

ORIGINAL ARTICLE

The Effect of Vaccine Literacy on Vaccine Hesitancy in Türkiye: The Mediating Role of Trust in the Health System

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Received: 20 November 2025 / Accepted: 12 February 2026

ABSTRAK

Kajian ini mengkaji peranan mediasi kepercayaan terhadap sistem penjagaan kesihatan dalam hubungan antara literasi vaksin dan keraguan terhadap vaksin dalam kalangan individu yang tinggal di Türkiye. Kajian ini berasaskan Model Kepercayaan Kesihatan dan membuat hipotesis bahawa literasi vaksin yang lebih tinggi serta kepercayaan institusi yang lebih tinggi dikaitkan dengan pengurangan keraguan vaksin, dengan kepercayaan berfungsi sebagai mediator separa. Kajian ini menggunakan reka bentuk keratan rentas untuk meninjau 400 orang di wilayah Marmara Timur Türkiye. Analisis ini melibatkan penggunaan kaedah deskriptif, analisis korelasi Pearson dan penggunaan "Process Macro Model" 4 dalam konteks analisis regresi. Purata tahap literasi vaksin dalam kalangan peserta ialah 3.49 ± 0.66 . Purata tahap kepercayaan terhadap sistem penjagaan kesihatan ialah 3.44 ± 0.67 , manakala purata tahap keraguan vaksin ialah 2.33 ± 0.69 . Tahap literasi vaksin yang rendah boleh menyebabkan keraguan terhadap vaksinasi. Kesan ini dijelaskan lebih lanjut apabila kepercayaan dalam sistem penjagaan kesihatan diperkenalkan sebagai pembolehubah mediasi. Peningkatan literasi vaksin dan pengukuhan kepercayaan terhadap institusi merupakan strategi utama untuk mengurangkan keraguan vaksin. Komunikasi yang telus, penyebaran maklumat yang boleh dipercayai dan dasar kesihatan yang dapat meningkatkan keyakinan adalah penting bagi memperkukuh penerimaan orang ramai vaksinasi.

Kata kunci: Kepercayaan; keraguan vaksin; literasi vaksin; pandemik

ABSTRACT

This research investigates the mediating role of trust in the healthcare system in the relationship between vaccine literacy and vaccine hesitancy among individuals residing in Türkiye. The study is grounded in the Health Belief Model and hypothesises that higher vaccine literacy and greater institutional trust are associated with reduced vaccine hesitancy, with trust functioning as a partial mediator. The study used a cross-sectional design to survey 400 people in Türkiye's Eastern Marmara region. The analysis involved employing descriptive methods, Pearson correlation analysis, and the utilisation of the Process Macro Model 4 in the context of regression analysis. The mean level of vaccine literacy among participants was 3.49 ± 0.66 . The mean level of trust in the healthcare system was 3.44 ± 0.67 , while the mean level of vaccine hesitancy was 2.33 ± 0.69 . A low level of vaccine literacy can cause hesitancy towards vaccination. This effect is further clarified when trust in the health system is introduced as a mediating

variable. Enhancing vaccine literacy and strengthening institutional trust are key strategies for mitigating vaccine hesitancy. Transparent communication, dissemination of credible information and confidence-building health policies are essential for strengthening public acceptance of vaccination.

Keywords: Pandemic; trust; vaccine hesitancy; vaccine literacy

INTRODUCTION

In recent years, vaccine hesitancy has become one of the most pressing global challenges facing by public health systems, particularly during the pandemic. This complex phenomenon arises from a combination of cognitive, psychological, socio-cultural and institutional factors that collectively influence individuals' decisions to get vaccinated. Of these, vaccine literacy and trust in the health system are increasingly recognised as modifiable factors that influence individuals' willingness to accept vaccines (Alqahtani 2021; Fadhel 2021; Naeem & Kamel Boulos 2021; Qi et al. 2021).

Although various theoretical frameworks, such as the Theory of Planned Behaviour and Social Ecological Models, address normative pressures and structural determinants effectively, they often overlook the cognitive appraisal processes involved in evaluating health information (Ajzen 1991; Ajzen 2011; McLeroy et al. 1998; Stokols 1992). As vaccine literacy pertains specifically to how individuals process and apply information when making health decisions, the Health Belief Model (HBM) is a more suitable explanatory framework for this study. Unlike broader contextual models, the HBM explicitly operationalises the internal "cost-benefit analysis" - weighing perceived benefits against perceived barriers - that is directly modulated by an individual's level of literacy. Within this framework, vaccine literacy is not just a contextual factor but a functional antecedent that reshapes risk perception and reduces perceived barriers (Champion & Skinner 2008; Jones et al. 2015; Rosenstock 1974). Furthermore, the model uniquely incorporates "trust in the health system" as a critical "cue to action" that initiates the decision-making process once the cognitive evaluation has been completed.

