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Abstract

Background: Religious personnel may shape community perceptions of vaccination. We assessed vaccine hesitancy and its attitudinal, information-source, and behavioral correlates among religious personnel in Malatya, Türkiye.

Methods: In February 2026, we conducted a cross-sectional survey of religious personnel in Battalgazi and Yeşilyurt, Malatya. Of 755 eligible personnel, 533 were included in the analysis. Vaccine hesitancy was assessed using the 10-item Vaccine Hesitancy Scale (VHS), with VHS-7 Lack of Confidence as the primary outcome. Adjusted associations were estimated using linear and modified Poisson regression; restricted cubic splines assessed nonlinearity, and Firth-penalized logistic regression evaluated the parent-reported childhood-vaccination outcome.

Results: Participants had a median VHS-7 score of 20 (IQR: 16-24). Overall, 81.8% reported vaccine-related concerns, 59.7% perceived traditional and complementary medicine (T&CM) as more reliable than vaccines, 65.7% did not support vaccination information in religious talks, 72.6% did not provide vaccine-related advice, and 36.0% reported COVID-19 nonvaccination. In adjusted models, VHS-7 scores were higher among participants reporting vaccine-related concerns ($B=4.77$; 95% CI 3.37-6.16) and perceiving T&CM as more reliable than vaccines ($B=3.07$; 95% CI 2.05-4.09). Each 5-point increase in VHS-7 was associated with higher prevalences of non-support for vaccination information in religious talks ($aPR=1.14$; 95% CI 1.09-1.19) and COVID-19 nonvaccination ($aPR=1.24$; 95% CI 1.14-1.34). In exploratory spline models, overall associations were observed for non-support ($p<0.001$), non-provision of advice ($p=0.013$), and COVID-19 nonvaccination ($p<0.001$); only non-provision showed evidence of nonlinearity (nonlinearity $p=0.004$; FDR $q=0.012$). In an exploratory analysis of 464 participants with children, each 5-point higher VHS-7 score was

associated with greater odds of parent-reported nonreceipt of ≥ 1 childhood vaccination (34/464 [7.3%]; aOR=2.18; 95% CI 1.57-3.12).

Conclusions: Lower vaccine confidence was more consistently associated with vaccine-related attitudes and behaviors than with sociodemographic characteristics. These findings may inform tailored engagement with religious personnel.

Keywords: Vaccination Hesitancy; Religious Personnel; Trust; Health Communication

1. Background

Vaccination is recognized as one of the most effective public health interventions, preventing approximately 3.5-5 million deaths worldwide each year [1]. Despite this, vaccine hesitancy (defined as the delay or refusal of vaccination despite its availability) has become a significant global health concern in recent years and was identified by the World Health Organization (WHO) in 2019 as one of the ten greatest threats to global health [2]. With the COVID-19 pandemic, attitudes toward vaccination became even more complex, as elements such as misinformation, distrust, and societal polarization further exacerbated vaccine hesitancy [3, 4]. Concerns about vaccine safety, distrust among health authorities, and the tendency to turn to alternative information sources such as social media significantly influence individuals' vaccine-related decisions [5, 6]. Furthermore, several studies have demonstrated a meaningful association between an inclination toward traditional and complementary medicine (T&CM) practices and vaccine hesitancy [7]. Religious beliefs and the influence of religious leaders are important but relatively underexplored determinants of vaccine confidence. Religious leaders can shape health-related decisions and may either facilitate or hinder vaccine acceptance depending on the sociocultural context [8-10]. During the COVID-19 pandemic, their role in communicating public-health guidance and addressing or, in some settings, amplifying vaccine-related concerns became increasingly visible [10, 11].

Nevertheless, the majority of studies examining vaccine hesitancy in the literature focus on the general population or healthcare workers, and studies focusing on religious personnel remain limited. However, particularly in countries such as Türkiye, where religious institutions play an important role in social life, the vaccination attitudes of religious personnel may shape both individual decisions and community-level communication. In this context, the present study aimed to assess vaccine hesitancy among religious personnel using the Vaccine Hesitancy Scale (VHS), with a particular focus on the dimension of “lack of confidence”. Additionally, the relationships between sociodemographic characteristics, attitudes, COVID-19-related variables, and vaccine hesitancy were examined. The findings of this study are expected to contribute to the development of targeted public health strategies aimed at improving vaccine acceptance through collaboration with religious personnel as potential partners in community health communication.

