.** Standardized Coefficients for Factor Loadings, Paths, and Covariances in the Longitudinal  
 2 Autoregressive Models

Row #	Factor Loadings	Flu Vaccine Model		MMR Vaccine Model		HPV Vaccine Model	
		Std. Coef	(se)	Std. Coef	(se)	Std. Coef	(se)
1	Philosophical 1 (W2) by Philosophical Beliefs (W2)	.45	(.00)	.51	(.00)	.56	(.00)
2	Philosophical 2 (W2) by Philosophical Beliefs (W2)	.42	*** (.04)	.57	*** (.05)	.65	*** (.06)
3	Moral 1 (W2) by Moral Beliefs (W2)	.52	(.00)	.54	(.00)	.54	(.00)
4	Moral 2(W2) by Moral Beliefs (W2)	.71	*** (.05)	.75	*** (.05)	.77	*** (.05)
5	Moral 3 (W2) by Moral Beliefs (W2)	.78	*** (.06)	.82	*** (.06)	.81	*** (.06)
6	Vaccine Attitude 1 (W2) by Vaccine Attitudes (W2)	.68	(.00)	.69	(.00)	.72	(.00)
7	Vaccine Attitude 2 (W2) by Vaccine Attitudes (W2)	.89	*** (.03)	.62	*** (.05)	.64	*** (.05)
8	Vaccine Attitude 1 (W3) by Vaccine Attitudes (W3)	.66	(.00)	.68	(.00)	.72	(.00)
9	Vaccine Attitude 2 (W3) by Vaccine Attitudes (W3)	.91	*** (.03)	.65	*** (.05)	.66	*** (.05)
10	Vaccine Attitude 1 (W4) by Vaccine Attitudes (W4)	.66	(.00)				
11	Vaccine Attitude 2 (W4) by Vaccine Attitudes (W4)	.92	*** (.04)				
<b>Paths</b>							
12	Age (W1) -> Philosophical Beliefs (W2)	.02	(.00)	-.01	(.00)	-.01	(.00)
13	Female (W1) -> Philosophical Beliefs (W2)	.05	† (.02)	.05	† (.03)	.10	** (.03)
14	White (W1) -> Philosophical Beliefs (W2)	-.10	*** (.03)	-.22	*** (.03)	-.16	*** (.04)
15	Education (W1) -> Philosophical Beliefs (W2)	-.10	** (.04)	-.22	*** (.06)	-.18	*** (.07)
16	Income (W1) -> Philosophical Beliefs (W2)	-.15	*** (.05)	-.16	*** (.06)	-.13	*** (.08)
17	Parent (W1) -> Philosophical Beliefs (W2)	.08	** (.04)	.08	* (.05)	.08	* (.05)
18	Conservative (W1) -> Philosophical Beliefs (W2)	.39	*** (.01)	.31	*** (.02)	.33	*** (.02)
19	Protestant (W1) -> Philosophical Beliefs (W2)	.36	* (.14)	.33	† (.18)	.36	† (.22)
20	Catholic-Orthodox (W1) -> Philosophical Beliefs (W2)	.19	(.14)	.23	(.18)	.24	(.21)
21	Mormon (W1) -> Philosophical Beliefs (W2)	.09	† (.17)	.02	(.20)	.02	(.23)
22	Just Christian (W1) -> Philosophical Beliefs (W2)	.33	* (.15)	.35	* (.19)	.34	* (.22)
23	Muslim (W1) -> Philosophical Beliefs (W2)	.14	* (.21)	.14	* (.26)	.14	* (.31)
24	Jewish (W1) -> Philosophical Beliefs (W2)	.04	(.14)	.07	(.19)	.07	(.23)
25	Buddhist-Hindu (W1) -> Philosophical Beliefs (W2)	.08	(.15)	.09	(.20)	.09	(.24)
26	Unitarian (W1) -> Philosophical Beliefs (W2)	.00	(.15)	.00	(.20)	.00	(.25)
27	Other (W1) -> Philosophical Beliefs (W2)	.08	(.16)	.09	(.21)	.12	† (.25)
28	Agnostic (W1) -> Philosophical Beliefs (W2)	-.02	(.13)	.01	(.17)	.00	(.20)
29	Nothing in Particular (W1) -> Philosophical Beliefs (W2)	.08	(.14)	.14	(.18)	.16	(.21)
30	Age (W1) -> Moral Beliefs (W2)	.16	*** (.00)	.15	*** (.00)	.13	*** (.00)
31	Female (W1) -> Moral Beliefs (W2)	.04	(.01)	.03	(.01)	.02	(.01)
32	White (W1) -> Moral Beliefs (W2)	-.08	* (.02)	-.07	* (.02)	-.07	* (.02)
33	Education (W1) -> Moral Beliefs (W2)	-.07	* (.03)	-.03	(.03)	-.03	(.03)
34	Income (W1) -> Moral Beliefs (W2)	-.13	*** (.03)	-.10	** (.03)	-.09	** (.03)
35	Parent (W1) -> Moral Beliefs (W2)	.06	* (.02)	.07	* (.02)	.07	* (.02)
36	Conservative (W1) -> Moral Beliefs (W2)	.36	*** (.01)	.34	*** (.01)	.36	*** (.01)
37	Protestant (W1) -> Moral Beliefs (W2)	.38	* (.10)	.38	* (.10)	.36	* (.10)
38	Catholic-Orthodox (W1) -> Moral Beliefs (W2)	.21	(.10)	.20	(.10)	.18	(.10)
39	Mormon (W1) -> Moral Beliefs (W2)	.13	* (.13)	.16	** (.13)	.16	** (.13)
40	Just Christian (W1) -> Moral Beliefs (W2)	.31	* (.10)	.30	* (.10)	.30	* (.10)
41	Muslim (W1) -> Moral Beliefs (W2)	.15	* (.15)	.14	* (.14)	.14	* (.14)
42	Jewish (W1) -> Moral Beliefs (W2)	.05	(.10)	.02	(.10)	.02	(.10)
43	Buddhist-Hindu (W1) -> Moral Beliefs (W2)	.07	(.11)	.05	(.10)	.04	(.10)
44	Unitarian (W1) -> Moral Beliefs (W2)	-.01	(.11)	.00	(.11)	.00	(.10)
45	Other (W1) -> Moral Beliefs (W2)	.08	(.11)	.06	(.11)	.06	(.11)