Therefore, the HBM provides the theoretical precision necessary to clarify how cognitive capacity (literacy) and institutional reliance (trust) interactively reduce hesitancy, offering a more granular understanding than generalised behavioural theories (Carpenter 2010).

Within this conceptual framework, vaccine literacy influences the cognitive processes by which individuals evaluate the perceived benefits versus the potential risks of vaccination. Those with higher literacy levels demonstrate a greater ability to evaluate the severity of vaccine-preventable diseases and vaccine efficacy. Consequently, this group tends to perceive magnified benefits and diminished barriers regarding immunisation (Lamot et al. 2021). Meanwhile, trust in the healthcare system acts as a key "cue to action", motivating individuals to adhere to institutional guidelines and consult reliable sources of information (Bagheri-Lankarani et al. 2021).

This study uses the HBM to investigate how vaccine literacy and trust interact to shape vaccine hesitancy. The aim is to clarify the mediating role of institutional trust in the relationship between literacy and hesitancy among adults living in Türkiye's Eastern Marmara Region. Previous research has framed vaccine hesitancy as a multifaceted behavioral outcome influenced by cultural, political, psychological and systemic factors (Peretti-Watel et al. 2019; Shen et al. 2021; Wang et al. 2021a; Wang et al. 2021b). Using a theoretical framework such as the HBM improves understanding by revealing the cognitive processes behind this behaviour. Vaccine hesitancy, defined as the refusal or delay in accepting vaccination despite its availability, is influenced by various factors, including misinformation, social values, political views, religion and access barriers (Chen et al. 2022;

Peretti-Watel et al. 2019; Thelwall et al. 2021; Wang et al. 2021a; Wang et al. 2021b).

According to the HBM, perceived susceptibility and severity influence how individuals assess their risk of contracting infectious diseases such as COVID-19. Limited vaccine or health literacy can distort these perceptions, leading to an underestimation of potential consequences (Badua et al. 2022; Choukou et al. 2022). Conversely, people with higher vaccine literacy are more likely to recognise the importance of immunisation and overcome common obstacles, such as misinformation or fear (Matterne et al. 2021; Mekonnen & Mengistu 2022; Moore & Millar 2021).

Trust in the health system is another key factor in this model (McCarthy et al. 2022; Jiang et al. 2022; Zhou et al. 2022). Those who trust healthcare institutions and professionals more are more likely to perceive vaccine recommendations as reliable and act upon them. Conversely, diminished trust reduces the credibility of public health information and increases hesitation (Alqahtani 2021; Yehualashet et al. 2022).

Recent research on the determinants of vaccine confidence demonstrates that trust in institutional actors, perceptions of vaccine safety and the credibility of information sources are key factors in shaping individuals' vaccination intentions (Lamot & Kirbiš 2024). The study emphasises that the quality of communication and perceived transparency significantly influence cognitive evaluations and emotional attitudes towards vaccination. By situating institutional trust within this broader evidence base, we can see how trust acts as a behavioural mechanism that can either reinforce or reduce the impact of informational competencies. This helps to explain why individuals with similar levels of vaccine literacy may differ in their hesitancy, depending on how reliable they find health authorities.

Empirical evidence supports these associations. For example, Tian et al. (2023) found that vaccine literacy positively predicts vaccine uptake, with trust acting as an intermediary factor - a relationship that has also been observed in various socio-cultural contexts (Fadel et al. 2025;

Gaye et al. 2025; Goren et al. 2023).

Accordingly, the following hypotheses are proposed: (i) H_1 : Vaccine literacy negatively influences vaccine hesitancy; (ii) H_2 : Trust in the health system negatively influences vaccine hesitancy; and (iii) H_3 : Trust in the health system mediates the relationship between vaccine literacy and vaccine hesitancy.

By applying the HBM, this research tests these hypotheses and contributes theoretical depth to our understanding of how cognitive and institutional factors jointly determine vaccination behavior.

MATERIALS AND METHODS

Ethical Considerations

Ethical approval was obtained from Sakarya University Ethics Committee (dated 03.03.2022 and numbered 113204). The study was conducted in accordance with the Helsinki Declaration. All participants were informed of the purpose of the research and assured that their participation was voluntary, confidential and anonymous.

