

	JOURNAL OF HEALTHCARE MANAGEMENT AND LEADERSHIP (JOHMAL) SAĞLIK YÖNETİMİ VE LİDERLİK DERGİSİ	
E-ISSN: 2667-5838	https://dergipark.org.tr/tr/pub/johmal	Paper Type: Research Paper, Makale Türü: Araştırma Makalesi
Sayı: 1, Eylül 2026	Issue: 1, September 2026	Received Date / Geliş Tarihi: 12.03.2026 Accepted Date / Kabul Tarihi: 26.08.2026
E-SAĞLIK OKURYAZARLIĞI VE AŞI OKURYAZARLIĞI AŞI TEREDDÜDÜNÜ AZALTMAYA YARDIMCI OLABİLİR Mİ?¹ COULD E-HEALTH LITERACY AND VACCINE LITERACY HELP REDUCE VACCINE HESITANCY?		
Atıf/ to Cite (APA): Ağırman, P. & Çetin, E., (2026). Could e-health literacy and vaccine literacy help reduce vaccine hesitancy? <i>Journal of Healthcare Management and Leadership (JOHMAL)</i> , 1(1), 1–13. DOI: https://doi.org/10.35345/johmal.1908101		Perver AĞIRMAN² Emine ÇETİN³

ÖZ

Bu çalışma, e-sağlık okuryazarlığı, aşı okuryazarlığı ve aşı tereddüdü arasındaki ilişkiyi incelemeyi amaçlamaktadır. Kesitsel araştırma tasarımındaki bu çalışma, İzmir-Türkiye’deki kamu üniversitelerinde öğrenim gören lisans öğrencileri üzerinde yürütülmüştür. Katılımcılar kolayda örnekleme yöntemiyle seçilmiş ve 389 geçerli anket elde edilmiştir. Anket; sosyodemografik özelliklere ilişkin soruların yanı sıra e-sağlık okuryazarlığı ölçeği, aşı okuryazarlığı ölçeği ve aşı tereddüdü ölçeğinden oluşmuştur. Ölçeklerin yapı geçerliliği keşfedici faktör analizi ile, güvenilirlikleri ve iç tutarlılıkları ise Cronbach Alfa katsayısı, uyumu doğrulayıcı faktör analizi ile değerlendirilmiştir. Ölçekler ve alt boyutları arasındaki ilişkiler korelasyon ve regresyon analizleri kullanılarak incelenmiştir. Araştırmada, e-sağlık okuryazarlığının aşı okuryazarlığı ve aşı okuryazarlığının iki alt boyutu ile pozitif yönde ilişkili olduğu bulunmuştur. Ayrıca e-sağlık okuryazarlığının, aşı tereddüdünün alt boyutlarından biri olan aşının fayda ve koruyucu değer algısını artırdığı belirlenmiştir. Aşı okuryazarlığının ise genel aşı tereddüdünü ve aşı tereddüdünün alt boyutları olan aşı isteksizliği ile aşı tereddüdünün meşrulaştırılmasını azalttığı saptanmıştır ($p<0,05$). E-sağlık okuryazarlığı aşı okuryazarlığını artırırken, her iki okuryazarlık alanındaki gelişmenin aşı tereddüdünün azalmasına katkı sağladığı görülmüştür. Bununla birlikte, aşı okuryazarlığının aşı tereddüdü üzerindeki etkisinin e-sağlık okuryazarlığından daha güçlü olduğu belirlenmiştir. E-sağlık okuryazarlığı ve aşı okuryazarlığının geliştirilmesinin, aşı tereddüdüyle mücadelede etkili bir strateji olabileceği değerlendirilmektedir.

Anahtar Kelimeler: E-sağlık okuryazarlığı, Aşı tereddüdü, Aşı okuryazarlığı, Lisans öğrencileri.

ABSTRACT

This study aims to investigate the relationship between e-health literacy, vaccine literacy, and vaccine hesitancy. This cross-sectional survey study was conducted among undergraduate students studying at public universities in İzmir, Türkiye. Participants were selected using a convenience sampling method, and 389 valid questionnaires were obtained. The questionnaire consisted of questions on sociodemographic characteristics, the e-health literacy scale, the vaccine literacy scale, and the vaccine hesitancy scale. The construct validity of the scales was assessed using exploratory factor analysis, while their reliability and internal consistency were evaluated using Cronbach’s alpha, and their fit was assessed using confirmatory factor analysis. The relationships between the scales and their sub-dimensions were examined using correlation and regression analyses. The findings indicated that e-health literacy was positively associated with vaccine literacy and its two sub-dimensions. In addition, e-health literacy was found to be positively associated with the perceived benefits and protective value of vaccines, which is one of the sub-dimensions of vaccine hesitancy. Vaccine literacy was negatively associated with vaccine hesitancy and its sub-dimensions, including reluctance to vaccination and the justification of vaccine hesitancy ($p<0.05$). While e-health literacy was positively associated with vaccine literacy, both e-health literacy and vaccine literacy were associated with lower levels of vaccine hesitancy. The association between vaccine