2. Methods

2.1 Study design and setting

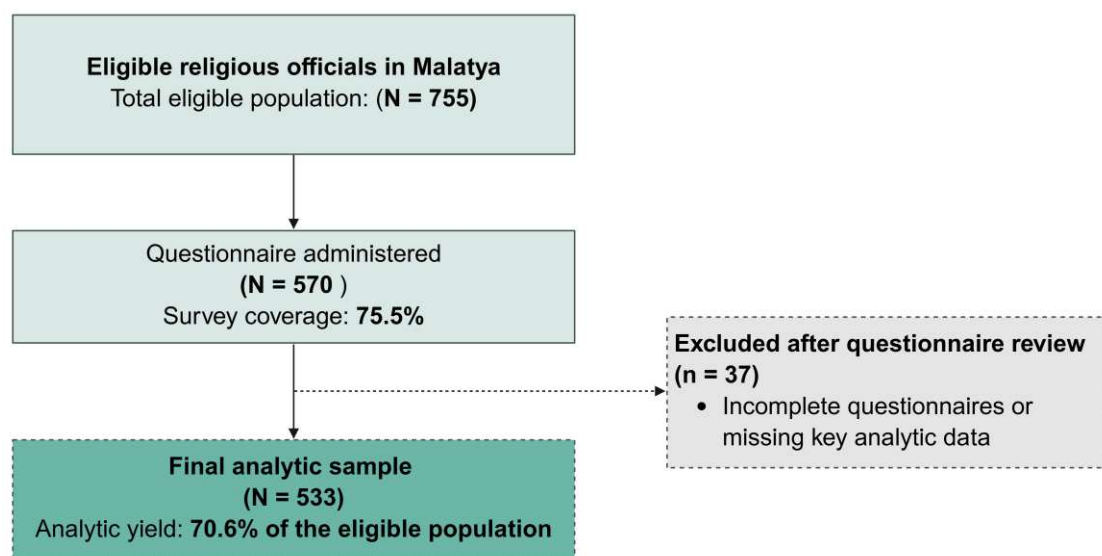
We conducted a cross-sectional survey of religious personnel affiliated with Türkiye’s Presidency of Religious Affairs in Battalgazi and Yeşilyurt, the two central districts of Malatya Province, eastern Türkiye. Participants completed a self-administered questionnaire in February 2026. Reporting followed the STROBE statement for cross-sectional studies.

2.2 Study population and recruitment

Eligible participants were mosque-based clergy (imams, preachers, and muezzins) and Qur’an course teachers actively serving in either district during data collection. We attempted to recruit the entire eligible population rather than sample from it. Personnel not on active duty were ineligible; unreturned questionnaires were classified as non-response.

Of 755 eligible personnel, 570 returned questionnaires (survey coverage, 75.5%). We excluded 37 questionnaires with missing VHS data, key vaccination-related behavioral variables, or prespecified core sociodemographic variables. The analytic sample comprised 533 participants (70.6% of the eligible population; Figure 1). Because the study targeted the complete finite occupational population, no a priori sample-size calculation was performed.

Figure 1. Participant flowchart.



Note. Survey coverage is the proportion of eligible personnel who returned a questionnaire; analytic yield is the proportion included after applying prespecified completeness criteria.

2.3 Data collection

Anonymous paper questionnaires were distributed at district-level meetings. Participants completed them independently and returned them in sealed envelopes. To reduce social-desirability and reporting bias, the questionnaire contained no personal identifiers and participation was voluntary. Researchers answered procedural questions but did not assist with item responses.

Before fieldwork, the complete Turkish-language questionnaire was pretested in 25 religious personnel outside the study districts for clarity, comprehension, and completion time. Minor wording and layout changes were made to the study-specific items; the VHS items were unchanged. The same procedures were used in both districts and occupational groups.

2.4 Measures

The self-administered Turkish-language questionnaire combined (1) 24 study-specific items developed by the research team for this study and not previously published, and (2) the previously published 10-item Turkish adult Vaccine Hesitancy Scale (VHS) [14]. The study-specific items were treated as individual variables and were not intended to constitute a new psychometric scale. An English-language version of the study-specific item wording and response options, reconstructed from the final variable definitions and coding used in the analysis, is provided [see Additional file 2]. The study-specific component covered sociodemographic and occupational characteristics, vaccine-information sources, vaccine-related attitudes and perceptions, and vaccination-related communication and behavior. Sociodemographic and occupational variables were age, sex, district of employment, education, having children, years in service, occupation, chronic disease, and current smoking. Having children was defined as reporting at least one child.

Attitudinal measures covered vaccine-related concerns, perceived vaccine safety, perceived reliability of traditional and complementary medicine (T&CM) relative to vaccines, support for including information about the importance of vaccination in Friday sermons or other religious talks, and whether participants believed they had accurate knowledge about COVID-19 vaccines. COVID-19 items assessed previous infection, receipt of at least one COVID-19 vaccine dose, and whether views about vaccination had become more positive, more negative, or had not changed compared with before the pandemic. Participants could select healthcare workers, social media, religious institutions, family or friends, and television

as vaccine-information sources. Communication items assessed vaccine-related questions received, advice provided, referrals to health institutions, and perceived influence on vaccination decisions.

2.5 Vaccine Hesitancy Scale

Vaccine hesitancy-related attitudes were assessed using the 10-item Vaccine Hesitancy Scale (VHS), derived from the survey tool developed by the WHO Strategic Advisory Group of Experts Working Group on Vaccine Hesitancy [12, 13]. We administered the Turkish version modified and validated by Çelik et al. for use among adults [14]. In this adaptation, parent- and child-referent statements were reworded to refer to respondents' own vaccination or to vaccines generally. The instrument comprises seven positively worded confidence items and three perceived-risk items. Responses were recorded on a five-point Likert scale from 1 (strongly disagree) to 5 (strongly agree), with 3 denoting undecided.

The seven confidence items were reverse-scored as 6 minus the recorded response and summed to obtain the VHS-7 Lack of Confidence score (range, 7-35); higher scores indicate lower vaccine confidence. The three perceived-risk items were summed without reverse-scoring to obtain the VHS-3 Perceived Risks score (range, 3-15); higher scores indicate greater perceived risk. VHS-10 Total was calculated as the sum of VHS-7 and VHS-3 (range, 10-50), with higher scores indicating greater overall vaccine hesitancy. Because the Turkish adult VHS has no validated diagnostic cutoff, scores were analyzed continuously and were not used to classify participants as hesitant or non-hesitant. Component scores required complete responses to all corresponding items; no item-level imputation or prorating was performed.