Study Design and Setting

This cross-sectional study collected data from adults residing in Türkiye's Eastern Marmara Region between 15 April and 15 June 2022. The total population of this region was approximately 7.3 million ($N = 7,332,137$). Eligible participants were required to be at least 18 years old and to have received at least one dose of a COVID-19 vaccine. They also had to provide informed consent prior to participation. Data were collected from participants in the provinces of Kocaeli, Sakarya, Düzce, Bolu and Yalova, specifically targeting individuals in the waiting areas of family health centres and in high-traffic public community spaces, in order to ensure diverse demographic representation. This location was chosen because of its high analytical relevance as a demographic transition zone and a hub for internal migration. According to national migration statistics, the region receives substantial net migration from

rural Eastern Anatolia and other metropolitan areas. This created a population structure that reflected the broader sociodemographic diversity of Türkiye (Turkish Statistical Institute 2024). The region had a dual socio-economic structure, combining highly industrialised urban centres with active agricultural districts. This diversity enabled vaccine literacy and hesitancy to be assessed across a wide spectrum of educational levels and socioeconomic backgrounds within a single administrative unit, thereby mitigating some of the homogeneity biases often associated with single-centre studies.

Sampling Procedure

Convenience sampling was used to recruit participants. The minimum required sample size was calculated using GPower 3.1, version 3.1 (Heinrich Heine University Düsseldorf, Düsseldorf, Germany) based on an effect size of 0.20, a statistical power of 0.95, and a significance level (α) of 0.05. An effect size of 0.20 was chosen to represent a small-to-medium effect. This was considered appropriate for behavioural studies in order to ensure sufficient sensitivity (Cohen 1988). Analysis indicated that a minimum of 314 participants were required; however, to ensure sufficient statistical power, the final sample included 400 respondents. Each participant received a printed questionnaire accompanied by an informed consent form and a brief explanation of the study's objectives. Potential participants were invited to take part in the study in person in the designated data collection areas. Those who volunteered were provided with the questionnaire after being informed about the study's purpose and anonymity. The surveys were self-administered and completed anonymously in approximately 15-20 minutes.

Data Collection Tools

Data collection was carried out using a structured questionnaire divided into two main sections. The first section collected demographic information and the second section used three

validated scales to assess vaccine literacy, vaccine hesitancy and trust in the health system.

The questionnaire included the demographic information section and three validated scales to assess vaccine literacy, vaccine hesitancy and trust in the health system.

(i) Vaccine literacy scale

The vaccine literacy scale was first developed by Biasio et al. (2021) and subsequently adapted by Durmuş et al. (2021) to a Turkish-speaking population. Consisting of 12 items, it assessed individuals' understanding of vaccines and related information. The scale was structured around two sub-dimensions: functional literacy and communicative/critical literacy. Higher scores yielded by the instrument were indicative of a greater level of vaccine literacy. In the context of the HBM, this scale measured self-efficacy in relation to health information. Functional and communicative literacy reflected an individual's ability to access and comprehend vaccine-related information. This reduced the perceived barriers associated with information complexity and enabled a more accurate evaluation of the perceived benefits. The original validation study reported high reliability (Cronbach's $\alpha = 0.85$ and $\alpha = 0.76$ for the two sub-dimensions, respectively), and the Turkish adaptation also demonstrated strong internal consistency ($\alpha = 0.868$ overall). In the present study, Cronbach's alpha coefficients were 0.816 for the functional literacy sub-dimension, 0.798 for the communicative/critical literacy sub-dimension and 0.874 for the total scale.

(ii) Vaccine hesitancy scale

The vaccine hesitancy scale which was originally developed by Luyten et al. (2019) and adapted into Turkish by Yılmaz et al. (2021), was used to assess concerns regarding the vaccination against the COVID-19 virus. The instrument comprised two dimensions: "lack of trust" and "perceived risk". Within this theoretical framework, the "perceived risk" dimension of the scale related to perceived

barriers, particularly concerns about the safety and potential side effects of the vaccine. Conversely, the “lack of trust” dimension captured a deficit in external cues to action, representing the health environment’s failure to trigger preventive behaviour. In this study, the scoring protocol was applied so that higher scores on the “lack of trust” and “perceived risk” sub-scales corresponded to greater hesitancy. This alignment enabled the regression coefficients to be interpreted directly, with a negative association with vaccine literacy implying a reduction in hesitancy. To ensure consistency with the conceptual definition of vaccine hesitancy and the research hypotheses, scoring was standardised so that higher scores indicate higher levels of vaccine hesitancy. Items reflecting positive attitudes or trust were therefore reverse-coded prior to analysis. In the present study, the internal consistency coefficients (Cronbach’s alpha) were $\alpha = 0.800$ for the overall scale, $\alpha = 0.820$ for the “lack of trust” dimension and $\alpha = 0.690$ for the ‘risk’ dimension.

(iii) Trust in health system scale

The trust in health system scale initially created by Egede & Ellis (2008) and translated into Turkish by Dinç et al. (2013), was used to measure trust. This 17-item scale evaluated trust across three subdimensions: “trust in health care providers”, “trust in health care payers”, and “trust in health care institutions”. Higher scores on this instrument corresponded to greater levels of trust. The scale demonstrated excellent internal consistency in this study, with an overall Cronbach’s alpha of 0.914; the alpha values for the sub-dimensions ranged from 0.673 to 0.873. In the HBM framework of this study, trust in the health system was considered a key motivator for action. High levels of trust in healthcare providers and institutions acted as a catalyst, validating health recommendations and reducing uncertainty to promote the decision to vaccinate.