¹ This study was supported by the Scientific and Technological Research Council of Türkiye (TÜBİTAK) under the 2209-A 2023 1st term program. Part of this research was presented as an oral presentation at the ICHSR 8th International Conference on Humanity and Social Sciences November 15-17, 2024 – Rome. Ethics committee permission for the research was obtained by the decision of the İzmir Bakırçay University Non-Interventional Clinical Research Ethics Committee dated 25.10.2023 and numbered 1267.

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literacy and lower vaccine hesitancy was stronger than that of e-health literacy. Increasing e-health literacy and vaccine literacy may be considered as potential strategies for addressing vaccine hesitancy.

Keywords: E-health literacy, Vaccine hesitancy, Vaccine literacy, Undergraduate students.

1. INTRODUCTION

Vaccines can be defined as biological preparations that enhance immunity and prevent infectious diseases (Delany et al., 2014). Vaccination is one of the greatest achievements in public health and has made significant contributions to individual and population health (Eskola et al., 2015; Larson et al., 2014). Currently, more than 30 life-threatening diseases can be prevented through vaccination, contributing to longer and healthier lives. Vaccines prevent approximately 3.5–5 million deaths each year and represent an important tool in combating antimicrobial resistance, which remains a major global public health challenge (WHO, 2025). In its 2025 assessment, the WHO identified vaccination efforts among the notable public health achievements that represent successful interventions (WHO, 2026). The contribution of vaccines to society extends beyond health improvements. As highly cost-effective interventions for preventing vaccine-preventable diseases, vaccines also contribute to social and economic well-being (Çetin & Ağırbaş, 2013; Eskola et al., 2015). Due to these benefits, vaccination is considered “one of the best health investments money can buy” (Conceição Silva et al., 2023; WHO, 2025). To reduce mortality and morbidity associated with vaccine-preventable diseases, high vaccination coverage rates need to be achieved and maintained (Eskola et al., 2015).

High vaccination coverage rates and the achievement of the expected benefits of vaccines depend largely on public acceptance of vaccination (Nuwarda et al., 2022). For vaccines to provide the desired level of protection, the control and elimination of many infectious diseases require the achievement of “herd immunity,” also referred to as “population immunity,” which is achieved when a sufficient proportion of the population becomes immune through vaccination or previous infection. The proportion of the population that needs to be vaccinated to achieve herd immunity varies depending on the characteristics of each disease. This threshold is approximately 80% for polio, 95% for measles (WHO, 2020), and 60–75% for COVID-19 (Sallam, 2021). The main requirements for achieving high vaccination coverage rates include the availability and accessibility of vaccines, as well as public awareness of the importance of vaccination and confidence in the value of vaccines (Eskola et al., 2015). Although effective vaccines are available in many parts of the world, vaccine hesitancy remains a major barrier to achieving optimal vaccination coverage rates and is recognized as an important public health challenge. In 2019, the WHO included vaccine hesitancy among the “10 Threats to Global Health,” alongside other major global health challenges such as HIV and Ebola (WHO, 2019).

The WHO defines vaccine hesitancy as “delay in acceptance or refusal of vaccination despite the availability of vaccination services. Vaccine hesitancy is complex and context-specific, varying across time, place, and vaccines. It is influenced by factors such as complacency, convenience, and confidence” (MacDonald et al., 2015). Vaccine hesitancy reflects concerns and uncertainties regarding individuals’ decisions to vaccinate themselves or their children. Individuals who are hesitant about vaccination may demonstrate diverse patterns of behavior. While some individuals may refuse all vaccines, others may refuse specific vaccines or prefer to follow a vaccination schedule different from that recommended by health authorities. In addition, some individuals may continue to experience concerns about vaccines even after completing the recommended vaccination schedule (Salmon et al., 2015; Troiano & Nardi, 2021). Therefore, vaccine hesitancy is considered to exist on a continuum ranging from complete vaccine acceptance to complete vaccine refusal (Larson et al., 2014). Previous research has also demonstrated that even vaccinated individuals may have substantial doubts and concerns regarding vaccines (Dubé et al., 2013).

