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The mediating effect of E-health literacy on health belief model-based vaccine attitudes among parents in Türkiye: a cross-sectional study

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Abstract

Background Vaccination constitutes one of the most efficacious public health interventions, preventing millions of fatalities annually. Nevertheless, vaccine hesitancy persists as a significant challenge, particularly among parents. The dissemination of misinformation via the internet, notably through social media platforms, has contributed to the escalation of vaccine hesitancy. E-health literacy, defined as the capacity to locate and utilize online health information, possesses the potential to influence vaccine attitudes. This study aimed to investigate the relationships among education level, e-health literacy and childhood vaccination attitude among parents.

Methods The cross-sectional study design was used. This study was guided by STROBE. Convenience sampling recruited 699 parents in Türkiye with an online survey. The data tools used in the study were the parental information form, Public Attitudes Towards Vaccination - Health Belief Model Scale (PAV-HBM) and E-health Literacy Scale. The collected data were analyzed using SPSS version 25.0, and the PROCESS macro in SPSS was employed to estimate path coefficients and assess the adequacy of the model. The mediating effects of e-health literacy on the pathway in which education level of the parents affects childhood vaccination were verified using model 4 of the SPSS PROCESS macro proposed by Hayes.

Results The E-Health literacy had significantly mediate the relationship between educational level and the PAVS-HBM sub-dimensions of perceived susceptibility (B = 0.044, 95% CI= [0.023–0.071]), severity (B = 0.045, 95% CI= [0.023–0.070]), benefits (B = 0.054, 95% CI= [0.029–0.086]), and health motivation (B = 0.045, 95% CI= [0.023–0.071]). However, e-health literacy did not mediate the relationship between education level and perceived barriers (B = − 0.013, 95% CI= [− 0.049- −0.023]).

Conclusion The results revealed that education level among parents affect all vaccine attitudes without perceived barriers and the level of e-health literacy mediates this relationship. Therefore, health communication strategies, such as the development of e-health literacy by health authorities and the provision of reliable information

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about vaccination on digital platforms, including social media, may have potential benefits in promoting positive vaccination attitudes in the community.

Clinical trial number Not applicable.

Keywords Parental vaccine attitude, E-health literacy, Health belief model, Childhood vaccination, Mediating effect

Background

Vaccination plays a crucial role in public health by preventing the spread of infectious diseases and safeguarding individual and community health. Vaccines have significantly reduced the morbidity and mortality associated with vaccine-preventable diseases, contributing to increased life expectancy and quality of life worldwide [1]. The World Health Organization (WHO) estimates that vaccines prevent 3.5–5 million deaths annually, making them one of the most effective public health interventions [1] However, their efficacy depends on the number of individuals vaccinated [2], and factors such as vaccine hesitancy can impact their effectiveness at the population level [3]. Furthermore, vaccine hesitancy has been reported as a substantial barrier to achieving vaccine coverage and was recognized as one of the top ten threats to global health in 2019 [4]. Despite their demonstrated efficacy, parental vaccine hesitancy remains a significant barrier to optimal vaccination coverage.

Attitudes towards vaccination are a significant determinant of vaccination behavior, including parents' attitudes towards the vaccination of their children. Negative attitudes have been associated with vaccine hesitancy and outbreaks of infectious diseases globally. These attitudes can be influenced by various factors, including personal experiences, cultural beliefs, and exposure to misinformation [5]. The Health Belief Model (HBM) provides a theoretical framework for understanding vaccine hesitancy in parents. This model considers multiple factors that influence health-related behaviors, including vaccination decisions [6]. According to Huynh et al. (2022), within the HBM structure, perceived barriers are positively correlated with parents' hesitancy to vaccinate their children [7]. These barriers may include concerns regarding vaccine safety, side effects, or the necessity of certain vaccines. Conversely, perceived susceptibility and severity of illness, benefits of vaccination, and cues for action were associated with a lower likelihood of vaccine refusal. This suggests that parents who understand the risks of vaccine-preventable diseases and the protective benefits of vaccination are more likely to vaccinate their children. Zhang et al. (2023) also demonstrated that parents with higher health literacy perceived fewer barriers to vaccination decisions for their children and were consequently less hesitant to vaccinate their children [8].

While addressing perceived barriers and underscoring vaccination benefits effectively reduce vaccine hesitancy, incorporating e-health literacy, especially in today's digital age, introduces additional complexity. E-health literacy refers to an individual's ability to search, understand, and use health information from digital sources [9]. Given the increasing reliance on digital platforms for health information, it is imperative to explore how e-health literacy specifically influences decision-making in the context of vaccination. This exploration is particularly necessary in the face of rising vaccine-related misinformation online. The presence of anti-vaccine content on social media platforms has the potential to heighten parents' concerns regarding childhood vaccinations [10]. To elucidate, the rapid dissemination of both accurate and misleading health information online requires parents to not only access and understand this information but also critically evaluate its credibility. The Internet has been shown to play a substantial role in shaping parents' perceptions of the risks associated with vaccines. Research indicates that higher e-health literacy does not always foster more positive attitudes towards vaccination; it can sometimes even increase skepticism [11, 12]. Parents who have higher health literacy, which includes e-health literacy, often exhibit nuanced and sometimes skeptical attitudes towards vaccination. Contrary to expectations, Aharony et al. (2016) found that parents with high functional, communicative, and critical health literacy were at a higher risk of not vaccinating their children [12]. This finding suggests that increased access to and ability to process health information online do not necessarily result in pro-vaccination attitudes among parents.

