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Understanding Indonesian academics' engagement with vaccination: Exploring the influence of fake news, ideology, digital literacy, and attitude toward science: A cross-sectional study

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Abstract

Introduction: The widespread circulation of conspiracy theories on social media continues to influence public discourse around vaccination, often fostering skepticism and misinformation. Academics represent a unique community whose vaccine-related behaviors may be shaped by their socio-political orientations and access to credible information. This study aims to explore vaccine engagement among Indonesian academics by examining the predictive roles of fake news exposure, digital literacy, ideological orientation, and attitudes toward science.

Methods: Data were collected from 512 academic respondents across various higher education institutions in Indonesia. Multivariate correlation analysis and Structural Equation Modeling (SEM) were employed to examine the relationships among variables and to test the proposed model.

Results: The findings from Structural Equation Modeling (SEM) reveal that several factors significantly predict vaccine acceptance. Notably, digital literacy (Estimate = 0.477, $p < .001$), exposure to fake news (Estimate = 0.463, $p < .001$), and a positive attitude toward science (Estimate = 0.405, $p < .001$) were the strongest predictors. Ideological orientation (Estimate = 0.307, $p < .001$) and political choice (Estimate = 0.159, $p = .003$) also demonstrated a significant influence. Furthermore, digital literacy, ideology, and scientific attitudes were found to significantly moderate the adverse effects of fake news exposure.
Discussion: The results underscore the complex interplay between misinformation, personal beliefs, and digital competencies in shaping vaccine attitudes among educated populations. Promoting digital literacy and reinforcing trust in science are crucial strategies to counter misinformation and improve vaccine acceptance in academic communities.
Take-home message: To enhance vaccine engagement among academics, it is essential to strengthen digital literacy and foster positive attitudes toward science. Efforts to address misinformation must consider ideological diversity and academic status, ensuring that interventions are both targeted and evidence-based.
Key words: fake news, ideology, digital literacy, attitude toward science, vaccine acceptance.

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INTRODUCTION

Academics, as highly educated individuals, are typically well-informed about various trends and developments, including those on social media. However, their perspectives on socio-political issues can be influenced by misleading information, as viral content often distorts reality [1]. Social media provides a platform for the rapid and widespread dissemination of information, including hoaxes, rumors, and conspiracy theories, which can affect public opinion on important topics such as vaccination. Belief in such conspiracy theories has been shown to be a significant barrier to public health efforts, strongly correlating with vaccine hesitancy and lower adherence to safety measures [2]. This occurs despite extensive scientific evidence confirming the general safety and effectiveness of authorized COVID-19 vaccines in preventing severe disease and death [3]. This challenge is not limited to the initial vaccine series but also extends to subsequent booster doses, with studies in other Asian contexts like India highlighting significant hesitancy linked to concerns over side effects and misinformation [4]. Therefore, this study examines the dynamics of behavior and acceptance among academics toward vaccination programs introduced by the government. To understand these dynamics, it is essential to consider the wide range of psychological and informational factors that have been shown to influence how scientific ideas are received.

Various factors influence the acceptance of scientific ideas, including belief systems such as religion and spirituality [5,6], worldviews shaped by social or political ideologies [7], moral values [8], cognitive certainty or complexity [9], and knowledge factors such as scientific literacy [10]. Furthermore, the psychological dimension, particularly emotional states, has been identified as a critical correlate. For example, recent research on medical professionals found that lower anxiety and greater emotional well-being were significantly associated with higher COVID-19 vaccine uptake [11]. On a global scale, these issues are further complicated by challenges of vaccine inequality, including disparities in production and distribution between nations, which can also fuel public skepticism and distrust [12].

Media ecology suggests that social media significantly influences societal actions, perceptions, and experiences, leading to changes in the way individuals interpret the world [13]. The impact of information exposure on attitude and behavior can be intensified by strong emotions such as fear and anger [14,15], which are commonly associated with misinformation [16,17]. Moreover, the strategy of decontextualization is often employed in health and science-related hoaxes [18]. Studies examining social media content related to vaccination have shown similar levels of both positive and negative posts, which significantly shape attitudes and intentions toward vaccination [19].

Within this complex and often polarized information landscape, the influential role of academics in shaping societal attitudes becomes particularly critical. Given their position, their engagement with scientific issues (especially vaccination) warrants close examination. This study seeks to explore the predictors of vaccine acceptance among Indonesian academics, considering how digital literacy, exposure to fake news, ideological orientation, and attitudes toward science interact to influence behavior.

Misinformation and Behavioral Intentions

Although research on misinformation has grown rapidly, studies specifically examining its impact on vaccination-related behavioral intentions remain limited. Nevertheless, a substantial body of work in social psychology has established that information exposure, especially when paired with emotional appeals, significantly shapes attitudes and intentions [14,15]. For example, fear and anger are commonly found in misinformation and have been shown to amplify the persuasive power of false narratives [16,17].

A recent study by De Saint Laurent et al. [20] experimentally tested the effects of false information on participants' behavioral intentions. They found that misinformation related to caffeine consumption and mobile health applications led to modest changes in intention (e.g., a 5% decrease in app downloads), while vaccine-related conspiracy theories produced mixed outcomes, with some content failing to significantly alter behavior. These findings suggest that while misinformation can influence behavior, the magnitude of its effects varies depending on content, context, and individual differences.

Ideological and Cognitive Predictors of Scientific Acceptance

Attitudes toward science are shaped by a complex interplay of cognitive and ideological factors. Political conservatism, for example, has been linked to reduced openness to new information and greater resistance to scientific claims that conflict with worldview or identity [5,7]. This resistance is often rooted in specific socio-political ideologies. Sanders and Burnett [21] argue that modern vaccine hesitancy is deeply connected to neoliberal principles, which prioritize individual choice and autonomy over collective public health responsibilities and state authority. Similarly, moral foundations, such as purity or loyalty, can predict skepticism toward vaccination, particularly when framed as government interference [8].