46	Agnostic (W1) -> Moral Beliefs (W2)	-.02	(.09)	-.02	(.09)	-.01	(.09)
47	Nothing in Particular (W1) -> Moral Beliefs (W2)	.02	(.09)	.01	(.09)	.02	(.09)
48	Philosophical Beliefs (W2) -> Vaccine Attitudes (W2)	-1.88 ***	(.13)	-.73 ***	(.06)	-.45 ***	(.04)
49	Moral Beliefs (W2) -> Vaccine Attitudes (W2)	1.42 ***	(.23)	.18 ***	(.07)	-.15 ***	(.05)
50	Vaccine Attitudes (W2) -> Vaccine Attitudes (W3)	.99 ***	(.02)	.96 ***	(.05)	.94 ***	(.05)
51	Vaccine Attitudes (W3) -> Vaccine Attitudes (W4)	.96 ***	(.02)				
52	Philosophical Beliefs (W2) -> Vaccine Behavior (W2)	-1.20 ***	(.07)				
53	Moral Beliefs (W2) -> Vaccine Behavior (W2)	1.08 ***	(.13)				
54	Vaccine Behavior (W2) -> Vaccine Behavior (W3)	.75 ***	(.02)				
55	Vaccine Behavior (W3) -> Vaccine Behavior (W4)	.92 ***	(.03)				
56	Vaccine Attitudes (W2) -> Vaccine Behavior (W3)	.19 ***	(.02)				
57	Vaccine Attitudes (W3) -> Vaccine Behavior (W4)	.06 *	(.03)				
58	Philosophical Beliefs (W2) -> Encourage Others (W2)	-1.43 ***	(.18)				
59	Moral Beliefs (W2) -> Encourage Others (W2)	1.22 ***	(.35)				
60	Encourage Others (W2) -> Encourage Others (W3)	.79 ***	(.09)				
61	Encourage Others (W3) -> Encourage Others (W4)	1.01 ***	(.11)				
62	Vaccine Attitudes (W2) -> Encourage Others (W3)	.19 **	(.14)				
63	Vaccine Attitudes (W3) -> Encourage Others (W4)	-.04	(.18)				
<b>Covariances</b>							
64	Philosophical Beliefs (W2) with Moral Beliefs (W2)	.76 ***	(.00)	.33 ***	(.00)	.09†	(.00)
65	Vaccine Attitude 1 (W2) with Vaccine Attitude 1 (W3)	.38 ***	(.02)	.03	(.02)	.08	(.03)
66	Vaccine Attitude 1 (W2) with Vaccine Attitude 1 (W4)	.40 ***	(.02)				
67	Vaccine Attitude 1 (W3) with Vaccine Attitude 1 (W4)	.40 ***	(.02)				
68	Vaccine Attitude 2 (W2) with Vaccine Attitude 2 (W3)	-.13	(.03)	.32 ***	(.02)	.33 ***	(.03)
69	Vaccine Attitude 2 (W2) with Vaccine Attitude 2 (W4)	-.12	(.03)				
70	Vaccine Attitude 2 (W3) with Vaccine Attitude 2 (W4)	-.14	(.03)				
71	Encourage Others (W2) with Encourage Others (W3)	-.30 *	(.06)				
72	Encourage Others (W2) with Encourage Others (W4)	-.07	(.05)				
73	Encourage Others (W3) with Encourage Others (W4)	-.45 **	(.06)				
74	Encourage Others (W2) with Vaccine Behavior (W2)	.30 ***	(.01)				
75	Encourage Others (W3) with Vaccine Behavior (W3)	.28 ***	(.01)				
76	Encourage Others (W4) with Vaccine Behavior (W4)	.18	(.02)				