Furthermore, understanding the interaction between education and e-health literacy is crucial for effectively addressing vaccine hesitancy. Friis et al. (2016) suggested that health literacy mediates the association between educational attainment and health behaviors, accounting for 13–20% of the variance in different health-related outcomes [13]. Although this study did not specifically focus on vaccination, it provides evidence of the mediating role of health literacy in health behaviors. Therefore, it is reasonable to infer that similar mediation could exist in the context of vaccination decisions, wherein e-health literacy influences how educational attainment translates into vaccination behaviors. Notably, the relationship between health literacy and vaccination remains unclear and has conflicting findings. Lorini et al. (2017) noted that the role of health literacy in predicting vaccine hesitancy or

acceptance appears to be influenced by factors such as country, age, and vaccine type [14]. For instance, cultural perceptions of healthcare, the prevalent trust in medical institutions, and the specific diseases targeted by vaccines can significantly alter the impact of health literacy on vaccination decisions. Similarly, Zhang et al. (2023) concluded that although vaccine literacy plays a role in determining vaccine hesitancy across various populations, the nature of this association remains unclear [8]. In summary, although there is evidence suggesting that health literacy mediates the relationship between education and vaccination hesitancy, the specific mediation effect of e-health literacy on the relationship between education and vaccination attitudes has not been directly addressed. Further research, particularly longitudinal studies using multiple measurement tools, is needed to better understand the causal relationships between e-health literacy, education level and vaccination attitudes [8, 12]. Additionally, future studies should disaggregate types of e-health literacy and explore how each uniquely contributes to shaping vaccination attitudes, as the current understanding predominantly treats e-health literacy as a monolithic construct. Consequently, in the digital era, where misinformation can propagate rapidly online, understanding the impact of e-health literacy on vaccine attitudes is essential for developing effective interventions to combat misinformation.

Türkiye presents a unique context for this study because of its high Internet penetration rate and diverse sociocultural landscape, which influence both access to and interpretation of digital health information. Therefore, the objectives of this study were (1) to examine the status of attitudes towards childhood vaccination and (2) to investigate the role of e-health literacy as a mediator in the relationship between education and attitudes towards childhood vaccination among parents in Türkiye.

Methods

Study design and participants

A cross-sectional design was employed in the study. The STROBE checklist for cross-sectional studies was utilized in reporting this research. The data were collected using a questionnaire accessible via an internet link with the free software Google Forms® between August and October 2024. The online survey was distributed using a snowball technique.

In Türkiye, the national vaccination program continues until the age of 14. Therefore, this study was conducted among Turkish parents with children aged 0–14 years. The inclusion criteria were as follows: (a) having a child between the ages of 0–14 years, (b) willing to participate in the study. The exclusion criteria were as follows: (a) having a mental problem, (b) being illiterate.

Questionnaires

Three questionnaires were used in this study, namely the parental information form, e-health literacy scale and public attitudes towards vaccination - health belief model scale were used to collect data for the study.

The parental information form It includes information such as parents' age, gender, marital status, education level, employment status, socio-economic status, number of children, children's age and childhood vaccination status. This form was developed by researchers through a literature review [14].

E-Health literacy scale It was developed by Norman and Skinner in 2006 [15]. The validity and reliability study in Türkiye was conducted by Tamer Gencer in 2017 [16]. The scale was developed to determine traditional literacy, health literacy, information retrieval, scientific research, media literacy and computer literacy. The scale consists of 2 items related to internet use, which are not included in the total score, and 8 items measuring internet attitudes. Scale items; It was arranged as "1 = strongly disagree, 2 = disagree, 3 = undecided, 4 = agree, 5 = strongly agree" using a 5-point Likert type scaling method [18]. The lowest score that can be obtained from the scale is 8 and the highest score is 40. An increase in the score obtained from the scale indicates that the e-health literacy level also increases [18]. The Cronbach (α) value of the original scale is 0.88 [15]. In Tamer Gencer's study, Cronbach's α value of the e-health literacy scale was determined to be 0.91. The Cronbach's α value was 0.85 in the present study [16].

Public attitudes towards vaccination Scale - Health belief model (PAVS-HBM) It was developed in Turkish by Koçoğlu-Tanyer et al. 2020 [17]. The scale, which was developed to assess public attitudes towards vaccination according to the Health Belief Model, consists of 5 subdimensions and 26 items and is a 5-point Likert type. Each sub-dimension is assessed independently. The susceptibility and severity sub-dimensions contain four items, with possible scores ranging from 4 to 20 points. The benefit and health motivation sub-dimensions include five items, allowing for scores between 5 and 25 points. Meanwhile, the barrier sub-dimension consists of eight items, with scores varying from 8 to 40 points. A lower score on the barrier sub-dimension reflects a more positive attitude, whereas higher scores on the other sub-dimensions indicate a more positive attitude toward the vaccination. The Cronbach alpha of the original scale was 0.90 for perceived susceptibility, 0.89 for perceived severity, 0.86 for perceived benefit, 0.87 for perceived barrier, and 0.85 for health motivation in the sub-dimensions [19]. The Cronbach's α values were 0.91 for perceived susceptibility, 0.94

perceived severity, 0.94 for perceived benefits, 0.90 for perceived barriers, and 0.80 for health motivation in the present study.