Cognitive variables also play a role. Individuals with higher cognitive complexity and scientific literacy are generally more capable of evaluating misinformation and tend to be more supportive of vaccination efforts [10]. Conversely, those with low digital literacy may struggle to differentiate credible sources from misinformation, especially in online environments saturated with competing narratives.

The Role of Academics in Science Communication

Academics are expected to act as gatekeepers of knowledge and play a pivotal role in promoting scientific literacy and evidence-based decision-making. However, their engagement with science is not immune to personal beliefs, political ideologies, or social identities. Given their influence within educational institutions and broader intellectual circles, understanding how academics form their attitudes toward vaccination is essential for designing effective science communication strategies. This is supported by research in other contexts, such as South Africa, where pre-service science teachers are also seen as pivotal in promoting health literacy, yet their own vaccination intentions are complexly influenced by the information sources they trust [22].

This study builds on prior research by addressing the following key questions:

1. What factors predict Indonesian academics' acceptance of vaccines?
2. Do digital literacy, scientific orientation, and ideology moderate the effect of fake news exposure on vaccine acceptance?
3. How do gender, political preferences, academic status, and field of study influence vaccine-related attitudes and behaviors?

By examining these questions, the study aims to identify actionable insights for fostering greater scientific engagement and vaccine acceptance among one of the most influential professional groups in society.

Research Hypothesis

- Hypothesis 1: Higher levels of exposure to fake news are negatively associated with vaccine acceptance among Indonesian academics.
- Hypothesis 2: Academics with stronger ideological conservatism will report lower levels of vaccine acceptance.
- Hypothesis 3: Political orientation significantly predicts vaccine acceptance, with certain political alignments associated with higher or lower levels of acceptance.
- Hypothesis 4: Digital literacy moderates the relationship between exposure to fake news and vaccine acceptance, such that the negative effect of fake news is weaker among academics with higher digital literacy.
- Hypothesis 5: Attitude toward science mediates the relationship between ideology and vaccine acceptance, where more positive attitudes toward science will attenuate the negative effect of ideological conservatism.
- Hypothesis 6: Scientific orientation moderates the effect of fake news exposure on vaccine acceptance, such that those with stronger scientific orientation show more resilience to misinformation.
- Hypothesis 7: Academic status significantly influences vaccine acceptance levels, with senior academics potentially showing different acceptance patterns compared to junior academics.
- Hypothesis 8: Socio-demographic factors such as gender and directional orientation do not significantly influence vaccine acceptance among Indonesian academics.

Significance and advantage of our work

In the contemporary digital landscape, the acceptance of vaccines is increasingly shaped not only by scientific understanding but also by sociopolitical ideologies, informational exposure, and levels of digital literacy. Academics, as both knowledge producers and opinion leaders, play a pivotal role in shaping public discourse and policy directions on health-related matters, including vaccination.

This study is significant for several reasons. First, it offers a nuanced understanding of how exposure to fake news, ideological orientation, digital literacy, and attitudes toward science collectively influence vaccine acceptance among Indonesian academics. Unlike previous research that often targets the general population, this study focuses on a highly educated subgroup whose perceptions can significantly influence broader societal attitudes.

Second, the findings provide empirical evidence that can inform the development of targeted public health strategies and science communication practices aimed at academic communities. Such strategies are critical in mitigating the impact of misinformation and fostering trust in scientific guidance, particularly in low- and middle-income countries where digital ecosystems and ideological dynamics may differ markedly from Western contexts. Ultimately, this research contributes to a more context-sensitive understanding of vaccine hesitancy and offers actionable insights for strengthening science-based health advocacy within influential educational and intellectual spheres.

METHODS

Study procedure and data collection

This study adopted a cross-sectional quantitative design to explore the factors influencing vaccine acceptance among Indonesian academics and students. Data were collected using an online self-administered questionnaire distributed through digital platforms, allowing broad access across Indonesia. The survey was designed to ensure voluntary and anonymous participation.

The final sample size of 512 respondents was determined to be adequate for the planned Structural Equation Modeling (SEM) analysis based on established guidelines. Generally, a sample size of over 200 is considered sufficient for SEM, and a sample exceeding 400 is deemed very good, capable of producing stable and reliable parameter estimates. More specifically, following the recommendations by Hair et al. [23], a larger sample size is necessary for complex models that include multiple latent constructs and interaction effects, as is the case in this study. Therefore, the sample of 512 participants provides sufficient statistical power to detect significant effects and ensures the robustness of the model estimation, minimizing potential errors and enhancing the generalizability of the findings.

The questionnaire included sections on demographic background, exposure to fake news, political and ideological orientation, digital literacy, attitudes toward science, and vaccine acceptance. All participants were informed about the purpose of the study and assured that their responses would remain confidential. Participation was voluntary, and informed consent was implied through the completion of the survey.

The data collection process adhered to ethical research principles, ensuring anonymity and data protection throughout. While this study utilized an online survey for broad accessibility, we acknowledge the importance of deeper community engagement in health research. Future studies could enhance this process by implementing frameworks like the "Six Cs" (e.g., Constituents, Communication, Cultural Competency), which emphasize collaborative partnerships to build trust and ensure research relevance [24]. The data were subsequently analyzed using statistical techniques appropriate for testing hypotheses related to vaccine acceptance and its psychological, ideological, and informational predictors.

Study instruments

Exposure to Fake News

Exposure to fake news was measured through participants' responses to vaccine-related misinformation commonly circulated on social media platforms. Fake news is defined as intentionally misleading or fabricated information that mimics the format of legitimate news to deceive the public [25,26]. Drawing from León et al. [18], examples included manipulated content featuring decontextualized or exaggerated claims regarding vaccine safety and efficacy. Participants were presented with simulated misinformation stimuli and asked to evaluate the reliability of each statement using a 5-point Likert scale (1 = false, 2 = cannot be trusted, 3 = doubtful, 4 = likely to be trusted, 5 = very reliable). Lower scores indicate higher sensitivity to misinformation.