2.6 Outcomes and covariates

The primary continuous outcome was VHS-7 Lack of Confidence; VHS-3 Perceived Risks and VHS-10 Total were secondary continuous outcomes. Binary vaccination-related

outcomes were non-support for including information about the importance of vaccination in Friday sermons or other religious talks, non-provision of vaccine-related advice to community members, and COVID-19 nonvaccination. Vaccine-related concerns were evaluated in a separate secondary binary-outcome model.

Among participants with children, parent-reported nonreceipt of at least one childhood vaccination was examined as an exploratory outcome and was defined as reporting that at least one childhood vaccination had not been administered to their child or children.

Covariates were prespecified for each model on subject-matter grounds across demographic, health, vaccine-information-source, and vaccination-attitude domains. All prespecified variables were retained irrespective of statistical significance; no stepwise, automated, or univariable-significance-based variable selection was performed. Occupation and years in service were not included in the primary adjusted models because of their close relationships with sex and age, respectively. Occupation was subsequently substituted for sex in the sensitivity analyses described below.

2.7 Statistical analysis

Analyses were conducted using R version 4.6.0 (R Foundation for Statistical Computing, Vienna, Austria). Continuous variables were summarized as medians and interquartile ranges; means and standard deviations were additionally reported for VHS scores. Categorical variables were summarized as counts and percentages. Score distributions were examined graphically. Internal consistency was evaluated using Cronbach's α and McDonald's ω , and correlations between scale scores using Spearman's ρ .

All 533 participants had complete data for the main analyses; therefore, no imputation was performed. The childhood-vaccination analysis included 464 of the 465 participants with children because one participant had missing outcome data.

Univariable and multivariable associations with VHS-7 were estimated using ordinary least-squares linear regression and reported as unstandardized coefficients (B) with 95% confidence intervals (CIs). Corresponding multivariable models were fitted for VHS-3 and VHS-10. Covariates were selected on subject-matter grounds and entered simultaneously; the complete model terms and coding are presented in the corresponding tables. Model assumptions were assessed using residual-versus-fitted and Q-Q plots, and HC3 heteroskedasticity-consistent standard errors were used.

Adjusted prevalence ratios (aPRs) for the principal binary outcomes were estimated using modified Poisson regression with a log link and HC0-type robust sandwich variance. Models included sociodemographic, health-related, vaccine-information-source, and attitudinal covariates together with VHS-7 and VHS-3. Outcome-specific attitudinal and behavioral variables were added as appropriate, but a variable defining the modeled outcome was not included as a predictor in that model. VHS-7 and VHS-3 effects were expressed per 5-point and 1-point increase, respectively. Vaccine-related concerns were examined in a separate secondary model that excluded VHS-3 because of potential construct overlap.

Potential nonlinearity in the associations of VHS-7 with non-support for vaccination information, non-provision of vaccine-related advice, and COVID-19 nonvaccination was explored using modified Poisson restricted cubic-spline models. Three knots were placed at VHS-7 scores of 13, 20, and 31. Each spline model used the same outcome-specific covariates as the corresponding linear-score model. Adjusted marginal prevalences were standardized over the observed covariate distribution. Robust Wald tests evaluated overall and nonlinear associations. The non-provision-of-advice model was additionally examined using a four-knot spline with knots at scores of 8, 18, 22, and 35 (empirical 5th, 35th, 65th, and 95th percentiles) and a three-knot binomial-logit spline model. Benjamini-Hochberg correction was applied only to the three nonlinearity tests from the primary three-knot models.

Among participants with children, correlates of parent-reported childhood-vaccine nonreceipt were examined using Firth-penalized logistic regression because only 34 events were observed. Odds ratios were reported with profile penalized-likelihood 95% CIs and penalized likelihood-ratio p values. These results were considered exploratory.

Sensitivity analyses replaced sex with occupational group in the VHS-7 linear model, the three principal modified Poisson models, and the Firth model. Sex and occupation were not entered simultaneously, and years in service was excluded because of its close relationship with age. Unless otherwise specified, all tests were two-sided, and $p < 0.05$ was considered statistically significant; for the three nonlinearity tests from the primary three-knot spline models, this threshold was applied to Benjamini-Hochberg-adjusted p values. Associations were cross-sectional and should not be interpreted causally.

2.8 Ethical approval

The study was approved by the institutional Health Sciences Scientific Research Ethics Committee on 13 January 2026 (Approval No. 2026/9117). Administrative permission to conduct the study was obtained from the Malatya Provincial Mufti's Office. All participants provided written informed consent. Participation was voluntary, and participants could decline or withdraw without consequence. The study was conducted in accordance with the Declaration of Helsinki.

2.9 Declaration of generative AI and AI-assisted technologies in the manuscript preparation process

For English language proofreading, the authors used ChatGPT (OpenAI; accessed 25 August 2026). No AI tool was used to generate data, conduct statistical analyses, or make final scientific interpretations. All scientific content, analyses, interpretations, and final wording

were critically reviewed and approved by the authors, who take full responsibility for the integrity and accuracy of the manuscript.