Sample size

In this study, online survey methods were employed as data collection instruments. The Turkish Statistical Institute reported that the population of children aged 0–14 years in Türkiye in 2023 is approximately 18,000,000 [18]. Assuming two parents per child, the estimated number of parents is approximately 36 million. Utilizing a 99% confidence level, 5% margin of error, and 50% sampling rate, a minimum sample size of 664 was calculated using the Raosoft sample size calculator [19]. A total of 699 participants from diverse regions of Türkiye were recruited using the convenience sampling method. The data collection period spanned from August 1 to October 30, 2024.

Ethical consideration

Ethics committee approval was obtained from an university Non-Interventional Clinical Research Ethics Committee on June 11th, 2024 (number: KOU GOKAEK 2024/271). Written permissions were obtained from the owner of the scales planned to be used in the study. All stages of the research, the Declaration of Helsinki was followed. All participants were thoroughly informed about the study's purpose and their rights in the online survey form. Participation was entirely voluntary, and participants were informed of their right to withdraw from the study at any time without consequence.

Data analysis

Data analysis was performed using IBM® SPSS 25.0 (IBM Corporation, Armonk, NY, USA). The normality of the data was tested by examining the distribution of the variables by calculating the values of skewness (range −2 to +2) and kurtosis (range −7 to +7) (i.e. skewness = 2 and kurtosis = 7 is considered a violation of normality) [20, 21]. Based on this criterion, the variables in this study were found to be sufficiently normally distributed. The continuous data were described by the mean and standard deviation (SD). Categorical variables were described using frequency and percentage. The variables in our study are education (years), e-health literacy and PAVS-HBM sub-dimensions, and all variables are continuous. Pearson correlation analysis was applied to examine whether there was a correlation between the education (years), e-health literacy and PAVS-HBM sub-dimensions. Independent samples t tests and one-way analysis of variance (ANOVA) were used to evaluate the associations between PAVS-HBM and categorical variables in the sociodemographic characteristics. Finally, we used PROCESS V.4.1 Macro in SPSS (Model 4) to test the mediation model. Model 4 was used to investigate mediation effects due to its ability to assess whether the relationship between independent and dependent variables is mediated by a single mediating variable. This method provides the estimation of direct, indirect, and total effects. The direct and indirect effects of the education on PAVS-HBM sub-dimensions were examined using bootstrap analyses with 5000 bootstrap samples [22]. A p value of < 0.05 was considered significant.

Results

The 732 parents were included in this study. Of the 732 questionnaires, 33 had the same choice on all questions. Therefore, valid 699 questionnaires were recovered, and the ultimate effective response rate was 95.5%. Table 1 shows the sociodemographic, vaccination-related characteristics and vaccination attitude of the study participants. The 699 participants had a mean age of 36.13 years (SD = 5.97), with the majority being female (86.7%, $n = 606$), married (95.0%, $n = 664$), holding a bachelor's degree (48.2%, $n = 337$), employed (53.8%, $n = 376$), having a moderate income status (56.8%, $n = 397$), having two children (43.9%, $n = 307$) and having all their children's childhood vaccinations up to this time (90.7%, $n = 634$). In this study, statistically significant differences were found between the PAVS-HBM sub-dimensions and the parents' education level, employment status, number of children they had, and completion of their children's vaccinations. However, while there was a statistically significant difference between the income status of the parents and the perceived susceptibility, perceived severity and perceived benefits sub-dimensions of PAVS-HBM, there was no statistically significant difference in the perceived barriers and health motivation sub-dimensions (Table 1).

The total score of the PAVS-HBM scale is not calculable; therefore, the mean scores for the sub-dimensions of the scale are presented in Table 2. The perceived susceptibility score was 16.32 ± 3.26, the perceived severity score was 15.92 ± 3.59, the perceived benefits score was 19.68 ± 4.22, the perceived barriers score was 18.91 ± 6.79, and the health motivation score was 20.22 ± 3.37. The mean score of e-health literacy was 29.68 ± 5.45 (Table 2).

The results of the analysis of the relationships between the main variables of education, e-health literacy and PAVS-HBM sub-dimensions are presented in Table 3. A significant positive correlation was found between education and e-health literacy ($r = 0.22$, $p < 0.001$). There was a significant statistical relationship between PAVS-HBM sub-dimensions with e-health literacy. The highest correlation was between e-health literacy and perceived susceptibility. A statistically significant positive correlation was found between e-health literacy and perceived susceptibility ($r = 0.23$, $p < 0.001$). E-health literacy and perceived barriers had the lowest correlation. A statistically significant negative correlation was found between

Table 1 Mean PAVS-HBM sub-dimensions scores according to participants' characteristics