The reasons for vaccine hesitancy are multifaceted. Attitudinal factors, including cultural and religious beliefs, perceived risks and benefits, and individual and social influences, play critical and interconnected roles in vaccination decision-making (Nuwarda et al., 2022). Given the complexity of the concept of vaccine hesitancy, individual, social, and environmental factors may all contribute to vaccine-related attitudes and decisions. One of the most frequently discussed factors contributing to vaccine hesitancy is that, due to the high effectiveness and success of vaccines, individuals may underestimate the severity and consequences of vaccine-preventable diseases. Consequently, vaccine-related concerns may be perceived as more serious than the potential harms caused by the diseases themselves, reflecting a form of risk perception bias (MacDonald et al., 2015; McClure et al., 2017; Omer et al., 2009). In other words, “vaccines have become victims of their own success” (Salmon et al., 2015). This misconception may be associated with insufficient knowledge and understanding regarding vaccines and health.

In this context, improving individuals’ access to reliable health information and enhancing their ability to understand and evaluate vaccine-related information may play an important role in addressing vaccine hesitancy. In response to increasing vaccine hesitancy, the concept of vaccine literacy has emerged, emphasizing the acquisition, understanding, and appropriate use of accurate information about vaccines. Vaccine literacy, a relatively new concept, was first introduced by Ratzan (2011) and defined as “not simply knowledge about vaccines, but also developing a system with decreased complexity to communicate and offer vaccines as sine qua non of a functioning health system” (Ratzan, 2011). Initial research examining vaccine literacy began to emerge in the literature in 2015 (E. Zhang et al., 2023). Vaccine literacy refers not only to knowledge regarding vaccine effectiveness but also to the ability to access, understand, and use vaccine-related information effectively (Michel & Goldberg, 2020). It extends beyond individual knowledge about vaccination and includes the development of systems that facilitate effective communication and dissemination of messages regarding the importance and necessity of vaccines (Biasio, 2019; Gusar et al., 2021).

The COVID-19 pandemic has once again highlighted the societal importance of infectious diseases and increased attention toward vaccination-related issues (Salali & Uysal, 2022; Troiano & Nardi, 2021; Wiysonge et al., 2022). The pandemic also demonstrated that infectious diseases remain a significant threat to modern societies and that achieving widespread vaccination coverage continues to be essential. In Türkiye, epidemiological changes associated with migration have contributed to the re-emergence of infectious diseases that were previously rare, further emphasizing the importance of achieving and maintaining high vaccination coverage rates (Alan et al., 2018).

Vaccine literacy originates from health literacy and represents an important subcomponent of this broader concept (Badua et al., 2022; Biasio, 2019; Ratzan, 2011). Limited ability to access, understand, and critically evaluate health information has been associated with greater challenges in making informed vaccination decisions. Nevertheless, evidence indicates that health literacy is not a uniform construct and may vary across different health domains and processes, including vaccination-related decisions (F. Zhang et al., 2020). Therefore, strengthening health literacy in general, and vaccine literacy in particular, may serve as an effective strategy to address vaccine hesitancy, which is recognized as a significant public health challenge (Badua et al., 2022; Ratzan, 2011; E. Zhang et al., 2023).

In today’s context, where internet use has reached remarkably high levels, concerns regarding the reliability of health information obtained online have become increasingly prominent (Dib et al., 2022). Social media, in particular, plays a significant role in the dissemination of misinformation due to its user-generated content structure and the facilitation of uncontrolled information flow (Freeman et al., 2014). Although health professionals and policymakers largely agree on the need to address

health-related misinformation, the unregulated nature of social media makes effective control challenging. A study examining misinformation related to health on social media found that vaccines were the most frequently discussed topic, accounting for 32% of posts (Nuwarda et al., 2022; Suarez-Lledo & Alvarez-Galvez, 2021). The spread of false or misleading information regarding the benefits and risks of vaccines significantly fuels vaccine hesitancy (Dib et al., 2022).

This study aims to evaluate the effect of e-health literacy on vaccine literacy, as well as the effects of both e-health literacy and vaccine literacy on vaccine hesitancy among undergraduate students. Given that health-related information is increasingly accessed through electronic sources such as the internet and social media, e-health literacy was preferred over general health literacy in this study. Another rationale for focusing on e-health literacy is that university students, as a young population, use the internet and social media more frequently than the general population (Freeman et al., 2014; Özceylan et al., 2020). Moreover, it is considered important from a public health perspective that university students—who represent future parents and educated individuals—possess accurate knowledge about vaccines (Eskola et al., 2015). In addition, to the best of our knowledge, no previous study has simultaneously examined the relationship between e-health literacy, vaccine literacy, and vaccine hesitancy. Therefore, further research is needed to better understand the determinants of vaccine hesitancy.