Digital Information Literacy

Digital literacy was assessed using a scale adapted from Rodríguez-De-dios et al. [27], focusing on participants' ability to access, interpret, and critically evaluate digital information. The instrument included 8 items reflecting two core competencies: recognition of credible information and critical thinking. Each item was rated on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree), with higher scores indicating greater digital literacy.

Ideology

Participants' ideological orientation was measured using a combination of items from the Ideological Consistency Scale (28) and the Social and Economic Conservatism Scale (SECS). This composite measure encompassed social, economic, and religious dimensions of political ideology. A total of 12 items were rated on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). Higher scores reflect a more conservative ideological stance.

Attitude Towards Science

Attitudes towards science were assessed using a modified version of the Behaviors, Related Attitudes, and Intentions Towards Science (BRAINS) instrument developed by Summers and Abd-El-Khalick [29]. The scale captures participants' beliefs in science, willingness to engage in scientific activities, and reliance on scientific reasoning in everyday life. Responses were given on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). The mean score across items was used to indicate overall scientific orientation.

Attitude Towards Vaccination

Attitude toward vaccination was measured using an adapted scale from Laurent et al. [20], which evaluates behavioral intentions and psychological readiness to engage in vaccination programs. The instrument comprises 6 items assessing participants' beliefs, motivations, and willingness to receive vaccines. Items were rated on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree), with higher scores reflecting more favorable attitudes toward vaccination.

Reliability of Measures

The internal consistency and reliability of each latent construct were assessed using Composite Reliability (CR) and Average Variance Extracted (AVE). A construct is considered reliable when the CR value is greater than 0.7 and the AVE value is greater than 0.5. The analysis confirmed that all scales used in this study demonstrated strong reliability. The specific diagnostics for each scale were as follows: Fake News (CR = 0.745, AVE = 0.597), Ideology (CR = 0.752, AVE = 0.503), Attitude Toward Science (CR = 0.823, AVE = 0.609), Digital Literacy (CR = 0.850, AVE = 0.739), and Attitude Toward Vaccination (CR = 0.937, AVE = 0.882). These results indicate that all measurement instruments were reliable and suitable for hypothesis testing.

Study Design

The present study employs a quantitative correlational design, utilizing a survey-based approach to investigate the relationships between the proposed independent and dependent variables. Quantitative methods are employed to evaluate the extent to which variations in one variable are associated with changes in another, as indicated by correlation coefficients. Given the inherent complexity and interrelatedness of the variables under study, a multivariate correlational approach was implemented, utilizing Structural Equation Modeling (SEM).

SEM enables the specification, estimation, and evaluation of simultaneous regression equations to test hypothesized relationships among latent constructs [23]. This technique is particularly suitable for research aiming to model complex interactions involving mediating and moderating variables within a single comprehensive framework.

The collected data were then subjected to rigorous analysis using Structural Equation Modeling (SEM) with AMOS 26.0. The Maximum Likelihood (ML) estimation method was employed for parameter estimation. The adequacy of the structural model was assessed by evaluating several goodness-of-fit (GoF) indices based on established criteria. A model was deemed to have a satisfactory fit if it satisfied the following criteria: a probability value for the Chi-Square test of ≥ 0.05, a Goodness of Fit Index (GFI) and an Adjusted Goodness of Fit Index (AGFI) of ≥ 0.90, a Tucker-Lewis Index (TLI) and a Comparative Fit Index (CFI) of ≥ 0.95, and a Root Mean Square Error of Approximation (RMSEA) of ≤ 0.08 [30].

To ensure robust measurement, construct validity and reliability analyses were performed. Validity was assessed based on standardized factor loadings, with values above 0.50 indicating acceptable convergent validity. Indicators with loading values exceeding this threshold are considered to meaningfully represent the underlying latent constructs. The results of this measurement model are presented in Table 1.

Table 1. Results of validity analysis of research instruments.

Variable	*Indicator*	*Estimate*	*Explanation*
Fake News	FN1	.679	Valid
	FN2	.856	Valid
Ideology	ID1	.738	Valid
	ID2	.676	Valid
	ID3	.712	Valid
Toward Science	Si	.737	Valid
	Ts	.872	Valid
	Us	.724	Valid
Digital Literacy	Ct	.835	Valid
	IL	.884	Valid
Attitude Towards Vaccination	Inv	.938	Valid
	Int	.940	Valid

Note: FN, Fake News; ID, Ideology; Si, Scientific Participation; Ts, Trust in Science; Us, Use of Scientific Methods; Ct, Critical Thinking; IL, Information Literacy; Inv, Vaccine Involvement; Int, Vaccination Intention.

The measurement model analysis reveals that all indicators for fake news, ideology, science, digital literacy, and vaccine acceptance exhibit factor loadings greater than 0.5, confirming their validity in measuring the respective variables.

For the fake news variable, the loading factors for the disinformation (FN1) and misinformation (FN2) indicators are 0.679 and 0.856, representing contributions of 67.9% and 85.6%, respectively. Among these, FN2 is the most dominant indicator in measuring the fake news variable.

In the case of ideology, the loading factors for the social (ID1), religious (ID2), and economic (ID3) indicators are 0.738, 0.676, and 0.712, reflecting contributions of 73.8%, 67.6%, and 71.2%, respectively. The social indicator (ID1) emerges as the most significant contributor to measuring ideology. For the science variable, the indicators of scientific participation (Si), trust in science (Ts), and scientific method (Us) have loading factors of 0.737, 0.872, and 0.724, with contributions of 73.7%, 87.2%, and 72.4%, respectively. Trust in science (Ts) proves to be the most influential indicator of the science variable.