Data Analysis

The data were analysed using the statistical

package for the social sciences (SPSS), version 24 (IBM Corp., Armonk, NY, USA) and mediation analysis was conducted using Process Model 4 developed by Hayes (2022). First, descriptive statistics (mean, frequency and standard deviation) were computed. Pearson correlation coefficients were then calculated to explore the associations between the variables. Before conducting the mediation analysis using Hayes’ Process macro model 4, the underlying assumptions of the general linear model were evaluated. Specifically, the assumptions of linearity, residual normality and homoscedasticity were examined and found to be satisfactory. Furthermore, the variance inflation factor was examined to ensure there was no multicollinearity among the independent variables. Finally, a mediation analysis was conducted to assess whether trust in the health system mediated the relationship between vaccine literacy and vaccine hesitancy. A 95% confidence interval and a significance level of $p < 0.05$ were used throughout the analyses.

RESULTS

Participant Characteristics

The final sample consisted of 400 adult participants (mean age = 27.72 years, SD = 10.35 years). As detailed in Table 1, the sample was predominantly composed of Generation Z members (born between 1997 and 2012) (59.2%), females (57.5%), unmarried individuals (71.7%) and those reporting low income (61%). In terms of educational attainment, 63% had an undergraduate degree, while 10.8% had completed postgraduate studies.

Compare Analysis

Table 2 presented a comparative analysis examining differences in vaccine literacy, trust and vaccine hesitancy among various demographic groups. The results indicated that demographic variables, such as generation, sex and marital status, did not produce any statistically significant differences in the three scales measured ($p >$

TABLE 1: Socio-demographic characteristics of the participants

Variables	n	Percentage
Generation		
X	41	10.3
Y	122	30.5
Z	237	59.2
Sex		
Male	170	42.5
Female	230	57.5
Marriage status		
Single	287	71.7
Married	113	28.3
Perceived level of income		
Low	244	61.0
Medium	127	31.8
High	29	7.2
Level of education		
High school	72	18.0
Associate degree	33	8.2
Undergraduate	252	63.0
Postgraduate	43	10.8

TABLE 2: Comparing variables by demographics

Variables	Vaccine literacy		Trust		Vaccine hesitation	
	F	p	F	p	F	p
Generation						
X						
Y	0.277	0.758	0.181	0.834	0.110	0.896
Z						
Sex						
Male	3.687	0.930	2.014	0.480	1.337	0.623
Female						
Marriage status						
Single	1.604	0.606	0.002	0.663	0.046	0.614
Married						
Perceived level of income						
Low						
Medium	0.178	0.837	5.223	0.006	6.415	0.002
High						
Level of education						
High school						
Associate degree	1.607	0.187	1.545	0.202	3.536	0.015
Undergraduate						
Postgraduate						

0.05). However, perceived income level showed significant variation in both trust ($F = 5.223$, $p = 0.006$) and vaccine hesitation ($F = 6.415$, $p = 0.002$), though it had no significant effect on vaccine literacy. Furthermore, a statistically significant influence of level of education on vaccine hesitation was observed ($F = 3.536$, $p = 0.015$), though no significant differences were found for vaccine literacy or trust within this category.

Descriptive and Correlation Analysis

Table 3 presented the descriptive statistics and inter-variable correlation coefficients. Participants reported moderate levels of vaccine literacy ($M = 3.49$, $SD = 0.66$) and trust in the health system ($M = 3.44$, $SD = 0.67$). Conversely, the mean score for vaccine hesitation was relatively low ($M = 2.33$, $SD = 0.69$). As outlined in the Methods section, the vaccine hesitancy score ranged from 1 to 5, with higher values indicating greater hesitancy. With an observed mean of 2.33 ± 0.69 , the sample exhibited a relatively low level of vaccine hesitancy.

The correlation analysis indicated statistically significant associations among the variables. Vaccine literacy demonstrated a significant positive relationship with trust in the health system ($r = 0.309$, $p < 0.01$) and a significant negative

relationship with vaccine hesitancy ($r = -0.265$, $p < 0.01$). Similarly, trust in the health system was strongly and negatively correlated with vaccine hesitancy ($r = -0.488$, $p < 0.01$). These results suggested that higher levels of literacy and greater trust correspond to reduced vaccine hesitancy.

Mediation Analysis

A mediation analysis was conducted using Hayes' Process Macro (Model 4) to investigate the mediating role of trust in the health system. The findings revealed that both vaccine literacy ($\beta = -0.132$, $p < 0.001$) and trust in the health system ($\beta = -0.458$, $p < 0.001$) were significant negative predictors of vaccine hesitancy.