Variable	*n* (%)	PAVS-HBM Sub-dimensions									
		Perceived Susceptibility		Perceived Severity		Perceived Benefits		Perceived Barriers		Health Motivation	
		Mean ± SD	t/F (*P*)	Mean ± SD	t/F (*P*)	Mean ± SD	t/F (*P*)	Mean ± SD	t/F (*P*)	Mean ± SD	t/F (*P*)
Age	**Mean ± SD** 36.13 ± 5.97										
< 25	14 (2)	17.29 ± 2.43	F = 0.473	17.07 ± 2.40	F = 0.687	21.14 ± 2.77	F = 0.817	23.43 ± 7.63	F = 3.479	21.57 ± 2.90	F = 1.269
25–34	273 (39)	16.32 ± 3.41	(0.701)	15.92 ± 3.66	(0560)	19.66 ± 4.40	(0.485)	19.43 ± 7.36	(0.016)	20.37 ± 3.51	(0.284)
35–44	359 (51.4)	16.25 ± 3.23		15.84 ± 3.65		19.58 ± 4.22		18.47 ± 6.39		20.05 ± 3.32	
≥ 45	53 (7.6)	16.42 ± 3.26		16.24 ± 3.04		20.11 ± 3.51		17.96 ± 5.53		20.22 ± 3.37	
Gender											
Male	93 (86.7)	16.68 ± 2.74	t=-1.158	15.93 ± 3.33	t=-0.033	20.04 ± 3.81	t=-0.889	18.91 ± 6.27	t=-0.007	20.41 ± 3.08	t=-0.583
Female	606 (13.3)	16.26 ± 3.33	(0.247)	15.92 ± 3.63	(0.974)	19.63 ± 4.28	(0.375)	18.91 ± 6.87	(0.995)	20.19 ± 3.41	(0.560)
Marital status											
Married	664 (95)	16.32 ± 3.20	t=-0.477	15.93 ± 3.55	t = 0.307	19.67 ± 4.15	t=-0.171	18.90 ± 6.73	t=-0.106	20.22 ± 3.34	t=-0.017
Single	35 (5)	16.06 ± 4.20	(0.634)	15.74 ± 4.35	(0.759)	19.80 ± 5.46	(0.864)	19.03 ± 7.96	(0.915)	20.23 ± 3.87	(0.986)
Education level											
Middle school-8 years	144 (20.6)	15.65 ± 3.41	F = 4.460	15.06 ± 3.68	F = 7.973	18.93 ± 4.16	F = 6.525	20.96 ± 6.59	F = 14.71	19.56 ± 3.54	F = 4.774
High school-12 years	117 (16.7)	16.03 ± 3.26	**(0.004)**	15.18 ± 3.37	**(0.000)**	18.78 ± 4.02	**(0.000)**	20.86 ± 6.53	**(0.000)**	19.70 ± 3.01	**(0.003)**
Bachelors-16years	337 (48.2)	16.56 ± 3.21		16.28 ± 3.61		19.95 ± 4.31		18.14 ± 6.75		20.49 ± 3.35	
Post-graduate-18 years	101 (14.5)	17.09 ± 3.26		16.82 ± 3.23		20.88 ± 3.87		16.33 ± 6.14		20.84 ± 3.38	
Working status											
Yes	376 (53.8)	16.75 ± 3.19	t = 3.885	16.52 ± 3.57	t = 4.824	20.39 ± 4.26	t = 4.875	17.72 ± 6.95	t=-5.084	20.73 ± 3.34	t = 4.423
No	323 (46.2)	15.80 ± 3.27	**(0.000)**	15.23 ± 3.49	**(0.000)**	18.85 ± 4.02	**(0.000)**	20.30 ± 6.33	**(0.000)**	19.62 ± 3.30	**(0.000)**
Income status											
Low income	91 (91)	15.43 ± 3.91	F = 5.063	15.03 ± 3.92	F = 4.864	18.67 ± 4.69	F = 4.524	19.72 ± 6.43	F = 1.476	19.73 ± 3.71	F = 2.905
Moderate income	397 (56.8)	16.30 ± 3.00	**(0.007)**	15.87 ± 3.40	**(0.008)**	19.62 ± 4.00	**(0.011)**	19.03 ± 6.43	(0.229)	20.11 ± 3.16	(0.055)
High income	211 (30.2)	16.72 ± 3.26		16.41 ± 3.70		20.24 ± 4.34		18.33 ± 7.54		20.64 ± 3.55	
Number of children											
1	283 (40.5)	16.86 ± 3.19	F = 6.312	16.61 ± 3.51	F = 7.065	20.39 ± 4.17	F = 5.450	17.95 ± 7.21	F = 7.920	20.90 ± 3.27	F = 7.340
2	307 (43.9)	16.16 ± 3.21	**(0.000)**	15.63 ± 3.63	**(0.000)**	19.40 ± 4.30	**(0.001)**	18.83 ± 6.48	**(0.000)**	19.89 ± 3.37	**(0.000)**
3	86 (12.3)	15.26 ± 3.49		14.83 ± 3.55		18.53 ± 4.03		21.70 ± 5.99		19.33 ± 3.36	
≥ 4	23 (3.3)	15.65 ± 2.60		15.92 ± 2.52		19.09 ± 2.89		21.30 ± 5.00		19.61 ± 3.20	
Have you had your child's childhood vaccinations up to this age?											
All vaccinations	634 (90.7)	16.70 ± 2.76	F = 56.565	16.33 ± 3.11	F = 49.977	20.15 ± 3.63	F = 50.076	18.30 ± 6.55	F = 31.394	20.60 ± 2.95	F = 51.612
Some vaccinations	54 (7.7)	12.67 ± 4.62	**(0.000)**	12.20 ± 4.85	**(0.000)**	15.57 ± 5.98	**(0.000)**	24.26 ± 6.03	**(0.000)**	16.89 ± 4.37	**(0.000)**
Any vaccinations	11 (1.6)	11.82 ± 6.35		10.91 ± 7.05		12.50 ± 8.30		28.00 ± 6.57		14.73 ± 6.20	