2. METHOD

2.1. Study Design and Participants

This cross-sectional survey study was conducted among undergraduate students enrolled in public universities in İzmir, Türkiye. There are six public universities in İzmir, and the total number of undergraduate students enrolled in these institutions is approximately 100,000, according to official university statistics. For a population of this size, the minimum required sample size for representativeness is 384 (Sekaran & Bougie, 2016).

A total of 431 questionnaires were collected. After data screening, 42 questionnaires were excluded because they were completed by associate degree or graduate students. The final sample consisted of 389 valid questionnaires, which were included in the analyses.

2.2. Data Collection

Research data were collected using a structured questionnaire. For the online data collection process, the survey was designed using the Google Forms platform, and the survey link was distributed to participants via WhatsApp and email. Completing the questionnaire required approximately 4–5 minutes. Face-to-face data collection was conducted in social settings within the university campus and student dormitories. All participants were informed about the purpose of the study. Participation was voluntary, and it was clearly stated that the data would be used solely for scientific purposes. The questionnaire consisted of four sections: demographic characteristics (age and gender), the e-health literacy scale, the vaccine literacy scale, and the vaccine hesitancy scale. Data collection was carried out between February and July 2023.

E-health literacy scale: The scale was developed by Norman and Skinner in English (2006). The scale was adapted to Turkish by Tamer Gencer (2017). The Turkish scale consists of 8 items and is one-dimensional. The scale is a 5-point Likert type. There are no reverse-coded items in the scale. A high score on the scale indicates a high level of e-health literacy. The α (Cronbach's Alpha) coefficient of the original scale was 0.88, and 0.915 for the Turkish version (Tamer Gencer, 2017). In this study, explanatory factor analysis (EFA) was performed to evaluate the validity of the scale. As a result of the KMO (0.877) and Bartlett's sphericity test ($\chi^2 = 1566.476$, $df = 28$, $p = 0.000$), it was determined that sufficient sample size was reached and that the data were in accordance with EFA. According to

the EFA results, a single-factor structure consisting of 8 items was obtained. The scale explains 55.011% of the total variance. Factor loadings of scale items range from 0.615 to 0.843. The scale has a α coefficient of 0.880 and has high reliability (Nunnally and Bernstein, 1994).

Vaccination Literacy Scale: The scale developed by Durmuş et al. (2021) in Turkish consists of 12 items and two sub-factors. The scale is a 5-point Likert type. There are no reverse-coded items in the scale. A high score on the scale indicates a high level of vaccination literacy. The α coefficient was 0.868 for the scale, 0.915 for the communicative/critical skills sub-dimension, and 0.867 for the functional skills sub-dimension (Durmuş et al., 2021). The EFA was conducted to determine the validity of the scale. As a result of the KMO (0.762) and Bartlett's sphericity test ($\chi^2 = 962.661$, $df = 55$, $p = 0.000$), it was determined that sufficient sample size was reached and that the data were suitable for EFA. The item "Did you spend time understanding the information/texts about the vaccine?", which is in the functional skills dimension of the scale, was excluded from the analysis because it loaded under different dimensions. According to the EFA results of the scale, a two-factor structure consisting of 11 items was obtained. The scale explains 46.987% of the total variance. Factor loadings of the scale items range from 0.561 to 0.848. As a result of the reliability analysis, the α coefficient of the communicative/critical dimension was 0.770, the α coefficient of the functional skill dimension was 0.728, and the total scale was 0.713.

Vaccination Hesitancy Scale: The scale was developed by Kılınçarslan et al. (2020) in both long and short forms. The long form was used in the research, which consists of four dimensions and 21 items. The scale is a 5-point Likert type. There are no reverse-coded items in the scale. A high score on the scale indicates a high level of vaccination hesitancy. The α coefficient of the scale was 0.905 (Kılınçarslan et al., 2020). In this study, EFA was conducted to assess the validity of the scale. As a result of the KMO (0.923) and Bartlett's sphericity test ($\chi^2 = 3892.397$, $df = 171$, $p = 0.000$), it was determined that sufficient sample size was reached and that the data were in accordance with EFA. The expressions "If I were a child, I would not get vaccinated" and "Ancestral methods protect health better than vaccines" in the vaccine hesitancy dimension of the scale were excluded from the analysis because they loaded under different factors, respectively. According to the EFA results of the Vaccination Hesitancy Scale, a four-factor structure consisting of 19 items was obtained. The scale explains 65.549% of the total variance. Factor loadings of the scale items range from 0.460 to 0.835. As a result of the reliability analysis, the α coefficients were 0.882 for the benefit and protective value of the vaccine, 0.840 for vaccine repugnance, 0.782 for legitimization of vaccine hesitancy, and 0.782 for solutions for non-vaccination, while the total scale coefficient was 0.918, indicating high reliability (Nunnally & Bernstein, 1994).