Furthermore, a significant indirect effect of vaccine literacy on vaccine hesitancy via trust was identified (indirect effect: $\beta = -0.144$), confirming partial mediation. The total effect of vaccine literacy on hesitancy was $\beta = -0.276$. This indicated that individuals with higher vaccine literacy exhibit lower vaccine hesitancy, an effect operating both directly and indirectly by fostering enhanced trust in healthcare institutions. These results supported hypotheses H_1 , H_2 and H_3 , confirming the partial mediating role of trust in the relationship between vaccine literacy and vaccine hesitancy (Table 4, Figure 1).

TABLE 3: Correlation matrix and descriptive statistic

	1	2	3	M	SD
Vaccine literacy (1)	1			3.49	0.66
Trust in the health system (2)	0.309**	1		3.44	0.67
Vaccine hesitation (3)	-0.265**	-0.488**	1	2.33	0.69

TABLE 4: Direct and indirect effects

Variables	Direct effect (β)	Indirect effect (β)	Total effect (β)	LLCI	ULCI	t	p
Vaccine literacy	-0,132	-0,144	-0,276	-0,376	-0,177	-5,482	0,000
Trust in the health system	-0,458			-0,549	-0,366	-9,828	0,000
Dependent variable: Vaccine hesitancy							

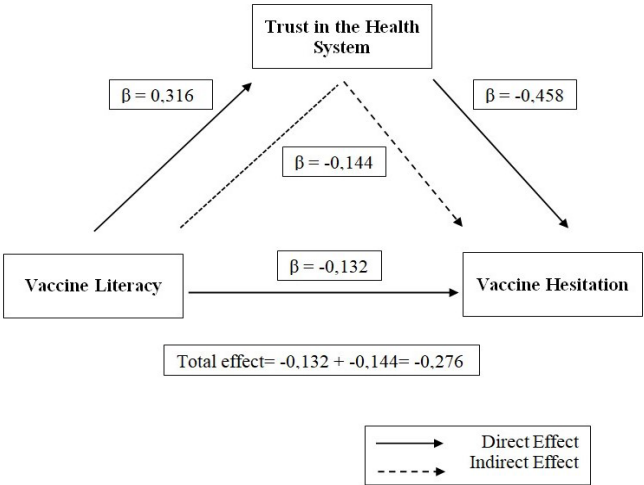


FIGURE 1: Mediation model of vaccine literacy, trust, and hesitancy

DISCUSSION

The results of this study suggest that both vaccine literacy and trust in the healthcare system are significantly associated with individuals’ attitudes towards vaccination. Specifically, participants with higher levels of both demonstrated significantly lower levels of vaccine hesitancy. An analysis of item-level responses (Table S1) reveals a more nuanced picture of vaccine hesitancy. While the vast majority of participants (84.2%) agreed or strongly agreed with the statement “Getting vaccinated is important for the health of others” (Item 3), indicating a strong sense of social responsibility, confidence in newer medical technologies was significantly lower. Notably, 44.2% of participants remained ‘neutral’ regarding the statement “New vaccines carry more risks than older vaccines” (Item 5). This high level of uncertainty suggests that, although general pro-vaccine attitudes are robust, hesitancy is specifically fuelled by ambiguity surrounding novel vaccines, which is likely to be influenced by the context of their rapid development in the era of the pandemic. These findings are consistent with prior national and international research exploring the psychological and institutional determinants of vaccination behaviour (Akman Dombekci &

Guzel 2023; Beller et al. 2023; Fernandez et al. 2022; Tian et al. 2023). However, the present study is distinguished by its integration of the HBM, which provides a structured theoretical lens through which to interpret the relationship between cognitive and trust-based mechanisms and vaccine-related decision-making.

The HBM suggests that an individual’s engagement in preventive health behaviours, such as vaccination, is primarily influenced by their perceptions of their susceptibility to a disease, its potential severity, and the anticipated benefits and barriers associated with the preventive action (Karimy et al. 2021). Within this theoretical construct, individuals with higher levels of vaccine literacy are better to understand disease-related risks and critically evaluate the scientific validity of vaccination. Consequently, they are less susceptible to misinformation, fear-based appeals or social pressures. The findings of the present study support this perspective, showing that higher literacy is linked to lower vaccine hesitancy. This may be due to accurate risk perception and the ability to make informed decisions. Closer examination of the items on the Vaccine Literacy Scale highlights a discrepancy between functional and critical literacy skills. Participants reported high confidence in basic

tasks, with 69.7% finding it easy to “read and understand” vaccine information (Item 1). However, critical evaluation proved more challenging: only 44% of participants felt confident in judging the reliability of information from valid and reliable media sources (Item 12). A significant proportion of participants either expressed difficulty or remained neutral. These results suggest that interventions should focus less on providing information and more on enhancing the public’s ability to critically evaluate media sources.