PAVS-HBM: Public Attitude Towards Vaccination Scale– Health Belief Model; SD: Standard Deviation

Table 2 The scores of EHL, and PAVS-HBM among parents

Scales	Number of items	Mean	SD
PAVS-HBM			
Perceived Susceptibility	4	16.32	3.26
Perceived Severity	4	15.92	3.59
Perceived Benefits	5	19.68	4.22
Perceived Barriers	8	18.91	6.79
Health Motivation	5	20.22	3.37
E-Health Literacy	8	29.68	5.45

PAVS-HBM: Public Attitude Towards Vaccination Scale– Health Belief Model; SD: Standard Deviation

e-health literacy and perceived barriers ($r = -0.079$, $p < 0.001$) (Table 3).

Tables 4 and 5 show the mediating effect of e-health literacy on the education and PAVS-HBM sub-dimensions. The complete model results are shown in Fig. 1. The education had a significant direct effect on perceived susceptibility (Y1) (B = 0.077, $p < 0.05$), with higher education level associated with higher perceived susceptibility score. The indirect effect of education on perceived susceptibility, via the mediating effect of e-health literacy, was found to be statistically significant (B = 0.044, $p < 0.001$), indicating that education influenced e-health literacy (B = 0.344, $p < 0.001$), which in turn affected perceived susceptibility (B = 0.129, $p < 0.001$). Generally, the total effect of education on perceived susceptibility was significant (B = 0.122, $p < 0.01$).

The education had a significant direct effect on perceived severity (Y2) (B = 0.133, $p < 0.01$), with higher education level associated with higher perceived severity score. The indirect effect of education on perceived severity, via the mediating effect of e-health literacy, was found to be statistically significant (B = 0.045, $p < 0.001$), indicating that education influenced e-health literacy (B = 0.344, $p < 0.001$), which in turn affected perceived severity (B = 0.131, $p < 0.001$). Generally, the total effect of education on perceived severity was significant (B = 0.178, $p < 0.001$).

The education had a significant direct effect on perceived benefits (Y3) (B = 0.122, $p < 0.01$), with higher education level associated with higher perceived benefits score. The indirect effect of education on perceived benefits, via the mediating effect of e-health literacy, was found to be statistically significant (B = 0.054, $p < 0.001$), indicating that education influenced e-health literacy (B = 0.344, $p < 0.001$), which in turn affected perceived benefits (B = 0.130, $p < 0.001$). Generally, the total effect of education on perceived benefits was significant (B = 0.176, $p < 0.001$).

The education had a significant direct effect on perceived barriers (Y4) (B = -0.429, $p < 0.001$), with higher education level associated with lower perceived barriers score. The indirect effect of education on perceived barriers, via the mediating effect of e-health literacy, was not found to be statistically significant (B = -0.013, $p > 0.05$), indicating that education influenced e-health literacy (B = 0.344, $p < 0.001$), which in turn affected perceived barriers (B = -0.037, $p > 0.05$). Generally, the total effect of education on perceived barriers was significant (B = -0.446, $p < 0.001$).

Table 3 The correlations among education (year), e-health literacy, and PAVS-HBM subscales

Variables	**Education**	**E-Health literacy**	**Perceived Susceptibility**
Education	1		
E-Health literacy	0.222**	1	
Perceived Susceptibility	0.131**	0.234**	1
Variables	**Education**	**E-Health literacy**	**Perceived Severity**
Education	1		
E-Health literacy	0.222**	1	
Perceived Severity	0.174**	0.227**	1
Variables	**Education**	**E-Health literacy**	**Perceived Benefits**
Education	1		
E-Health literacy	0.222**	1	
Perceived Benefits	0.146**	0.227**	1
Variables	**Education**	**E-Health literacy**	**Perceived Barriers**
Education	1		
E-Health literacy	0.222**	1	
Perceived Barriers	-0.228**	-0.079**	1
Variables	**Education**	**E-Health literacy**	**Health Motivation**
Education	1		
E-Health literacy	0.222**	1	
Health Motivation	0.137**	0.231**	1

**<0.01

Table 4 The mediating effect of e-health literacy on the education(year) and PAVS-HBM subscales ($n = 699$)