2.3. Research Hypotheses

The following research hypotheses were addressed in this study:

H1: What is the level of e-health literacy among university students?

H2: What is the level of vaccine literacy among university students?

H3: What is the level of vaccine hesitancy among university students?

H4: Is there a relationship between vaccine hesitancy and e-health literacy among university students?

H5: Is there a relationship between vaccine literacy and e-health literacy among university students?

H6: Is there a relationship between vaccine literacy and vaccine hesitancy among university students?

2.4. Statistical Analysis

SPSS 23 statistical software was used for the analysis. The socio-demographic characteristics of the participants were analyzed using frequency and percentage distributions, the validity of the scales was assessed through explanatory factor analysis (EFA), and their reliability was evaluated using the internal consistency Cronbach's alpha ($C\alpha$) coefficient. Confirmatory factor analysis (CFA) was conducted to test the fit between the predefined factor structure of the scales used in the study and the obtained data. The normality of the data was assessed based on the assumption that skewness and kurtosis values fall within the range of ± 1.500 . Depending on the research hypotheses, the relationships between variables were examined using correlation and regression analyses. In the evaluation of the research findings, a 95% confidence interval and a significance level of $p < 0.05$ were used.

2.5. Ethical Considerations:

Ethical approval for the study was obtained from the XXX University Non-Interventional Clinical Research Ethics Committee, with the decision dated 25.10.2023 and numbered 1267. In addition, informed consent was obtained from all participants, confirming their voluntary participation in the study.

3. RESULTS

The demographic characteristics of the undergraduate students are summarized in Table 1. Of the participants, 76.86% were female, and the mean age was 21.48 ± 3.85 years.

Table 1. Demographic characteristics of the participants

Variable	n	%
Age (Mean $\pm$ SD)	21.48 $\pm$ 3.852	
Gender	Women	299
	Male	90
Total	389	100

Descriptive statistics (minimum, maximum, mean, standard deviation, skewness, kurtosis, and Cronbach's alpha values) for the scales are presented in Table 2. The scales and their sub-dimensions were evaluated based on the mean scores calculated from the responses given by the participants to each item. However, since the Vaccine Literacy Scale is assessed using total scores, descriptive statistics for the total score are also presented. The skewness and kurtosis values of the three scales and their sub-dimensions ranged from -1.50 to +1.50, indicating that the data were normally distributed (Tabachnick & Fidell, 2013).

Table 2. Descriptive statistics of the scales

Scales	Min.	Max.	Mean	SS	Skewness	Kurtosis
E-Health Literacy Scale	1	5.	3.41	0.700	-0.449	0.495
Vaccine Literacy Scale (Mean)	1.36	3.82	2.70	0.440	0.075	-0.196
Functional Skill	1	4	2.31	0.700	0.388	0.031
Communication/Critical	1	4	2.84	0.540	-0.389	0.300
Anti-Vaccination Scale (Mean)	1	4.74	2.64	0.660	0.109	0.086
Anti-Vaccination Scale (Total)	21	100	54.65	13.998	0.161	0.097
Benefit and protective value of vaccine	1	5	2.53	0.830	0.641	0.658
Vaccine repugnance	1	5	3.31	0.780	-0.341	0.029
Legitimization of vaccine hesitancy	1	5	1.89	0.750	0.822	0.595
Solutions for non-vaccination	1	5	2.80	0.980	0.134	-0.49

According to the analysis, the mean score of the e-health literacy scale was 3.41 ± 0.700 . The mean score of the items in the Vaccine Literacy Scale was 2.70 ± 0.440 , while the mean scores of its sub-dimensions were 2.31 ± 0.700 and 2.84 ± 0.540 . The mean score of the Vaccine Hesitancy Scale was 2.64 ± 0.660 , and the mean scores of its sub-dimensions ranged from 1.89 ± 0.750 to 3.31 ± 0.780 . In the evaluation of the Vaccine Hesitancy Scale, higher scores indicate higher levels of vaccine hesitancy. The mean total score of the scale was calculated as 54.65 ± 13.998 .