Moreover, the mediating role of trust within the health system sheds further light on behavioural dynamics. Trust acts as a type of “social capital” that encourages compliance with institutional recommendations and reduces uncertainty (Alagili & Bamashmous 2021; Adiyoso et al. 2023). When individuals have confidence in healthcare institutions and professionals, they are more likely to perceive vaccination campaigns as credible and beneficial. Conversely, a lack of trust can lead to skepticism and anxiety, which can hinder public health initiatives, even among well-informed populations. In terms of trust in the healthcare system, the item analysis distinguishes between interpersonal trust and institutional reliance. Participants expressed a high level of trust in the competence of healthcare professionals, with 72.3% agreeing with the statement “Healthcare professionals can treat medical problems” (Item 7). In contrast, items related to the financial and structural aspects of the system, such as whether institutions “pay for everything they are obligated to pay for” (Item 14), received lower levels of agreement and higher levels of neutrality. This suggests that, although faith in medical personnel remains a pillar of the health system, structural and financial uncertainties could act as barriers to achieving full institutional trust.

To fully appreciate the mediating role of trust in the Turkish context, it is important to understand the country’s specific regional and political health landscape dynamics. Since 2003, Türkiye has undergone a significant “Health Transformation Programme” (Ministry of Health 2003), which has drastically expanded access

to healthcare and increased patient satisfaction (Caner & Cilasun 2019; Phooko et al. 2025). This has bolstered “service quality” as a pillar of institutional trust. However, this trust is fragile and sensitive to political history and transparency. For example, the 2015 Constitutional Court ruling that changed the status of childhood vaccinations from mandatory to requiring parental consent marked a critical turning point, legally framing vaccination as an individual choice rather than a public health obligation. Furthermore, during the pandemic, public debates about the transparency of case reporting and vaccine procurement processes may have politicised health decisions, influencing the ‘institutional trust’ measured in this study. Cultural factors also play a dual role: while traditional vaccine hesitancy was historically associated with conservative or religious concerns, recent trends in Türkiye suggest an increase in ‘modern’ hesitancy among educated, urban populations who question the safety of imported vaccines and pharmaceutical governance. Therefore, in Türkiye, the link between vaccine literacy and hesitancy is not merely cognitive, but deeply embedded in the evolving sociopolitical compact between citizens and the state.

The finding that trust partially mediates the relationship between vaccine literacy and hesitancy is consistent with previous studies based on the HBM and related behavioural models (Morgan et al. 2023; Wang et al. 2022). This partial mediation indicates that institutional confidence may play a crucial role in the relationship between cognitive understanding (literacy) and hesitancy by reinforcing the motivation to act, in addition to the direct association between the two. Therefore, strategies to combat vaccine hesitancy should adopt a dual approach of improving health and vaccine literacy through education, while also strengthening institutional trust through transparent communication, consistent policies and equitable access to care. Our findings align with recent insights suggesting that public health strategies must enhance literacy-based skills and cultivate institutional trust simultaneously. As Lamot and Kirbiş (2024)

have noted, effective vaccination programmes depend not only on disseminating information, but also on consistently practising transparent and reputable communication to build confidence in health authorities.

Within the broader public health framework, these findings highlight the importance of addressing the informational and relational factors that influence acceptance of vaccination. Pedagogical strategies that encourage critical appraisal of health information, particularly among younger demographics and lower socioeconomic groups, are vital in empowering individuals to make evidence-based health decisions. At the same time, government bodies and public health institutions must prioritise initiatives that cultivate public trust, ensuring that vaccination policies are perceived as equitable, evidence-based and responsive to societal concerns.

Limitations

The present study used a convenience sampling methodology to recruit participants, a strategy implemented amid the constraints of the pandemic. While this approach offered pragmatic advantages, it inherently restricted the generalisability of the findings. Furthermore, the sample was predominantly composed of young, single, university-educated individuals. Consequently, this demographic profile, which is skewed towards younger, more educated individuals, may not be representative of the broader population. Therefore, the associations identified in this study should be interpreted with caution, given that older or less educated populations may exhibit different patterns of trust and vaccine literacy.

While the study offers valuable insights, its limitations with regard to generalisability must be acknowledged. Although the Eastern Marmara Region is a demographic melting pot due to high internal migration, it is also one of the most industrialised and economically developed regions in Türkiye. Consequently, participants may have better access to healthcare services

and trust the health system more than individuals residing in less developed or rural areas of the country. Therefore, while the findings provide a robust representation of Türkiye's urbanising population, caution should be exercised when generalising these results to populations with significantly lower socioeconomic development indices.