Variables	Perceived Susceptibility (Y1)				95% CI	
	B	SE	t	*p*	LLCI	ULCI
Constant	11.400	0.745	15.305	0.000	9.938	12.863
Education (X)	0.077	0.035	2.213	0.027	0.009	0.146
E-Health literacy (M)	0.129	0.023	5.732	0.000	0.085	0.173
R2	0.062					
F	22.812					
p	0.000					
Variables	Perceived Severity (Y2)				95% CI	
	B	SE	t	p	LLCI	ULCI
Constant	10.189	0.817	12.468	0.000	8.584	11.793
Education (X)	0.133	0.038	3.464	0.001	0.057	0.208
E-Health literacy (M)	0.131	0.025	5.291	0.000	0.082	0.179
R2	0.068					
F	25.300					
p	0.000					
Variables	Perceived Benefits (Y3)				95% CI	
	B	SE	t	p	LLCI	ULCI
Constant	13.234	0.971	13.627	0.000	11.327	15.140
Education (X)	0.122	0.045	2.693	0.007	0.033	0.211
E-Health literacy (M)	0.160	0.029	5.442	0.000	0.102	0.217
R2	0.062					
F	22.720					
p	0.000					
Variables	Perceived Barriers (Y4)				95% CI	
	B	SE	t	p	LLCI	ULCI
Constant	25.992	1.561	16.650	0.000	22.927	29.957
Education (X)	-0.429	0.073	-5.835	0.000	-0.573	-0.283
E-Health literacy (M)	-0.037	0.047	-0.775	0.439	-0.129	0.056
R2	0.053					
F	19.312					
p	0.000					
Variables	Health Motivation (Y5)				95% CI	
	B	SE	t	p	LLCI	ULCI
Constant	15.136	0.770	19.665	0.000	13.625	16.647
Education (X)	0.087	0.036	2.400	0.017	0.016	0.157
E-Health literacy (M)	0.131	0.023	5.606	0.000	0.085	0.176
R2	0.061					
F	22.688					
p	0.000					

PAVS-HBM: Public Attitude Towards Vaccination Scale– Health Belief Model; SE: Standard error; CI: Confidence Interval; LLCI: Lower Limit of 95% Confidence Interval; ULCI: Upper Limit of 95% Confidence Interval

The education had a significant direct effect on health motivation (Y5) (B = 0.087, $p < 0.05$), with higher education level associated with higher health motivation score. The indirect effect of education on health motivation, via the mediating effect of e-health literacy, was found to be statistically significant (B = 0.045, $p < 0.001$), indicating that education influenced e-health literacy (B = 0.344, $p < 0.001$), which in turn affected health motivation (B = 0.131, $p < 0.001$). Generally, the total effect of education on health motivation was significant (B = 0.131, $p < 0.001$).

Discussion

This study investigated the attitudes of parents in Türkiye towards childhood vaccinations and the role of e-health literacy as a mediator between educational level and these attitudes. According to the results of this study, significant relationships were found between parental education level, e-health literacy, and the PAVS-HBM sub-dimensions. Education level had a direct effect on health beliefs regarding childhood vaccination. In addition, e-health literacy was found to have a mediating role in the relationship between educational level and the

Table 5 Total, direct, and indirect effects of the education (year) on PAVS-HBM subscales through e-health literacy ($n=699$)

Path	Effect	SE	t	*p*	95% CI	
					LLCI	ULCI
Total effect Education→ Perceived susceptibility	0.122	0.035	3.494	0.001	0.053	0.190
Direct effect Education→ Perceived susceptibility	0.077	0.035	2.213	0.027	0.009	0.146
Indirect Effect Education→E-health literacy→Perceived susceptibility	0.044	0.012	-	-	0.023	0.071
Path	**Effect**	**SE**	**t**	**p**	**95% CI**	
					LLCI	**ULCI**
Total effect Education→ Perceived severity	0.178	0.038	4.665	0.000	0.103	0.252
Direct effect Education→ Perceived severity	0.133	0.038	3.464	0.001	0.057	0.208
Indirect Effect Education→E-health literacy→Perceived severity	0.045	0.012	-	-	0.023	0.070
Path	**Effect**	**SE**	**t**	**p**	**95% CI**	
					LLCI	**ULCI**
Total effect Education→ Perceived benefit	0.176	0.045	3.899	0.000	0.087	0.264
Direct effect Education→ Perceived benefit	0.122	0.045	2.693	0.007	0.033	0.208
Indirect Effect Education→E-health literacy→Perceived benefit	0.054	0.015	-	-	0.029	0.086
Path	**Effect**	**SE**	**t**	**p**	**95% CI**	
					LLCI	**ULCI**
Total effect Education→ Perceived barriers	-0.442	0.072	-6.168	0.000	-0.582	-0.301
Direct effect Education→ Perceived barriers	-0.429	0.073	-5.835	0.000	-0.573	-0.284
Indirect Effect Education→E-health literacy→Perceived barriers	-0.013	0.018	-	-	-0.049	-0.023
Path	**Effect**	**SE**	**t**	**p**	**95% CI**	
					LLCI	**ULCI**
Total effect Education→ Health motivation	0.131	0.036	3.656	0.000	0.061	0.202
Direct effect Education→ Health motivation	0.087	0.036	2.400	0.017	0.016	0.157
Indirect Effect Education→E-health literacy→Health motivation	0.045	0.012	-	-	0.023	0.071

PAVS-HBM: Public Attitude Towards Vaccination Scale– Health Belief Model; SE: Standard error; CI: Confidence Interval; LLCI: Lower Limit of 95% Confidence Interval; ULCI: Upper Limit of 95% Confidence Interval

sub-dimensions of perceived susceptibility, severity, benefits, and health motivation. However, e-health literacy did not mediate the relationship between education level and perceived barriers. The results of this study show that education level can positively influence individuals' attitudes towards vaccination through e-health literacy.