For digital literacy, the loading factors for critical thinking (Ct) and information literacy (I.L.) are 0.835 and 0.884, contributing 83.5% and 88.4%, respectively. Information literacy (I.L.) emerges as the most dominant indicator in measuring digital literacy.

Regarding the vaccine acceptance variable, the loading factors for participation (Inv) and intention (Int) are 0.938 and 0.940, with contributions of 93.8% and 94.0%, respectively. Intention (Int) is the most dominant indicator of vaccine acceptance.

Construct reliability testing was performed to evaluate the reliability of the indicators in measuring the latent variables. The reliability of each latent variable was assessed using average variance extracted (AVE) and construct reliability. An indicator is considered reliable if the AVE value exceeds 0.5, or the construct reliability is greater than or equal to 0.7, as shown in Table 2.

Table 2. Results of reliability analysis research instruments.

Variable	*AVE*	*CR*
Fake News	.597	.745
Ideology	.503	.752
Toward Science	.609	.823

Digital Literacy	.739	.850
Attitude Towards Vaccination	.882	.937

Note: AVE, Average Variance Extracted; CR, Composite Reliability.

The reliability analysis demonstrates that all constructs—fake news, ideology, attitude towards science, digital literacy, and attitude towards vaccination—meet the required thresholds for measurement reliability. Specifically, the Average Variance Extracted (AVE) values for each variable exceed the minimum standard of 0.5, indicating adequate convergent validity. Furthermore, the Composite Reliability (CR) values for all constructs are greater than 0.7, confirming internal consistency reliability. Thus, all measurement indicators used for these latent variables are considered both valid and reliable and are therefore appropriate for further structural modeling analysis.

RESULTS

Sample Characteristics

The total sample consisted of 512 respondents, including students and lecturers from various educational backgrounds. Specifically, 24% of participants were from senior high schools, 59.3% were undergraduate students, and 16.7% were postgraduate students. In terms of gender distribution, 72.7% identified as female and 27.3% as male. The participants were geographically diverse, representing regions from western, central, and eastern Indonesia, thus capturing a wide range of sociocultural and educational perspectives.

Descriptive Statistics and Correlation Analysis

Prior to the evaluation of the structural model, a Pearson correlation analysis was conducted to ascertain the bivariate relationships between the primary study variables. Table 3 presents the descriptive statistics (mean and standard deviation) and the correlation matrix.

Table 3. Descriptive Statistics and Correlations for Study Variables

Variable	M	SD	1	2	3	4	5
1. *Fake News*	25.97	5.54	-				
2. *Ideology*	47.65	7.05	.392***	-			
3. *Toward Science*	35.63	5.42	.157***	.259***	-		
4. *Digital Literacy*	30.72	4.68	.028	.332***	.563***	-	
5. *Attitude Towards Vaccination*	20.33	3.50	-.080	.012	.370***	.344***	-

***p < .001

Table 3 presents the descriptive statistics (mean and standard deviation) and the Pearson correlation matrix for the primary study variables. A descriptive analysis of the data revealed that the participants reported the highest average scores on the Ideology scale (M=47.65, SD=7.05) and the lowest on the Attitude Towards Vaccination scale (M=20.33, SD=3.50).

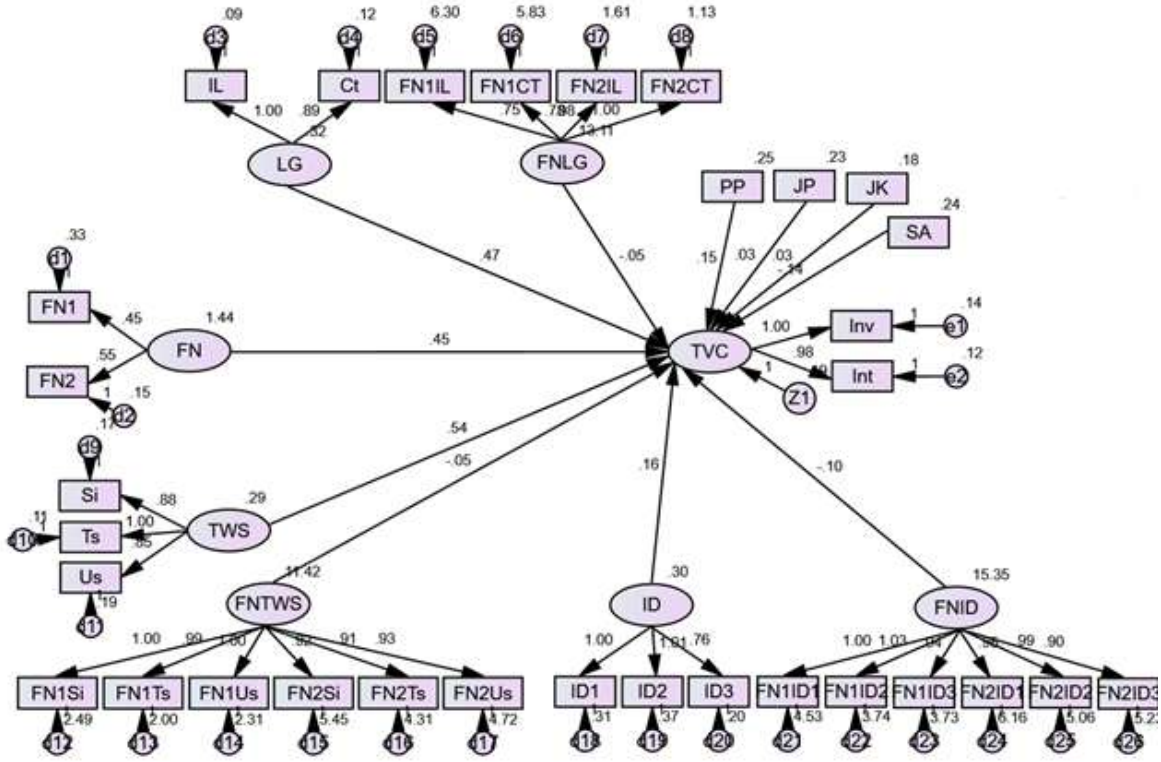
The correlation analysis indicates a robust and substantial positive relationship between Attitude Towards Vaccination and Attitude Towards Science ($r = .370$, $p < .001$) as well as Digital Literacy ($r = .344$, $p < .001$). This finding suggests a potential correlation between a more positive attitude toward science and higher digital literacy with a more favorable attitude toward vaccination. In contrast, the relationships between "fake news" ($r = -.080$) and "ideology" ($r = .012$) with "attitude toward vaccination" were not significant at this bivariate level.