Furthermore, several methodological limitations warrant attention. Firstly, reliance on self-reported data introduces the potential for bias in responses, such as social desirability bias, whereby participants respond in a way that they think will be viewed favourably by others, rather than reflecting their true attitudes. Secondly, as all variables were measured simultaneously using a single survey instrument, there is potential for common method variance, which could artificially inflate the observed relationships between vaccine literacy, trust and hesitancy. Finally, this study relied exclusively on validated quantitative scales. The absence of qualitative triangulation limits our understanding of the complex, contextual and nuanced factors that drive vaccine hesitancy, which quantitative measures alone may not fully capture. Future research utilising mixed-methods designs would help to overcome these limitations.

Crucially, while the mediation analysis provides statistical evidence that is consistent with the Health Belief Model, the cross-sectional design of this study means that causal inference is inherently limited. Specifically, the "temporal ambiguity" of cross-sectional data means that we cannot strictly verify whether vaccine literacy leads to trust, which then leads to reduced hesitancy, as all variables were measured simultaneously. While the proposed directionality is supported by theoretical frameworks, bidirectional relationships cannot be excluded. Furthermore, the assumption of "the absence of omitted confounders" is difficult to satisfy in observational studies. Unmeasured variables, such as political ideology, prior negative experiences of healthcare, or exposure to specific media sources, could potentially confound the relationships between literacy, trust

and hesitancy. Therefore, the mediation results should be interpreted as associational rather than strictly causal.

Finally, it is important to acknowledge the limitations imposed by the cross-sectional design of this study. Although the mediation analysis provides a statistical framework for understanding the relationships between vaccine literacy, trust and hesitancy, it does not allow for the drawing of strictly causal inferences. The directionality of the described associations is based on the HBM theoretical framework, and reciprocal relationships between these variables are possible. Further longitudinal studies are required to confirm the suggested causal pathways.

Future research could build on this model by incorporating other psychosocial factors, such as perceived social norms, cultural orientation and self-efficacy. Furthermore, longitudinal or multi-regional studies could clarify how vaccine literacy and institutional trust evolve over time, particularly in response to major public health crises or communication failures.

CONCLUSION

Vaccine hesitancy remains one of the most pressing challenges to global public health. This problem has become even more evident during the ongoing pandemic. This study's findings highlight the significant roles played by both vaccine literacy and trust in the health system in reducing hesitancy towards vaccination. Those who have a better knowledge and understanding of vaccines, and who have confidence in healthcare institutions, are more likely to participate in vaccination programmes.

This research highlights the importance of prioritising enhanced vaccine literacy and strengthened institutional trust as complementary public health strategies. Transparent communication, evidence-based policymaking and equitable health service delivery are pivotal in fostering vaccine acceptance. For individuals who are sceptical or have diminished levels of trust, it is imperative to restore confidence through

consistent messaging and the dissemination of reliable information.

Given the specific demographic profile of this study, which comprises predominantly Generation Z (59.2%) and university-educated individuals (63%), intervention strategies must extend beyond basic functional literacy. Instead, public health efforts should prioritise "communicative and critical literacy" dimensions. As this demographic is digitally native yet has a moderate level of vaccine literacy, interventions should focus on enhancing the ability to evaluate the reliability of online health information and identify misinformation.

Digital platforms and university networks have been identified as the most effective channels to reach this audience. Furthermore, as a significant proportion of participants reported low income (61%), trust-building policies must ensure that accurate information is accessible regardless of economic status. To effectively convert vaccine literacy into acceptance, therefore, policymakers should design targeted digital health campaigns that empower young adults to critically appraise scientific data, thereby fostering institutional trust through transparency rather than authoritative mandates.

Further research is needed to explore the psychological and cultural factors that underpin trust and hesitancy, particularly in different demographic and socioeconomic contexts. This line of inquiry could inform the development of interventions tailored to address informational deficits and systemic barriers to vaccination.

Author contributions: Conceptualisation: HK, CA; Data collection: CA; Methodology: HK; Data analysis: HK; Supervision: HK; Writing-original draft: CA; Writing-review & editing: HK. All authors approve of the final manuscript.

Acknowledgement: Not Applicable

Funding: This research did not receive any specific grant from funding agencies in the public, commercial or not-for-profit sectors.

Conflict of interest: The authors declare there are no conflicts of interest.

Ethics statement: The study was approved by the Ethics Committee of the Sakarya University (03.03.2022 date and number 113204).