3. Results

3.1 Study flow and participant characteristics

Of 755 eligible personnel, 570 returned questionnaires (75.5%), and 533 were analyzed after 37 exclusions (70.6% of the eligible population). The analytic sample comprised mosque-based clergy and 220 Qur'an course teachers; 223 participants (41.8%) were women. Median age was 41 years (IQR 35-46), median service duration was 14 years (IQR 8-20), and 465 participants (87.2%) had children. Vaccine-related concerns were reported by 436 participants (81.8%); 318 (59.7%) perceived traditional and complementary medicine as more reliable than vaccines; 350 (65.7%) did not support vaccination information in religious talks; 387 (72.6%) did not provide vaccine-related advice; and 192 (36.0%) reported COVID-19 nonvaccination (Table 1). Vaccine-information sources are shown in Supplementary Figure S1 [see Additional file 1].

Table 1. Participant characteristics, vaccination-related context, study outcomes, and Vaccine Hesitancy Scale scores (N = 533)

Characteristic	Overall (N = 533)
Participant characteristics	
District	
Battalgazi	244 (45.8%)
Yeşilyurt	289 (54.2%)
Age, years	41 (35-46)
Sex	
Male	310 (58.2%)
Female	223 (41.8%)

Characteristic	Overall (N = 533)
Educational attainment	
High school or lower	29 (5.4%)
University degree	453 (85.0%)
Postgraduate degree	51 (9.6%)
Occupational group	
Mosque-based clergy	313 (58.7%)
Qur'an course teachers	220 (41.3%)
Years in service	14 (8-20)
Has children	465 (87.2%)
Any chronic disease	86 (16.1%)
Current smoking	79 (14.8%)
Vaccination-related context and study outcomes	
Has vaccine-related concerns	436 (81.8%)
Perceives T&CM as more reliable than vaccines	318 (59.7%)
Receives vaccine-related questions from community members	260 (48.8%)
Does not provide vaccine-related advice to community members	387 (72.6%)
Does not support vaccination information in religious talks	350 (65.7%)
COVID-19 nonvaccination	192 (36.0%)
More negative post-pandemic vaccination attitude	397 (74.5%)
Parent-reported nonreceipt of at least one childhood vaccination	34/464 (7.3%)
Vaccine Hesitancy Scale scores	
VHS-7 Lack of Confidence score	20 (16-24)
VHS-3 Perceived Risks score	10 (8-12)
VHS-10 Total score	30 (25-35)

Note. Values are n (%) or median (IQR). Unless a different denominator is shown, percentages were calculated using N = 533. The childhood-vaccination outcome was evaluated among participants with children and nonmissing outcome data (n = 464). Higher scores indicate greater vaccine hesitancy; for VHS-7, higher scores specifically indicate lower vaccine confidence. Possible score ranges are 7-35 for VHS-7, 3-15 for VHS-3, and

10-50 for VHS-10; VHS-10 is the sum of the VHS-7 and VHS-3 subscales. Abbreviations: IQR, interquartile range; T&CM, traditional and complementary medicine; VHS, Vaccine Hesitancy Scale.

3.2 VHS score distributions and internal consistency

Median scores were 20 (IQR 16-24) for VHS-7 Lack of Confidence, 10 (IQR 8-12) for VHS-3 Perceived Risks, and 30 (IQR 25-35) for VHS-10 Total. Cronbach's α and McDonald's ω were 0.94 and 0.94 for VHS-7, 0.70 and 0.72 for VHS-3, and 0.87 and 0.89 for VHS-10, respectively. VHS-7 and VHS-3 scores were weakly positively correlated (Spearman's $\rho = 0.24$; $p < 0.001$). Full distribution and internal-consistency results are reported in Supplementary Table S1, and item-response distributions are shown in Supplementary Figure S2.

3.3 Correlates of VHS scores

Univariable and multivariable associations with VHS-7 are shown in Table 2. In the adjusted model, VHS-7 scores were higher among participants reporting vaccine-related concerns ($B = 4.77$; 95% CI 3.37-6.16), perceiving T&CM as more reliable than vaccines ($B = 3.07$; 95% CI 2.05-4.09), not supporting vaccination information in religious talks ($B = 2.89$; 95% CI 1.83-3.96), or reporting COVID-19 nonvaccination ($B = 2.67$; 95% CI 1.56-3.79). Television as a vaccine-information source was associated with lower VHS-7 scores ($B = -1.64$; 95% CI -2.94 to -0.34). The adjusted R^2 was 0.328 (Table 2). In the secondary adjusted VHS-3 model, scores were higher among participants reporting vaccine-related concerns, non-support for vaccination information, or a more negative post-pandemic vaccination attitude, and lower among those reporting television as an information source. Complete adjusted VHS-3 and VHS-10 models are reported in Supplementary Table S2. Replacing sex with occupational group left the highlighted VHS-7 estimates essentially unchanged (Supplementary Table S3).