Among the predictor variables, the strongest positive correlation was identified between Attitude Toward Science and Digital Literacy ($r = .563$, $p < .001$). In addition, a substantial positive correlation was demonstrated by Ideology with Fake News ($r = .392$, $p < .001$), Attitude Toward Science ($r = .259$, $p < .001$), and Digital Literacy ($r = .332$, $p < .001$). In sum, the observed correlations provide preliminary support for the hypothesized relationships in the model. Consequently, the use of a correlational design for further investigation via structural equation modeling (SEM) is justified.

Result of Analysis

The initial hypothesized model was first tested for its goodness-of-fit. Figure 1 presents the path diagram for this initial model.

Figure 1. The Initial Hypothesized Model Before Modification.



Note: This figure presents the structural equation model illustrating the hypothesized relationships among key constructs in the study. *Fake News (FN)* represents exposure to or belief in vaccine-related misinformation. *Ideology (ID)* captures participants' sociopolitical orientation that may influence their health-related decisions. *Attitude Toward Science (TWS)* is a latent construct measured by indicators such as Scientific Participation (Si), Trust in Science (Ts), and Use of Scientific Methods (Us). *Digital Literacy (LG)* includes Critical Thinking (Ct) and Information Literacy (IL) as indicators reflecting participants' ability to evaluate online information. The outcome variable, *Vaccine Acceptance (TVC)*, is measured by Vaccine Involvement (Inv) and Vaccination Intention (Int). Interaction pathways such as *FN × LG* and *FN × ID* denote moderation effects, examining whether digital literacy and ideology alter the relationship between fake news exposure and vaccine acceptance. All constructs are modeled with their respective observed indicators, and error terms are included accordingly.

Table 4. Goodness of Fit Indices Before Model Modification: The model did not meet the recommended thresholds, indicating poor fit across all major indices (GFI, AGFI, TLI, CFI, and RMSEA).

Index	Goodness of Fit	Criteria	Description
Chi Square	<.001	> 0.05	Not suitable
GFI	0.27	≥ 0.9	Not suitable
AGFI	0.16	≥ 0.9	Not suitable
TLI	0.16	≥ 0.95	Not suitable
CFI	0.23	≥ 0.95	Not suitable
RMSEA	0.367	≤ 0.08	Not suitable

As demonstrated in the above table, the fit indices for the initial model did not meet the requisite criteria, indicating an unsatisfactory fit to the data. Consequently, model modification was executed based on the modification indices recommended by the software to enhance its fit.

After modification, the final structural model was tested. Figure 2 shows the path diagram for the revised, final model.

Figure 2. The Initial Hypothesized Model After Modification.

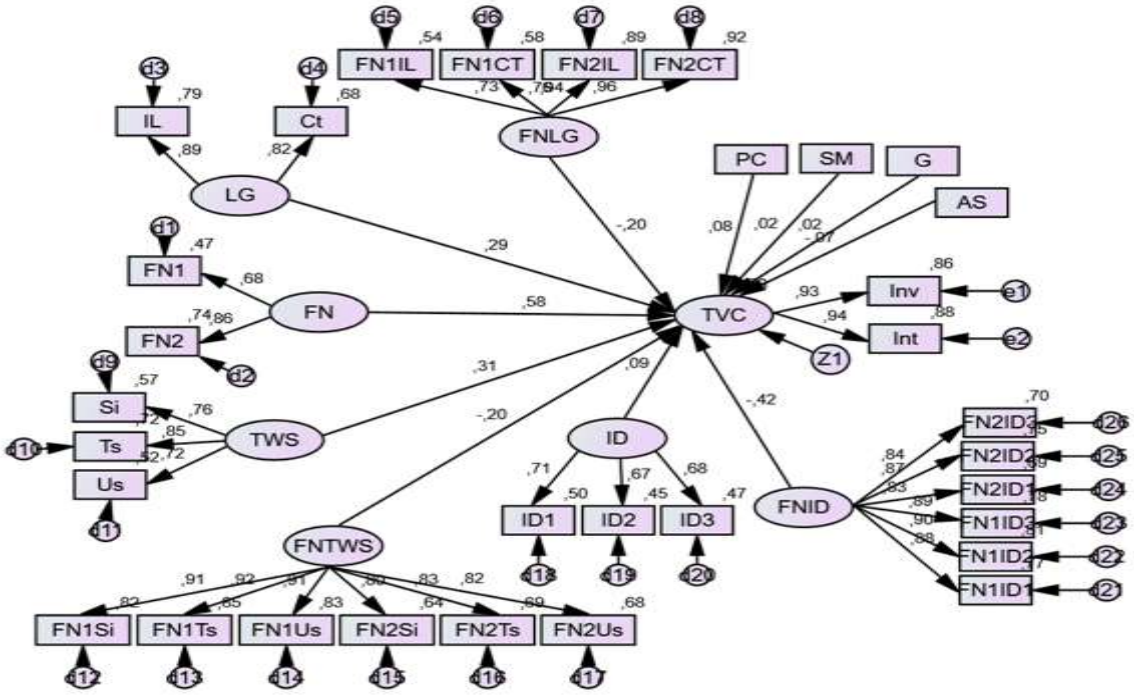


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Table 5. Goodness of Fit Indices After Model Modification: The model did not meet the recommended thresholds, indicating poor fit across all major indices (GFI, AGFI, TLI, CFI, and RMSEA).