3.1. Confirmatory Factor Analysis

Since the χ^2/df value for the eHealth Literacy scale was greater than 5, covariances were assigned between e7-e8 and e4-e5 in accordance with the modification recommendations. The results of the DFA analysis indicated that the unidimensional structure of the eHealth Literacy scale, consisting of 8 items, had acceptable fit indices. Since the Vaccine Literacy scale had an NFI value of 0.90 and a CFI value below 0.95, covariances were assigned between e6-e9 and e7-e8 in accordance with the modification recommendations. According to the CFA results, the two-dimensional structure of the 11-item Vaccine Literacy scale exhibits acceptable goodness-of-fit values. Since the GFI and NFI values for the Vaccine Hesitancy scale were 0.90 and the AGFI value was below 0.85, covariances were assigned between e9-e10, e15-e18, and e1-e2 in accordance with the modification recommendations. The results of the DFA analysis showed that the four-dimensional structure of the Vaccine Hesitancy scale, consisting of 19 items, has acceptable goodness-of-fit values. The CFA results indicated that the factor structures of the three scales used in the study showed an acceptable fit to the data obtained from the current sample, supporting the construct validity of the scales.

Table 3. Confirmatory factor analysis of the scales

Fit Values*	χ^2/df	GFI	AGFI	CFI	NFI	RMSEA	SRMR
Good Fit*	≤ 2	≥ 0.95	≥ 0.95	≥ 0.97	≥ 0.95	≤ 0.05	≤ 0.05
Acceptable Compliance*	≤ 5	≥ 0.90	≥ 0.85	≥ 0.95	≥ 0.90	≤ 0.08	≤ 0.10
E-Health Literacy	4.11	0.96	0.91	0.97	0.96	0.08	0.05
Vaccine Literacy	2.04	0.96	0.93	0.95	0.90	0.06	0.06
Anti-Vaccination	2.78	0.90	0.86	0.93	0.90	0.07	0.07

χ^2/df : Chi-kare/degrees of freedom; GFI: Goodness of fit index; AGFI: Adjusted goodness of fit index; NFI: Normed fit index; CFI: Comparative fit index; RMSEA: Root mean square error of approximation; SRMR: Standardized Root Mean Square Residual

*Source: Wheaton et al. (1977); Schermelleh-Engel et al. (2003); Kline (2015)

3.2. Correlation Analysis

Pearson correlation analysis was conducted to examine the relationships between the scales and their sub-dimensions (Table 3). A significant positive correlation was found between e-health literacy and vaccine literacy, as well as between e-health literacy and the sub-dimensions of the Vaccine Literacy Scale (functional skills and communication/critical skills) ($p < 0.05$). These findings indicate that higher levels of e-health literacy are associated with higher levels of vaccine literacy, functional skills related to vaccine literacy, and communication/critical skills.

The analysis revealed a significant negative correlation between e-health literacy and the benefit and protective value of vaccines, which is a sub-dimension of the Vaccine Hesitancy Scale ($p < 0.05$). No significant correlation was found between e-health literacy and overall vaccine hesitancy or its other sub-dimensions. Since the benefit and protective value sub-dimension is reverse-coded, this finding indicates that higher levels of e-health literacy are associated with lower levels of negative perceptions regarding the usefulness and protective value of vaccines.

A negative correlation was found between vaccine literacy and vaccine hesitancy, as well as its sub-dimensions, vaccine repugnance and legitimization of vaccine hesitancy ($p < 0.05$). The negative correlations between the functional skills and communication/critical skills sub-dimensions of vaccine

literacy and vaccine hesitancy indicate that higher levels of vaccine literacy skills are associated with lower levels of vaccine hesitancy.

Table 3: Relationship Between E-Health Literacy, Vaccine Literacy, and Vaccine Hesitancy

	Variables	1	2	3	4	5	6	7	8	9
1	E-Health literacy p	1								
2	Vaccine literacy p	.285 .000*	1							
3	Functional skill p	.229 .000*	.470 .000*	1						
4	Communication/Critical skill p	.211 .000*	.901 .000*	.040 .427	1					
5	Vaccine hesitancy p	-.050 .329	-.126 .013*	-.057 .258	-.115 .024*	1				
6	Benefit and protective value of the vaccine p	-.200 .000*	-.023 .645	-.011 .825	-.021 .674	.813 .000*	1			
7	Vaccine repugnance p	-.003 .961	-.134 .008*	-.113 .026*	-.097 .057	.839 .000*	.578 .000*	1		
8	Solutions for non- vaccination p	-.061 .230	-.201 .000*	-.071 .163	-.192 .000*	.739 .000*	.410 .000*	.452 .000*	1	
9	Legitimizing vaccine hesitancy p	-.008 .875	-.014 .788	.048 .347	-.039 .440	.837 .000*	.627 .002*	.610 .000*	.559 .000*	1

3.3. Regression Analysis

Regression analyses were performed for the variables that showed significant correlations in the correlation analysis (Table 4). E-health literacy was found to be a positive predictor of vaccine literacy. A one-unit increase in e-health literacy was associated with a 0.180-unit increase in vaccine literacy, and e-health literacy explained 8.1% of the variance in vaccine literacy ($R^2=0.081$). Similarly, e-health literacy was found to be a positive predictor of the functional skills and communication/critical skills sub-dimensions of the Vaccine Literacy Scale. In addition, e-health literacy significantly predicted the benefit and protective value of the vaccine sub-dimension of the vaccine hesitancy scale. This negative association may indicate that higher levels of e-health literacy are associated with lower negative perceptions and stronger positive perceptions regarding the benefits and protective value of vaccines.