Table 2. Univariable and multivariable associations with VHS-7 Lack of Confidence (N = 533)

Variable	Univariable B (95% CI)	p value	Adjusted B (95% CI)	p value
Age, per 10-year increase	−1.55 (−2.23, −0.88)	<0.001	−0.51 (−1.20, 0.18)	0.148
Female sex (ref: male)	0.98 (−0.22, 2.17)	0.109	−0.04 (−1.12, 1.04)	0.946
High school or lower (ref: university degree)	−0.67 (−3.63, 2.29)	0.655	−0.86 (−3.21, 1.48)	0.471
Postgraduate degree (ref: university degree)	1.58 (−0.66, 3.81)	0.167	0.81 (−1.05, 2.66)	0.392
Has children (ref: no)	0.37 (−1.39, 2.13)	0.681	0.66 (−1.07, 2.39)	0.452
Any chronic disease (ref: no)	−1.93 (−3.46, −0.40)	0.014	−1.27 (−2.69, 0.14)	0.078
Current smoking (ref: no)	0.09 (−1.60, 1.79)	0.912	−0.12 (−1.55, 1.32)	0.873
Healthcare workers as vaccine-information source (ref: no)	0.10 (−1.46, 1.66)	0.902	0.83 (−0.59, 2.25)	0.250
Social media as vaccine-information source (ref: no)	1.78 (0.53, 3.04)	0.005	0.87 (−0.31, 2.05)	0.149
Religious institutions as vaccine-information source (ref: no)	0.85 (−1.06, 2.75)	0.383	−0.06 (−1.87, 1.75)	0.949
Family or friends as vaccine-information source (ref: no)	2.09 (0.51, 3.67)	0.010	0.93 (−0.52, 2.38)	0.210
Television as vaccine-information source (ref: no)	−1.07 (−2.53, 0.40)	0.153	−1.64 (−2.94, −0.34)	0.013
Has vaccine-related concerns (ref: no)	7.20 (5.81, 8.60)	<0.001	4.77 (3.37, 6.16)	<0.001
Perceives T&CM as more reliable than vaccines (ref: no)	4.63 (3.51, 5.74)	<0.001	3.07 (2.05, 4.09)	<0.001
Does not support vaccination information in religious talks (ref: supports)	4.77 (3.63, 5.90)	<0.001	2.89 (1.83, 3.96)	<0.001
COVID-19 nonvaccination (ref: vaccinated)	4.78 (3.59, 5.97)	<0.001	2.67 (1.56, 3.79)	<0.001
More negative post-pandemic vaccination attitude (ref: positive or unchanged)	1.71 (0.22, 3.21)	0.024	0.54 (−0.67, 1.75)	0.379

Note. Values are univariable and adjusted unstandardized regression coefficients (B) with HC3-based 95% confidence intervals. Univariable estimates were obtained from separate linear regression models for each

predictor; educational attainment was modeled as a single three-level factor with university degree as the reference category. The multivariable model included all 17 prespecified predictor parameters simultaneously; no significance-based variable selection was performed. The intercept is not displayed. Occupation and years in service were excluded because of their close relationships with sex and age, respectively. Adjusted $R^2 = 0.328$. p values are two-sided and unadjusted for multiplicity. Abbreviations: CI, confidence interval; T&CM, traditional and complementary medicine; VHS, Vaccine Hesitancy Scale.

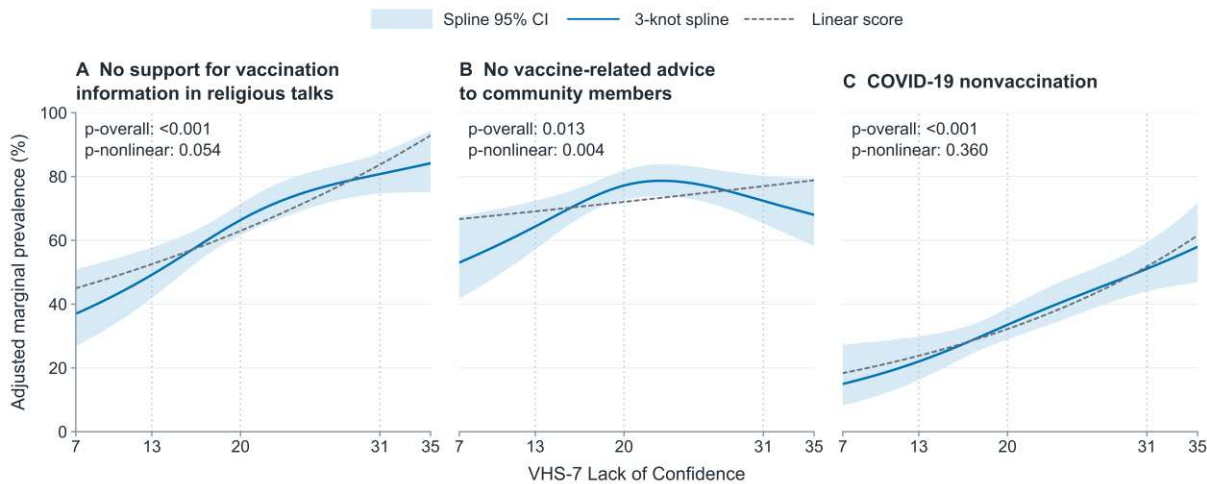
3.4 VHS scores and vaccination-related outcomes

Non-support for vaccination information in religious talks was reported by 350 participants (65.7%), non-provision of vaccine-related advice by 387 (72.6%), and COVID-19 nonvaccination by 192 (36.0%). In adjusted modified Poisson models, each 5-point higher VHS-7 score was associated with a 14% higher prevalence of non-support for vaccination information (aPR = 1.14; 95% CI 1.09-1.19) and a 24% higher prevalence of COVID-19 nonvaccination (aPR = 1.24; 95% CI 1.14-1.34). The corresponding linear-score association with non-provision of advice was imprecisely estimated (aPR = 1.03; 95% CI 0.99-1.07). Each 1-point higher VHS-3 score was associated with a slightly higher prevalence of non-support (aPR = 1.02; 95% CI 1.01-1.04), whereas its associations with the other outcomes were imprecise. Full adjusted models, with every entered variable displayed, are reported in Supplementary Table S4. Replacing sex with occupational group did not materially change the VHS-7 estimates (Supplementary Table S5).