Index	Goodness of Fit	Criteria	Description
Chi Square	<.001	> 0.05	Not suitable
GFI	0.89	≥ 0.9	Marginal Fit
AGFI	0.86	≥ 0.9	Marginal Fit
TLI	0.91	≥ 0.95	Acceptable Fit
CFI	0.93	≥ 0.95	Acceptable Fit
RMSEA	0.065	≤ 0.08	Good Fit

Given the demonstrated adequate fit of the final model to the data, the subsequent hypothesis testing was conducted based on this revised model. The ensuing section will present the results of the direct and moderating effects.

Hypothesis Testing Direct Effects

This study seeks to examine the hypothesized direct effects of exogenous variables on endogenous variables. Additionally, it investigates the moderating effects of specific variables on the relationship between exogenous and endogenous constructs. These relationships are assessed using Structural Equation Modeling (SEM), as illustrated in the structural model. The model evaluation adheres to standard statistical significance criteria. A direct or moderating effect is considered statistically significant if the p-value is less than or equal to the significance level ($\alpha = 0.05$). The results of the hypothesis testing and path analysis are summarized in Table 6.

Table 6. Direct influence of exogenous variables on endogenous variables.

Exogenous	*Endogenous*	*Estimate*	*S.E.*	*C.R.*	*P*
Fake News	*Attitude Toward Vaccination*	.463	.031	14.947	***
Political Choice	*Attitude Toward Vaccination*	.159	.054	2.961	.003
Studies Major	*Attitude Toward Vaccination*	.022	.055	.379	.691
Gender	*Attitude Toward Vaccination*	.041	.063	.654	.513
Academic Status	*Attitude Toward Vaccination*	-.138	.055	-2.497	.013
Digital Literacy	*Attitude Toward Vaccination*	.477	.058	8.262	***
Toward Science	*Attitude Toward Vaccination*	.405	.056	7.273	***
Ideology	*Attitude Toward Vaccination*	.307	.056	5.434	***

Note: Exogenous, Independent variable (predictor); Endogenous, Dependent variable (outcome); S.E., Standard Error; C.R., Critical Ratio; P, P-value.

The hypothesis testing results reveal a mix of significant and non-significant predictors of vaccine acceptance. Notably, the influence of fake news on attitude toward vaccination is statistically significant, with a p-value of <0.001, which is well below the conventional significance threshold ($\alpha = 0.05$). Similarly, political choice demonstrates a significant effect on attitude toward vaccination ($p = 0.003$), as does academic status, which shows a negative but statistically significant relationship ($p = 0.013$). Furthermore, both digital literacy and attitudes toward science are significantly associated with attitude toward vaccination, each with p-values <0.001, indicating strong predictive power. Ideological orientation also shows a significant positive influence on attitude toward vaccination, with a p-value <0.001.

In contrast, study major and gender do not exhibit statistically significant relationships with attitude toward vaccination. The p-values for these variables are 0.691 and 0.513 respectively, both exceeding the standard alpha level, suggesting that they do not contribute meaningfully to the model. In summary, the findings highlight that fake news exposure, political choice, academic status, digital literacy, scientific orientation, and ideology significantly predict attitude toward vaccination, whereas study major and gender do not appear to have a measurable impact within the context of this model.

Hypothesis Moderating Effect

Moderation testing was conducted to analyze the moderating effect of digital literacy, science, and ideology on the influence of fake news on vaccine acceptance. The results showed that all three variables have a significant interaction effect with fake news, as indicated by p-values of <0.001, 0.008, and <0.001, respectively. Since these p-values are less than the significance level (α = 5%), digital literacy, science, and ideology are considered effective moderators in the relationship between fake news and attitude toward vaccination.

Furthermore, the influence of digital literacy, science, and ideology on fake news showed significant path coefficients, suggesting that these variables serve as quasi-moderators in the relationship between fake news and attitude toward vaccination. These results are summarized in Table 7, confirming that digital literacy, science, and ideology play important roles in moderating the impact of fake news on attitude toward vaccination.

Table 7. Results of Moderating Effect Analysis.

Exogenous	*Endogenous*	*Estimate*	*S.E.*	*C.R.*	*P*
*Fake News * Digital Literacy*	*Attitude Toward Vaccination*	-.052	.008	-6.793	***
*Fake News * Toward Sience*	*Attitude Toward Vaccination*	-.021	.008	-2.647	.008
*Fake News * Idiology*	*Attitude Toward Vaccination*	-.135	.008	-17.405	***

Note: Exogenous, Independent variable (predictor); Endogenous, Dependent variable (outcome); S.E., Standard Error; C.R., Critical Ratio; P, P-value.

DISCUSSION

The direct effect coefficient value of political choices on the direction of vaccine acceptance was 0.159. Therefore, political choices had a positive and significant effect on the direction of vaccine acceptance. The coefficient value of the direct effect of academic status on the direction of vaccine acceptance is -0.138. Academic status has a negative and significant effect on the direction of vaccine acceptance. In this context, vaccine acceptance for the group of lecturers is higher than for students.

A notable finding emerges from a comparison of the correlational analysis with the final structural equation model (SEM) results. At the bivariate level, both Fake News and Ideology demonstrated an absence of a significant direct correlation with Attitude Toward Vaccination. However, within the more complex structural model, both variables emerged as significant predictors. This apparent discrepancy does not constitute a contradiction; rather, it underscores the nuanced nature of these relationships, thereby suggesting the presence of suppression or complex moderation effects. This suggests that the impact of misinformation and ideology on an educated population is not a simple matter. Instead, their impact is likely to become salient only when considered in conjunction with other cognitive and attitudinal factors, such as digital literacy and attitude toward science. This finding provides substantial validation for the utilization of SEM in this research, as a more elementary correlational analysis would have been ineffective in discerning these critical, indirect relationships, thereby leading to an underestimation of the true influence of fake news and ideology.