3 **Notes.** † for  $p < .10$ , \* for  $p < .05$ , \*\* for  $p < .01$ , and \*\*\* for  $p < .001$ . Significance levels for first items in factor  
4 loadings are not shown as they are set to variance 1. Reference: Atheist. Standardized coefficients are shown  
5 representing STDYX standardization. As clarified in Table 1, Philosophical 1 is disease item, Philosophical 2 is  
6 health item, Moral 1 is drugs item, Moral 2 is marriage item, Moral 3 is high school sex item, Attitude 1 is risk  
7 perception about vaccine, Attitude 2 is positivity about vaccine. Encourage Others is intention to encourage others to  
8 get the flu vaccine.

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<sup>1</sup> In contrast, the intensity of religiosity (such as frequency of praying, adherence to all practices) has been found to be not significantly associated with teenage females' vaccination (Reynolds, 2014).

<sup>2</sup> Given the exploratory question about differences across religious affiliations and the use of a path model for our prediction, we do not formally state or numerate specific hypotheses.

<sup>3</sup> Our primary interest concerned the pathways in this model. We did not hypothesize differences between three distinct vaccines but treated the multi-vaccine data as a self-replication and vaccine-generalizability robustness test.

<sup>4</sup> Measurement models differed slightly across vaccines. We did not have sufficient statistical power to analyze MMR and HPV vaccination among the respondents' children although we asked parents to report on their children's vaccination. Whether respondents themselves had the MMR and HPV vaccines was not measured since the respondents' parents/caretakers, not themselves, were involved in that decision.

<sup>5</sup> As, by law, the U.S. Census does not include any question about religious preferences and affiliations (Pew Research Center, 2010), these figures rely on large nationally representative surveys.

<sup>6</sup> The U.S. Census Bureau 2018 estimates for this group is 35% (Bureau, 2019). This difference was largely due to a lower survey completion rate among respondents with lower education at Wave 1 (completion rates = 38% and 57% for high school graduates and those with college degree/more, respectively). The survey company NORC successfully employed *adaptive targeting* (e.g., more incentives, reminders) of this group of respondents in later waves to keep education distribution less skewed (SI-1).



<sup>7</sup> Although there are multiple flu and HPV vaccines, we referred to the general name flu and HPV in singular for simplicity.

<sup>8</sup> Aside from the fact that we cannot meaningfully test vaccine behavior for MMR and HPV, our study also had limited question space due to time-sharing with other questions. For example, for MMR and HPV, we asked the respondents' intention to encourage others to vaccinate their children but only in one wave. In Wave 4, MMR encouragement intentions were asked but those variables were part of an unrelated experiment (the measures in this study were asked before experimental module in Wave 4).

<sup>9</sup> This question was asked for descriptive purposes and was not included in model testing due to extremely low variance and lack of a clear theoretical relation with religious beliefs.

<sup>10</sup> We note that the philosophical belief items may correlate with locus of control, self-efficacy (Bandura, 1989) or decision power in the Health Belief Model (Rosenstock, 1974). However, our items are concerned with religious and supernatural forces, which is not the case for self-efficacy.

<sup>11</sup> The cross-sectional ANCOVA analysis (details in SI 6) showed that Atheists had the least vaccine hesitancy across all variables. All pairwise differences among religious affiliations are shown in SI6 as well.

<sup>12</sup> We assessed chi-square (model fit between the sample and fitted covariance matrices), RMSEA (refers to root mean square error of approximation; 90% CIs are given in parentheses), CFI (comparative fit index) and SRMS (standardized version of root mean square residuals; standardization provides more valuable statistic when measures have different number of

response range).

<sup>13</sup> We also document significant pairwise correlations between religious affiliations and our key outcome variables (SI-2).

<sup>14</sup> [https://osf.io/r8asd/?view\\_only=4d39c586a9f84a048d236d6488c8d6df](https://osf.io/r8asd/?view_only=4d39c586a9f84a048d236d6488c8d6df)

<sup>15</sup> The reference category in these results was Atheists; SI-6 provides cross-sectional pairwise differences among all religious affiliations as well.

<sup>16</sup> We note that for intentions to encourage others, negative covariances observed at the bottom of Table 2 (intention to encourage others at W2 and W3 as well as at W3 and W4) suggest that path coefficients among intentions to encourage others across waves might not be as strong as estimated.

<sup>17</sup> We also found similar pairwise differences among affiliations in the cross-sectional analysis in SI-6.