The analysis findings indicate that vaccine literacy was a significant negative predictor of vaccine hesitancy and all of its sub-dimensions. Vaccine literacy explained 1.6% of the variance in vaccine hesitancy ($R^2=0.016$), with the strongest explanatory contribution observed for the legitimization of vaccine hesitancy ($R^2=0.040$). Vaccine literacy was also negatively associated with the sub-dimensions of vaccine hesitancy, including vaccine repugnance and legitimization of vaccine hesitancy. Higher levels of functional skills may associate with lower levels of vaccine repugnance, while higher levels of communication/critical skills were associated with lower levels of both vaccine repugnance and legitimization of vaccine hesitancy.

Table 4. Regression Analysis of The Scales

Variables	B	F	t	P	R	R ²
E-health literacy ¹ Vaccine literacy ²	.180	34.329	5.859	.000	.285	.081
E-health literacy ¹ Functional skill ²	.229	21.335	4.619	.000	.229	.052
E-Health Literacy ¹ Communication/Critical skill ²	.161	17.992	4.242	.000	.211	.044
E-health literacy ¹ Benefit and protective value of the vaccine ²	-.235	16.082	-4.010	.000	.200	.040
Vaccine literacy ¹ Vaccine hesitancy ²	-.188	6.244	-2.499	.013	.126	.016
Vaccine literacy ¹ Vaccine repugnance ²	-.239	7.123	-2.669	.008	.134	.018
Vaccine literacy ¹ Legitimizing of vaccine hesitancy ²	-.340	16.217	-4.027	.000	.201	.040
Functional skill ¹ Vaccine repugnance ²	-.126	5.002	-2.236	.026	.113	.013
Communication/Critical skill ¹ Vaccine hesitancy ²	-.141	5.154	-2.270	.024	.115	.013
Communication/Critical skill ¹ Legitimizing of vaccine hesitancy ²	.268	14.865	-3.855	.000	.192	.037

1 : Independent variable;

2: Dependent variable

4. DISCUSSION

This study was conducted to examine the relationships between e-health literacy, vaccine literacy, and vaccine hesitancy among university students. The study focused on this young and educated population to evaluate vaccination attitudes and explore the potential role of health and vaccine literacy in vaccine hesitancy. The importance of vaccination in protecting public health has been demonstrated by extensive scientific evidence. However, the increasing prevalence of vaccine hesitancy in recent decades, despite its existence since the early history of vaccination, has become a significant public health concern. The COVID-19 pandemic has further highlighted that infectious diseases continue to pose substantial threats to public health. Therefore, developing effective strategies to address vaccine hesitancy is of critical importance.

Although vaccines may have some risks, previous studies have indicated that perceiving these risks as greater than their benefits, together with the spread of misinformation online, are among the major factors contributing to vaccine hesitancy (MacDonald et al., 2015; McClure et al., 2017; Omer et al., 2009; Salmon et al., 2015). In the current digital era, where internet use is widespread, e-health literacy and vaccine literacy play important roles in individuals' ability to distinguish accurate from inaccurate vaccine-related information (Suarez-Lledo & Alvarez-Galvez, 2021). However, studies investigating the roles of e-health literacy and vaccine literacy in vaccine hesitancy across different populations remain limited. Therefore, assessing these factors among young adults in a specific region of Türkiye may provide valuable insights for developing effective strategies to address vaccine hesitancy.

We found that e-health literacy was positively associated with vaccine literacy and both of its sub-dimensions (functional skills and communication/critical skills). This finding is consistent with previous literature suggesting that vaccine literacy represents a specific domain of health literacy and

is closely related to individuals' ability to access, understand, evaluate, and use vaccine-related information (Badua et al., 2022; Biasio, 2019; Gusar et al., 2021; Ratzan, 2011). Vaccine literacy includes not only access to information about vaccine effectiveness but also the skills required to interpret and apply this information in decision-making processes (Michel & Goldberg, 2020). Limited access to and inadequate evaluation of health-related information may hinder informed decision-making regarding vaccination (F. Zhang et al., 2020). Krishnamoorthy et al. (2019) reported that rumours disseminated through social media were among the major contributors to vaccine hesitancy. Similarly, Dib et al. (2022) found that misinformation spreads faster than accurate information on the internet. Since the widespread use of digital platforms facilitates the rapid dissemination of vaccine-related concerns and claims regarding adverse effects worldwide (Gust et al., 2004; Salmon et al., 2015), improving e-health literacy and vaccine literacy may help individuals critically evaluate vaccine-related information and mitigate the impact of misinformation.