The childhood vaccination rate observed in our study, 90.7%, aligns with the high rates reported in Türkiye [23–25]. These results suggest that high childhood vaccination rates in Türkiye are likely the result of effective national vaccination programs and strong parental awareness. However, despite these high rates, the COVID-19 pandemic has influenced attitudes towards childhood vaccinations [26]. A study conducted in Türkiye revealed that 79.15% of participants sğtated that the pandemic negatively affected their views on childhood vaccination and 58.71% expressed vaccine hesitancy [27]. According to the World Health Organization (WHO) and UNICEF (2023), approximately 20.5 million children missed routine vaccination in 2022 [27, 28]. Although this number represents an improvement from 24.4 million in 2021, it still exceeds the 18.4 million recorded before the pandemic in 2019 [29]. With the pandemic, the behavior of seeking health information from the Internet increased [30]. In this context, it is believed that the development of e-health literacy policies can contribute to the

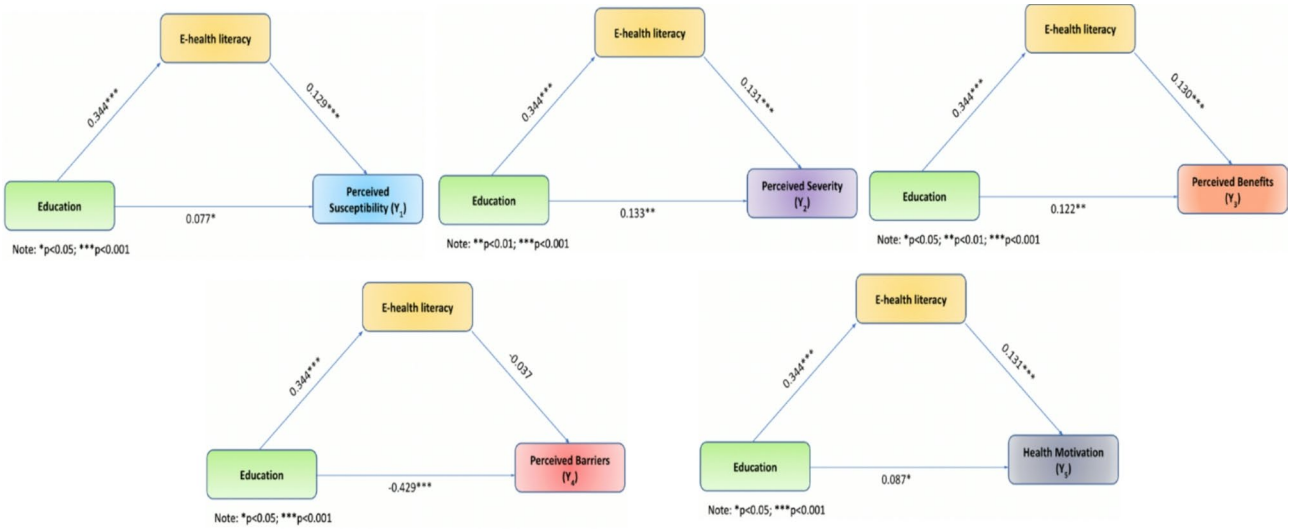

Fig. 1 The mediating role of e-health literacy in the relationship between the parents' length of education and vaccination attitudes

development of positive attitudes towards vaccination in the community and increase vaccination rates.

In this study, statistically significant differences were found between the PAVS-HBM sub-dimensions (perceived susceptibility, severity, benefits, barriers, and health motivation) and factors such as parents' education levels, the number of children, and their children's vaccination status. The findings suggest that individuals with lower education levels, a higher number of children, and no vaccinations administered to their children tend to have negative attitudes toward vaccination uptake. Similarly, Üzüm et al. (2019) reported that lower education levels and having multiple children negatively impacted vaccine awareness in Türkiye [31]. Hadjipanayis et al. (2020) also found that parents with higher education levels were less likely to be hesitant about vaccination [32]. According to the results of our study, higher levels of education decreased perceived barriers to vaccination and increased perceived susceptibility, severity, benefits, and health motivation. A systematic review examining parental hesitancy to vaccinate their children with the MMR vaccine found that mothers with higher levels of education were skeptical about vaccine safety and perceived the risk of disease to be low [32]. When Novilla et al. 's study is considered in the context of the Health Belief Model, it can be inferred that, in contrast to our study, the perceived susceptibility of highly educated mothers is low and the perceived barriers are high. Although the alleged link between the MMR vaccine and autism has been scientifically refuted, some parents continue to express concerns that the MMR vaccine causes this problem [34]. The reason why the results of this systematic review differ from our study may be due to the fact that this study focused only on the MMR vaccine and the misinformation about the MMR vaccine in the community [33].