Exploratory adjusted spline models indicated a nonlinear association between VHS-7 and non-provision of vaccine-related advice (overall $p = 0.013$; p for nonlinearity = 0.004; false-discovery-rate $q = 0.012$). Adjusted prevalence increased from 64.3% (95% CI 57.2%-72.4%) at a VHS-7 score of 13 to 77.2% (95% CI 72.7%-81.9%) at 20, remained relatively stable at scores of approximately 20-24, and declined to 72.4% (95% CI 65.3%-80.2%) at 31. The curvature persisted in the four-knot and binomial-logit sensitivity analyses (p for nonlinearity = 0.015 and 0.007, respectively). There was no clear evidence of nonlinearity for

non-support or COVID-19 nonvaccination (q for nonlinearity = 0.081 and 0.360, respectively; Figure 2).

Figure 2. Adjusted marginal prevalence of vaccination-related attitudes and behaviors across VHS-7 Lack of Confidence scores.



Note. Solid blue lines and shaded bands show adjusted marginal prevalences and robust 95% confidence intervals from outcome-specific modified Poisson restricted cubic-spline models; dashed grey lines show the corresponding linear-score models. Figure annotations show unadjusted p values for nonlinearity; the corresponding Benjamini-Hochberg-adjusted q values were 0.081, 0.012, and 0.360. Knots were placed at VHS-7 scores of 13, 20, and 31 (empirical 10th, 50th, and 90th percentiles). Models used the complete outcome-specific adjustment sets reported in Supplementary Table S4. Overall p values are from robust Wald tests; q values for nonlinearity use Benjamini-Hochberg adjustment across the three nonlinearity tests. Analyses were exploratory. Higher VHS-7 scores indicate lower vaccine confidence. Abbreviations: CI, confidence interval; VHS, Vaccine Hesitancy Scale.

Vaccine-related concerns were reported by 436 participants (81.8%). In the secondary adjusted model, concern prevalence increased with each 5-point higher VHS-7 score (aPR = 1.11; 95% CI 1.07-1.15) and was higher among participants who perceived T&CM as more reliable than vaccines (aPR = 1.12; 95% CI 1.03-1.22), did not provide vaccine-related advice (aPR = 1.18; 95% CI 1.07-1.31), reported more negative post-pandemic attitudes (aPR = 1.19;

95% CI 1.07-1.32), or had chronic disease (aPR = 1.13; 95% CI 1.03-1.24; Supplementary Table S6).

3.5 Exploratory parent-reported nonreceipt of at least one childhood vaccination

Among 464 participants with children and complete outcome data, 34 (7.3%) reported that at least one childhood vaccination had not been administered to their child or children. The most frequent reasons for nonreceipt of at least one childhood vaccination were health concerns (27/34, 79.4%), fear of side effects (21/34, 61.8%), vaccine hesitancy (19/34, 55.9%), and religious beliefs (2/34, 5.9%); multiple responses were permitted. In the exploratory Firth-penalized model, this outcome was associated with higher VHS-7 scores (aOR per 5-point increase = 2.18; 95% CI 1.57-3.12), COVID-19 nonvaccination (aOR = 4.99; 95% CI 1.86-15.65), and social media as a vaccine-information source (aOR = 2.54; 95% CI 1.12-5.96), whereas age was inversely associated (aOR per 10-year increase = 0.43; 95% CI 0.21-0.83). VHS-3 was not clearly associated (aOR per 1-point increase = 0.96; 95% CI 0.85-1.07). Because the model contained 34 events and nine predictor parameters, these estimates should be interpreted as exploratory (Table 3). Estimates were materially similar when occupational group replaced sex (Supplementary Table S7).

Table 3. Exploratory correlates of parent-reported childhood-vaccination nonreceipt using Firth-penalized logistic regression (N = 464)

Variable	Univariable OR (95% CI)	p value	Adjusted OR (95% CI)	p value
Age, per 10-year increase	0.32 (0.18, 0.55)	<0.001	0.43 (0.21, 0.83)	0.011
Female sex (ref: male)	0.68 (0.32, 1.38)	0.291	0.50 (0.20, 1.16)	0.108
High school or lower (ref: university or higher)	2.98 (0.75, 9.12)	0.112	2.09 (0.35, 10.72)	0.399
Any chronic disease (ref: no)	0.20 (0.02, 0.76)	0.014	0.62 (0.06, 3.13)	0.598

Variable	Univariable OR (95% CI)	p value	Adjusted OR (95% CI)	p value
Social media as vaccine-information source (ref: no)	2.77 (1.38, 5.70)	0.004	2.54 (1.12, 5.96)	0.026
COVID-19 nonvaccination (ref: vaccinated)	11.82 (5.01, 33.55)	<0.001	4.99 (1.86, 15.65)	0.001
Does not support vaccination information in religious talks (ref: supports)	4.98 (1.84, 18.60)	<0.001	1.25 (0.37, 5.40)	0.738
VHS-7 Lack of Confidence, per 5-point increase	2.77 (2.06, 3.82)	<0.001	2.18 (1.57, 3.12)	<0.001
VHS-3 Perceived Risks, per 1-point increase	1.05 (0.94, 1.19)	0.383	0.96 (0.85, 1.07)	0.451