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TABLE S1: Item-level response distribution for vaccine hesitancy, literacy, and health system trust

The Vaccine Hesitancy Scale					
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. Vaccines are important for my health.	2.2%	2.3%	12.0%	38.0%	45.5%
2. Vaccines are effective.	2.0%	3.8%	15.2%	39.2%	39.8%
3. Getting vaccinated is important for the health of others in the community.	2.3%	2.5%	11.0%	37.7%	46.5%
4. All vaccines in the government vaccination programme are beneficial.	5.0%	13.2%	36.8%	23.7%	21.3%
5. New vaccines carry more risks than older vaccines.	12.3%	19.0%	44.2%	17.2%	7.3%
6. The information I receive about vaccines from the government vaccination programme is credible and reliable.	5.0%	9.5%	36.7%	33.0%	15.8%
7. Getting vaccinated is an effective way to protect myself from illness.	3.3%	3.0%	15.5%	42.7%	35.5%
8. I generally follow my doctor's or healthcare provider's recommendations about vaccines.	2.8%	5.0%	12.0%	44.2%	36.0%
9. I am concerned about the potential serious side effects of vaccines.	19.0%	27.0%	32.2%	18.5%	3.3%
The Vaccine Literacy Scale					
<i>When reading or listening to information about existing or potential vaccines for COVID-19;</i>					
1. I encountered some unfamiliar concepts and words.	6.8%	15.5%	15.5%	42.0%	20.2%
2. I found the information/texts about vaccines difficult to understand.	11.2%	32.3%	19.7%	26.5%	10.3%
3. I spent time trying to understand the information about vaccines.	9.8%	24.7%	19.3%	32.4%	13.8%
4. I needed help to understand the information about vaccines.	17.3%	30.2%	14.7%	24.5%	13.3%
<i>When researching information about Covid-19 vaccines or existing vaccines;</i>					
5. I reviewed multiple sources.	4.5%	20.3%	9.4%	40.3%	25.5%
6. I found the information I was looking for.	4.5%	14.5%	25.7%	38.8%	16.5%
7. I had the opportunity to use the information.	6.7%	17.3%	21.7%	36.5%	17.8%
8. I discussed my understanding of vaccines with my doctor and other people.	6.0%	14.5%	15.0%	42.0%	22.5%
9. I considered whether the information I had gathered was relevant to my situation.	4.0%	9.5%	19.0%	44.8%	22.7%
10. I considered whether the sources were reliable.	3.0%	8.0%	15.7%	42.0%	31.3%
11. I checked that the information was accurate.	4.5%	8.5%	19.5%	42.0%	25.5%
12. I obtained any information that would help me decide whether or not to get vaccinated.	3.3%	7.2%	14.4%	42.3%	32.8%
Continued...					

...continuing

The Trust in Health System Scale					
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<i>Trust in healthcare professionals;</i>					
1. The healthcare professional providing me with services considers and prioritises my needs.	2.8%	8.7%	23.5%	43.5%	21.5%
2. I trust them so much that I always try to follow their advice.	6.3%	15.4%	25.2%	37.3%	15.8%
3. I trust my healthcare professional so much that I believe everything they tell me.	16.0%	19.8%	35.2%	20.0%	9.0%
4. Sometimes, however, I don't trust their opinion and therefore feel the need for a second opinion.	4.7%	14.3%	21.5%	40.5%	19.0%
5. I trust the healthcare professional to make decisions about my medical care.	1.8%	5.0%	30.0%	47.2%	16.0%
6. The healthcare professional providing me with services will do whatever it takes to provide me with the medical care I need.	4.0%	10.0%	29.0%	39.8%	17.2%
7. As an expert, the healthcare professional can treat medical problems like mine.	1.5%	7.2%	19.0%	53.0%	19.3%
8. I can trust the healthcare professional to make decisions about which medical treatments are best for me.	3.0%	6.3%	27.5%	45.5%	17.7%
9. The healthcare professional provides me with the highest quality of care.	3.5%	12.2%	31.8%	37.5%	15.0%
10. Taking all of this into account, I have complete trust in the healthcare professional providing me with services.	4.0%	14.2%	30.8%	35.0%	16.0%
<i>Trust in individuals/institutions that cover the cost of healthcare services;</i>					
11. Healthcare providers are good at what they do.	4.5%	13.0%	34.5%	34.0%	14.0%
12. They pay for you to see a specialist when needed.	7.5%	17.0%	35.2%	27.8%	12.5%
13. They give honest answers when asked about the types of treatment available.	5.8%	14.0%	35.0%	30.8%	14.4%
14. They pay for everything they are obligated to pay for, even if the treatment is expensive.	7.5%	16.7%	33.8%	28.5%	13.5%
<i>Trust in healthcare institutions;</i>					
15. Healthcare organisations prioritise reducing medical costs over providing me with the treatments I need.	5.0%	20.0%	33.2%	29.0%	12.8%
16. Healthcare organisations provide the highest quality medical care.	5.0%	10.3%	37.4%	34.3%	13.0%
17. Healthcare organisations prioritise my medical needs, including cost, when treating my health problems.	5.4%	12.8%	36.5%	31.8%	13.5%