The measurement model analysis shows that all indicators for each variable—fake news, ideology, science, digital literacy, and vaccine—produce a loading factor greater than 0.5. This indicator is declared valid or capable of measuring the variables. Based on the measurement model

for fake news, the loading factor value of the disinformation indicator (FN1) is 0.679 with a contribution of 67.9%. The loading factor value of the misinformation indicator (FN2) is 0.856, with a contribution of 85.6%. In this model, the misinformation indicator (FN2) is the most dominant in measuring the fake news variable.

In the measurement model for the ideology variable, the loading factor values of the social (ID1), religion (ID2), and economic (ID3) indicators are 0.738, 0.676, and 0.712 with a contribution of 73.8%, 67.6%, and 71.2%, respectively. The measurement shows that the social indicator (ID1) is the most dominant in measuring the ideological variable. The model for the variable instrument shows that the loading factor values of scientific participation (Si), trust in science (Ts), and scientific approach (Us) indicators are 0.737, 0.872, and 0.724 with a contribution of 73.7%, 87.2%, and 72.4%, respectively. The measurement model for the variable toward science shows that trust in science (Ts) is the most dominant indicator.

The digital literacy measurement model shows that the loading factor value of the critical thinking (Ct) and information literacy (I.L.) indicators are 0.835 and 0.884 with contributions of 83.5% and 88.4%, respectively. Therefore, the information literacy indicator is the most dominant in measuring the digital literacy variable. Based on the model for the variable toward vaccine, the loading factor value of the participation (Inv) and intention (Int) indicators are 0.938 and 0.940, with contributions of 93.8% and 94.0%, respectively. Therefore, intention (Int) is the most dominant indicator in measuring the variable toward vaccine. According to the Center for Digital Society (CfDS) Fisipol UGM in February 2021, 49.9% of the total 601 respondents refused to be the first recipients of the vaccine. Furthermore, 40% of the public, largely consisting of highly educated people, does not agree with the mandatory policy. This has a direct impact on the negative perception of society, reducing the willingness to receive the vaccine. Approximately 81.5% of Indonesians have been exposed to posts containing conspiracy theories stating that the vaccine is created for the profit of pharmaceutical corporations and the interests of the global elite [31].

The case is in line with the results, where the direct effect coefficient of fake news on the direction of vaccine is 0.463. Therefore, fake news has a positive and significant effect on the direction of vaccine. This powerful effect can be understood through the lens of psychological defense mechanisms; as suggested by Tarchi et al. [2], belief in conspiracy theories may function as a coping strategy to manage the threat and uncertainty of the pandemic, leading individuals to reject official health guidance in favor of alternative narratives. This psychological process could explain the strong link between exposure to misinformation and vaccine rejection observed in our study.

Previous studies conducted in India, Pakistan, and Bangladesh stated that vaccines cause infertility and miscarriage [32]. In Spain, another study analyzed journalism and the role of fake news in shaping public attitude towards vaccines. The poor quality of the press caused the circulation of fake news, forming wrong perceptions and reluctance about vaccines [33]. In 2020, an observational study conducted in Italy showed that more than 2,000 online fake news articles related to the pandemic were shared more than 2 million times [34]. The press is known as an agent for disseminating news, which should be able to filter information spreading in society. Khudejah Ali, Cong Li, et al. found that the spread of fake news was triggered by anti-vaccine individuals' fear. In contrast, individuals continued to contribute to the spread based on feelings of anger about misinformation [35]. According to WHO, fake news poses a significant threat to global health [36,37]. Therefore, it is crucial to control the spread in resolving vaccine hesitancy.

The powerful effect of fake news on vaccine attitudes found in our academic sample is consistent with findings from the general population in other developing nations. For example, a study in India by Achrekar et al. [4] found that concerns fueled by misinformation were major drivers of COVID-19 booster dose hesitancy. While our study identified ideological orientation and digital literacy as key predictors within an academic community, their research highlighted demographic factors such as younger age and lower education as more influential in the general population. This suggests that

the drivers of vaccine attitudes may differ significantly between the general public and highly educated subgroups.

Digital literacy becomes very important when false issues regarding vaccines are increasing, and misinformation is known as a "disinfodemic." Disinfodemic can be interpreted as information chaos, with its contents primarily being fake news. Based on data collected by AIS, Directorate General of Aptics 2020, Kominfo, Republic of Indonesia, the findings of such issues reached 1,471 and spread through social media [38]. The direct effect coefficient value of digital literacy was 0.477 and was significant towards vaccine. Meanwhile, the fake news interaction coefficient value with digital literacy towards vaccine was -0.052. Considering the coefficient value, the influence of fake news on the direction of vaccine is positive, while the interaction between fake news and digital literacy is negative. This indicates that digital literacy weakens the influence of fake news on vaccine attitudes.

The findings of this study, which highlight digital literacy as the most dominant factor influencing vaccine acceptance, underscore the critical role of information evaluation skills. Interestingly, a study on pre-service teachers in South Africa found a similar reliance on diverse information sources, including social media and government communiques, which significantly impacted their attitudes toward vaccination. This suggests that across different developing nations, official and social media channels are key battlegrounds for shaping health-related attitudes among the educated [22].