We found that e-health literacy was positively associated with the benefit and protective value of vaccines, which is a sub-dimension of the vaccine hesitancy scale. This sub-dimension reflects positive perceptions regarding the importance of vaccines for individual and public health, as well as trust in the healthcare system. Previous studies have shown that misinformation, particularly that disseminated through digital platforms, plays an important role in shaping vaccine-related attitudes. Krishnamoorthy et al. (2019) reported that rumours spread through social media were among the major reasons for vaccine hesitancy among parents and healthcare workers, while Troiano and Nardi (2021) emphasized the influence of misinformation on vaccine-related decision-making. Similarly, Aharony and Goldman (2017) found that individuals who refused vaccination had the lowest levels of perceived e-health literacy. They suggested that individuals who obtain vaccine-related information from the internet may not always access reliable information and that search engines may encourage superficial information-seeking behaviours rather than systematic and comprehensive evaluation of available information, potentially causing individuals to overlook critical issues.

The findings of a study conducted among parents in Türkiye (Aslan et al., 2023) are consistent with our results, indicating that higher levels of e-health literacy may be associated with more positive vaccine-related perceptions. However, contrary to our findings, Ceylan et al. (2022) reported that increased parental e-health literacy was associated with decreased trust in vaccines. These inconsistent findings suggest that the relationship between e-health literacy and vaccine-related attitudes may vary depending on contextual factors, including the reliability of online health information, individuals' information evaluation skills, and sociocultural characteristics.

Another important finding of this study is that vaccine literacy was negatively associated with vaccine hesitancy and its sub-dimensions, namely vaccine repugnance and legitimization of vaccine hesitancy. The vaccine repugnance sub-dimension reflects concerns regarding the commercialization of vaccines and the emphasis placed on their potential side effects. The legitimization of vaccine hesitancy sub-dimension represents the belief that infectious diseases are no longer a significant threat and that vaccination is unnecessary because others in the community have already been vaccinated. These concerns are among the most frequently discussed factors contributing to vaccine hesitancy in the literature. Therefore, the findings of this study suggest that improving vaccine literacy may help address some of the major concerns underlying vaccine hesitancy. Similarly, Zhang et al. (2023) stated that vaccine literacy may contribute to immunization efforts by helping individuals understand the value of vaccines and strengthening trust in vaccination (Zhang et al., 2023). Other researchers have also emphasized that vaccine literacy may serve as an important tool in addressing vaccine hesitancy (Badua et al., 2022; Biasio, 2019; Ratzan, 2011; Wang et al., 2018).

This study has several limitations. First, the study was conducted only among undergraduate students enrolled in public universities in İzmir, Türkiye. Second, the data are based on self-reported information; therefore, reporting bias may have influenced the results. Third, the study has a cross-sectional design, which limits the ability to infer causality and implies that the findings may change over time. Fourth, convenience sampling was used in this study; therefore, the findings may not be fully generalizable to all populations. Finally, although the results of the regression analysis showed that the effect of vaccine literacy on reducing vaccine hesitancy was statistically significant, it was found to be small (R^2 : 0.016–0.040). We believe it would be beneficial to investigate these findings in similar populations.

5. CONCLUSION

The main finding of this study suggests that e-health literacy is associated with higher levels of vaccine literacy, and both are associated with lower levels of vaccine hesitancy. However, the effect of e-health literacy on vaccine hesitancy appears to be relatively limited, with vaccine literacy showing a stronger association. Based on these findings, efforts to enhance vaccine literacy may be particularly important in reducing vaccine hesitancy, which remains a significant public health concern. Considering the rapid spread of anti-vaccination content in online environments, public health authorities should consider promoting accessible, reliable, and engaging vaccine-related information. In addition, further research examining the factors influencing vaccine hesitancy is needed to better inform effective intervention strategies.

ACKNOWLEDGEMENT

This study was supported by the Scientific and Technological Research Council of Türkiye (TÜBİTAK) under the 2209-A 2023 1st term program.

Ethical considerations: Ethics committee approval for the study was obtained from the XXX University Non-Interventional Clinical Research Ethics Committee (dated 25.10.2023, decision number: 1267). In addition, written informed consent was obtained from all participants who voluntarily agreed to participate in the study.

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