Information and communication technologies have a dual impact on parents: they can increase knowledge and willingness to vaccinate, but they also have the potential to spread misinformation, which can escalate vaccine hesitancy. While these technologies can facilitate the vaccination process by providing accurate information, they may also contribute to the dissemination of misinformation, vaccine-related concerns, and escalation of vaccine hesitancy. Parents frequently seek information regarding perceived barriers, such as the potential side effects of vaccines, from the Internet [35]. The study revealed the mediating role of e-health literacy in the relationship between education and the PAVS-HBM sub-dimensions (perceived susceptibility, severity, benefits, and health motivation) and highlighted its potential to influence childhood vaccination attitudes. Similarly, Ustuner Top et al. (2023) found that vaccine hesitancy decreased as parents' digital health literacy increased [36]. However, in contrast to these findings, Aharony and Goldman (2017) emphasized that parents who refuse vaccination have higher levels of e-health literacy [12]. Ceylan et al. (2022) also reported that parents' confidence in vaccination decreased as their level of e-health literacy increased [11]. This suggests that although e-health literacy often promotes positive health behaviors, it can also lead to vaccine hesitancy. This paradox may arise from the selective exposure to misleading health information online. Social media may play a role in the spread of misinformation in the digital environment. Social media platforms may increase misinformation due to their algorithms that favour interaction over accuracy. In their study analyzing the impact of social media on vaccine hesitancy, Bar-Lev et al. (2020) found that more traffic on social

media resulted in fewer vaccinations for some childhood vaccines [37]. At the same time, it is thought that confirmation bias may play a role in the paradox of e-health literacy and vaccine attitudes. Nyhan et al. (2015) reported that individuals may be more skilled at finding information that confirms their pre-existing beliefs, whether pro- or anti-vaccine [38]. Zhang et al. (2023) investigated the effect of parental health literacy and health beliefs on hesitancy to vaccinate against COVID-19. The study found that parents with better health literacy perceived fewer barriers and experienced less hesitation when deciding to vaccinate their children against COVID-19. However, unlike the study by Zhang et al., our study did not find a mediating role for e-health literacy in the relationship between education and perceived barriers. This difference may be due to the different vaccine types and research models used in the studies [8].

Limitations

About 90% of the participants in the study had received all their vaccinations, which is a limitation of the study. Our sample was limited to a specific geographic region, and results may not be generalizable to other populations with different cultural or socio-economic backgrounds.

Conclusions

In this study, e-health literacy was found to have a partial mediating role in the relationship between education level and perceived susceptibility, severity, benefit and health motivation. However, e-health literacy did not have a mediating role in the relationship between education and perceived barriers. At the same time, education level directly affected health beliefs about childhood vaccines. In addition, attitudes towards childhood vaccines differed with demographic factors such as education level, number of children and vaccination status of children. It was determined that individuals with low education levels, high numbers of children and never vaccinated their children tended to develop negative attitudes towards vaccination. In conclusion, it was found that increasing e-health literacy can improve positive attitudes towards vaccination in the society. However, it should be taken into consideration that e-health literacy may also increase vaccine hesitancy through exposure to misinformation. This study showed that as the level of education and e-health literacy increases, parents may develop more positive attitudes towards vaccination. It is thought that the results of the study may contribute to the development of health communication strategies to increase e-health literacy by health authorities in order to promote positive vaccination attitudes in the community.

Future research should prioritize evaluating the effectiveness of e-health literacy interventions in promoting positive attitudes toward vaccination, particularly among demographic groups characterized by lower educational attainment and limited access to health care services. It should be noted, however, that e-health literacy may also increase vaccine hesitancy through exposure to misinformation. Therefore, longitudinal studies are essential to elucidate the causal relationships between e-health literacy, health beliefs, and vaccination behavior over time. In addition, qualitative research can provide deeper insights into individuals' processes of seeking online health information, identifying misinformation, and making vaccine-related decisions. These findings can inform the development of targeted health communication strategies aimed at increasing vaccine confidence and reducing misinformation among diverse populations.

Abbreviations

PAV-HBM	Public Attitudes Towards Vaccination - Health Belief Model Scale
WHO	World Health Organisation
sd	Standart Deviation
ANOVA	Analysis of variance

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Author contributions

GT, IA, FA designed the study, collected the data. GT analyzed the data. All authors interpreted and validated the data, contributed to writing and editing the original craft. All authors have approved the final version of the manuscript."Conceptualization G.T., I.A., and F.A; methodology, G.T., I.A., F.A and A.K.; formal analysis, G.T., A.K.; investigation, I.A., F.A.; resources, G.T., I.A., F.A. AND A.K; data curation, G.T., I.A., F.A. and A.K.; writing—original draft preparation, G.T., I.A., F.A. and A.K.; writing—review and editing, G.T., I.A., F.A. and A.K.; visualization, G.T and I.A.; supervision, G.T.; project administration, X.X.; All authors have read and agreed to the published version of the manuscript."

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

Ethics committee approval was obtained from Kocaeli University Non-Interventional Clinical Research Ethics Committee on June 11th, 2024 (number: KOU GOKAEK 2024/271). Written permissions were obtained from the owner of the scales planned to be used in the study. All stages of the research, the Declaration of Helsinki was followed. All participants were thoroughly informed about the study's purpose and their rights in the online survey form. Informed consent was obtained from all participants. Participation was entirely voluntary, and participants were informed of their right to withdraw from the study at any time without consequence.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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