Note. One participant with missing outcome data was excluded. Among 464 participants with children, 34 (7.3%) reported nonreceipt of at least one childhood vaccination. All nine prespecified predictor parameters entered in the adjusted model are shown (3.78 events per parameter). Values are odds ratios with profile penalized-likelihood 95% confidence intervals; p values were obtained using penalized likelihood-ratio tests. Findings are exploratory, and p values are two-sided and unadjusted for multiplicity. Abbreviations: aOR, adjusted odds ratio; CI, confidence interval; OR, odds ratio; VHS, Vaccine Hesitancy Scale.

4. Discussion

In this survey of 533 religious personnel following attempted census recruitment, the clearest adjusted correlates of higher VHS-7 Lack of Confidence scores were vaccine-related concerns, perceiving traditional and complementary medicine (T&CM) as more reliable than vaccines, non-support for including vaccination information in religious talks, and COVID-19 nonvaccination. The measured sociodemographic characteristics showed no clear adjusted association with VHS-7. Higher VHS-7 scores were also associated with greater prevalences of non-support and COVID-19 nonvaccination, whereas the association with non-provision of advice was nonlinear. VHS-7 and VHS-3 were only weakly correlated, and VHS-3 showed a narrower pattern across the examined outcomes. Results were materially similar when occupation replaced sex. Because all attitudes and behaviors were measured

contemporaneously, these findings describe clustering of lower vaccine confidence with other vaccine-related perceptions and behaviors rather than a causal sequence.

Vaccine-related concerns were reported by 81.8% of participants and showed the largest adjusted difference in VHS-7 scores. UK data likewise identified beliefs about efficacy, adverse effects, collective benefit, and mistrust as stronger correlates of COVID-19 vaccine hesitancy than sociodemographic characteristics alone [6], while broader reviews emphasize that demographic associations vary by context [5, 15]. In our study, however, concerns and confidence were conceptually related and measured in the same questionnaire; their association should be interpreted as concordance rather than evidence that concerns caused lower confidence. Perceiving T&CM as more reliable than vaccines was also associated with higher VHS-7 scores and a higher prevalence of concerns. Similar cross-sectional associations between endorsement or use of complementary or alternative medicine and less favorable vaccine attitudes or behavior have been reported among physicians in four European countries and parents in Finland [16, 17]. Together, these findings identify safety perceptions, trust, and broader orientations toward conventional medicine as relevant topics for engagement, without establishing their temporal order.

Each 5-point higher VHS-7 score was associated with a 24% higher prevalence of COVID-19 nonvaccination. U.S. data show overlap between hesitancy toward COVID-19 vaccines and vaccines in general [18], while studies in China and the United States link COVID-19 acceptance or hesitancy to prior vaccination, confidence, and safety or effectiveness perceptions [19,20]. In our cross-sectional data, nonvaccination may mark a broader low-confidence profile, but prior behavior may also shape later attitudes; temporal direction cannot be determined.

The association between lower confidence and non-support for vaccination information in religious talks is particularly relevant to this occupational setting: each 5-point higher VHS-

7 score was associated with a 14% higher prevalence of non-support. Qualitative studies show that religious leaders' positions may range from acceptance to explicit objection and may align with prevailing views within their congregations [21]. In Ethiopia, faith leaders promoted vaccination and acted as role models but reported difficulty addressing rumors [22]. Our data extend this literature by linking personnel's own confidence with willingness to support vaccination communication, but congregants' attitudes and uptake were not measured. Advice provision was more complex. Its linear-score estimate was imprecise, whereas exploratory splines suggested that non-provision increased across lower-to-middle scores, plateaued, and declined modestly at higher scores. This curve does not establish a threshold or imply that very low confidence improves communication: uncertainty increased toward the score tails, and advice content or direction was not recorded. Non-provision may also reflect appropriate role boundaries or referral rather than reluctance. For non-support and COVID-19 nonvaccination, there was no clear evidence against the linear-score specification.

Reporting social media as a vaccine-information source was associated with VHS-10 and COVID-19 nonvaccination in adjusted analyses; its associations with VHS-7 and VHS-3 individually were imprecise. Social media use as a COVID-19 information source has been associated with conspiracy beliefs, and the broader literature describes mechanisms through which online anti-vaccine content may reinforce hesitancy [23, 24]. However, our item did not assess platform, frequency, content, reliance, or misinformation exposure, so causation and mechanism cannot be inferred. Social media was also associated with parent-reported childhood-vaccination nonreceipt in the exploratory Firth model, alongside higher VHS-7 scores and COVID-19 nonvaccination. Confidence-related barriers have been linked to childhood-vaccination uptake [15], but our analysis contained only 34 events for nine parameters, relied on parent report without record verification, did not identify the specific

vaccine or timing of nonreceipt, and assessed reasons using four predefined response options without an open-ended option. These findings are therefore hypothesis-generating.