To promote the acceptance of vaccines, individual digital literacy skills should be enhanced in detecting fake news and improving health literacy through education and communication programs [39]. At higher academic levels, vaccine hesitancy is often caused by minimal digital literacy. This group, defined as the digital native immigrant generation (born before 1980), tends to experience confusion in obtaining information due to a lack of preparedness to process data. There is a noticeable gap between digital natives and digital immigrants when it comes to obtaining health-related data. The digital native generation tends to refer to the digital immigrant generation when sharing health information on social media [40]. The direct effect coefficient value of ideology was 0.307, indicating that the variable has a positive and significant effect on vaccine acceptance. This finding aligns with arguments from Sanders and Burnett [21], who identify neoliberalism as a key driver of contemporary vaccine hesitancy. According to their analysis, this ideology fosters a mindset that views personal choice as superior to state-mandated public health initiatives, a sentiment that may resonate within the educated academic community studied here and explain their resistance. Fake news also influences vaccine attitudes, consistent with the study conducted by Park et al. [41].

The direct effect coefficient toward science is 0.405, indicating a positive and significant relationship. In this context, a positive attitude towards science is directly proportional to vaccine acceptance. The interaction between fake news and science has a negative and significant effect on the direction of vaccine. Considering the coefficient value, the influence of fake news on the direction of vaccine is positive, while the interaction between fake news and science weakens the influence of vaccine acceptance. The success of vaccine acceptance depends on indisputable scientific truth, high levels of public acceptance, and widespread population coverage [42]. Scientific truth has been demonstrated to positively influence an individual's attitude towards vaccines. Conversely, individuals who exhibit skepticism toward scientific principles tend to be more receptive to conspiracy theories [43]. Previous results showed that pro-vaccine individuals had a very positive attitude towards science and were significantly more supportive of scientific approaches. This study provides two explanations: 1) respondents perceive the pro-scientific group as significant or influential in shaping pro-vaccine attitudes, and 2) pro-vaccine attitudes are directly linked to a pro-scientific orientation [43]. Attitudes and beliefs towards science are influenced by media exposure [44], political beliefs [45,46], politicized science communication [47], social familiarity with scientists, and the level of factual knowledge about science [45]. Ordinary people who are not from pro-scientific groups may view science as part of elite institutions working for specific group interests,

making them more vulnerable to misinformation, especially individuals with low trust in government institutions [48].

The results of the equation demonstrate the exogenous variables that predominate over the endogenous variables. The variable with the most significant total coefficient towards vaccine is digital literacy, with a value of 0.477. Digital literacy emerges as the paramount variable, exerting a preeminent influence on the acceptance of vaccines. The findings of the equipment results further underscore the pivotal role of digital literacy in shaping individuals' attitudes and decisions regarding vaccines, thereby establishing it as the most influential factor in the direction of vaccine acceptance.

Implications for Research and Policymakers

This study has several important implications for both future research and policymaking. To build on these findings, researchers and policymakers should consider principles of effective community engagement. The "Six Cs" framework—which includes fostering Connections, ensuring clear Communication, and maintaining a Commitment to common goals—offers a valuable roadmap for developing more effective health interventions and research partnerships within academic communities [24].

For researchers, future studies could adopt longitudinal designs to explore how exposure to misinformation and changes in digital literacy influence vaccine attitudes over time. Additionally, comparative studies across diverse cultural and demographic groups would enhance the understanding of vaccine hesitancy dynamics globally. Exploring moderating factors such as trust in health authorities or religiosity could offer deeper insights into the psychological underpinnings of vaccine acceptance.

For policymakers, the findings underline the urgent need for targeted digital literacy campaigns, especially for older generations (digital immigrants) who may struggle with evaluating the credibility of online information. To be effective, these campaigns must be part of a broader evidence-based policy framework where health authorities engage in open and transparent communication to build public trust and counter misinformation directly [48]. Efforts should be made to design interventions that both increase scientific literacy and build trust in public health institutions. Programs aimed at correcting misinformation must be accompanied by emotionally resonant, culturally relevant, and politically neutral communication strategies. Moreover, since academic status and political choices significantly shape vaccine attitudes, universities and policymakers should collaborate to cultivate critical thinking and civic awareness among students and lecturers alike.

Finally, strengthening partnerships with trusted community figures and leveraging pro-science influencers could help amplify evidence-based messages and reduce the spread of vaccine-related misinformation. Lessons can be drawn from countries like Italy, which resorted to mandatory vaccination laws as a health policy instrument to counteract the effects of widespread misinformation and falling immunization coverage, demonstrating the critical need for proactive, evidence-based public health policies [48-50].

Limitations

This study has several limitations that should be acknowledged. First, the data used was cross-sectional, limiting the ability to draw causal inferences. While significant associations were found between variables such as fake news, political choice, digital literacy, ideology, and attitudes toward vaccines, these relationships cannot confirm causality. Second, the sample consists predominantly of Indonesian academics, which may limit the generalizability of findings to other populations or cultural contexts. The dynamics of vaccine acceptance may differ in non-academic or rural populations. Third, self-report questionnaires were used, which may be subject to social desirability bias, especially concerning sensitive issues such as political ideology and trust in science. Fourth, although the model includes key psychological and sociopolitical factors, other influential variables such as religious beliefs, peer group norms, and prior vaccine experiences were not included in the

analysis. Similarly, this study did not assess the emotional correlates of vaccine acceptance. Research by Sitibondo et al. [11], on medical professionals highlights that psychological factors like state anxiety are significantly linked to vaccination status. Future studies on academic populations should consider incorporating measures of emotional well-being to provide a more holistic understanding of vaccination decisions. Finally, this study did not investigate longitudinal behavioral changes over time in response to vaccine-related information, which would be essential for understanding evolving attitudes in the digital information age.

CONCLUSIONS

In conclusion, this study validates a theoretical model of vaccine acceptance among Indonesian academics. The findings demonstrate that exposure to fake news, digital literacy, and attitude towards science are significant predictors of vaccine acceptance. The final structural model was consistent with the empirical data, confirming the complex interplay between informational exposure, digital competencies, and personal beliefs. These results underscore the critical need for interventions that enhance digital literacy and trust in science to combat misinformation effectively within influential academic communities.

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