These findings support partnership rather than one-way use of religious personnel as message transmitters. Healthcare workers were the most frequently reported source of vaccine information, providing a potential channel for public health teams and religious authorities to co-develop brief materials, referral pathways, and responses to common safety questions. Training should distinguish medical from religious questions, avoid assuming that religious identity itself is the source of low confidence, and support referral of clinical questions to qualified health professionals. Whether such engagement changes communication practices or vaccine uptake should be evaluated prospectively [22].

4.1 Limitations

Several limitations should be considered. First, the cross-sectional design precludes causal or temporal inference, and reciprocal associations are plausible. Some predictors, particularly vaccine-related concerns and perceived T&CM reliability, are conceptually close to confidence, and all variables were measured in the same questionnaire. Second, vaccination, information-source, communication, and childhood-vaccination data were self-reported and may be affected by recall, social-desirability, and common-method bias; vaccination records were not verified, and advice provision did not capture content, direction, or accuracy. Third, despite attempted census recruitment, 533 of 755 eligible personnel were analyzed. Nonresponse and complete-case exclusions may have introduced selection bias, while the two-district, single-province setting limits generalizability to other regions, institutions, and faith communities. Fourth, residual confounding is possible because health literacy, specific media exposure, vaccine access, and religious interpretations were not measured. The Turkish adult VHS has no validated diagnostic cutoff and may not capture religion-specific meanings; continuous scores therefore cannot estimate the prevalence of hesitancy. Most secondary and

exploratory analyses were unadjusted for multiplicity, the spline findings were exploratory, and the Firth model remained information-limited despite penalization. Finally, strong sex-occupation overlap prevented estimation of their independent associations; substitution sensitivity supports stability of the focal estimates but cannot disentangle these factors.

Strengths include attempted census recruitment with 70.6% analytic coverage, inclusion of both mosque-based clergy and Qur'an course teachers, use of the validated Turkish adult VHS without an arbitrary cutoff, complete main-analysis data, and full reporting of prespecified covariates. Robust variance estimators, prevalence-ratio models for common outcomes, nonlinear modeling, sparse-data methods, and sex-to-occupation sensitivity analyses provided complementary checks on the main conclusions. The study adds evidence on personal confidence, communication practices, and parent-reported behavior in an occupational population that remains underrepresented in vaccine-hesitancy research.

5. Conclusions

Among religious personnel in Malatya, lower vaccine confidence was cross-sectionally associated with vaccine-related concerns, perceiving T&CM as more reliable than vaccines, non-support for vaccination information in religious talks, and COVID-19 nonvaccination, whereas the measured sociodemographic characteristics showed no clear adjusted association with VHS-7. The nonlinear advice-provision and parent-reported childhood-vaccination findings require replication. Because no validated VHS cutoff exists and the data were cross-sectional, this study neither estimates the prevalence of vaccine hesitancy nor establishes causal pathways. The findings support co-designed, non-stigmatizing engagement between public health services and religious institutions focused on reliable information, safety questions, and referral to health professionals; effectiveness should be evaluated prospectively.

List of abbreviations

AI, artificial intelligence; aOR, adjusted odds ratio; aPR, adjusted prevalence ratio; CI, confidence interval; FDR, false discovery rate; HC0/HC3, heteroskedasticity-consistent covariance estimators; IQR, interquartile range; OR, odds ratio; STROBE, Strengthening the Reporting of Observational Studies in Epidemiology; T&CM, traditional and complementary medicine; VHS, Vaccine Hesitancy Scale; WHO, World Health Organization.

Declarations

Ethics approval and consent to participate

The study was approved by the Health Sciences Scientific Research Ethics Committee on 13 January 2026 (Approval No. 2026/9117). Administrative permission to conduct the study was obtained from the Malatya Provincial Mufti's Office. All participants provided written informed consent before participation. Participation was voluntary, and participants could decline or withdraw without consequence. The study was conducted in accordance with the Declaration of Helsinki.

Consent for publication

Not applicable.

Availability of data and materials

The participant-level data generated and analysed during the current study are not publicly available because they contain potentially identifiable and sensitive information from a finite occupational population. Deidentified data may be made available from the corresponding author upon reasonable request and subject to institutional and ethical approval.

Competing interests

478 The authors declare that they have no competing interests.

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484 **Authors' contributions**

485 GB: Conceptualization, Methodology, Investigation, Data curation, Visualization,
486 Project administration, Writing - original draft, Writing - review and editing. AB:
487 Investigation, Data curation, Writing - review and editing. ABA: Investigation, Data curation,
488 Formal analysis, Software, Writing - review and editing. OK: Data curation, Software,
489 Validation. AÖ: Conceptualization, Methodology, Supervision, Validation, Writing - review
490 and editing. SUY: Investigation, Resources. DYT: Investigation, Data curation, Writing -
491 review and editing. All authors reviewed and approved the final manuscript.

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496 **Additional files**

497 **Additional file 1**

498 **File format:** Microsoft Word (.docx)

499 **Title:** Supplementary material

Description: Supplementary Tables S1-S7 and Figures S1-S2. Detailed psychometric, multivariable, and sensitivity analyses, vaccine-information sources, and item-level VHS response distributions.

Additional file 2

File format: Microsoft Word (.docx)

Title: English-language version of the study-specific questionnaire items

Description: English-language version of the wording and response options for the 24 study-specific questionnaire items developed by the research team, reconstructed from the final variable definitions and coding used in the analysis. The previously published Turkish adult 10-item VHS is not reproduced; it is described and cited as reference 14 in the main manuscript.

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