Journal of Public Health (2025) 33:913–923
https://doi.org/10.1007/s10389-023-02089-8

ORIGINAL ARTICLE

The relationship between individuals' knowledge about human papilloma virus, beliefs, and vaccination status: analysis with data mining

Metin Yıldız[1] · Büşra Yolcu[1] · Nazlı Ünlü Bıdık[1] · Gönül Gökçay[2] · Aylin Şengan[1]

Received: 15 March 2023 / Accepted: 24 August 2023 / Published online: 5 September 2023

Abstract

Aim This study aimed to investigate the relationship between individuals' knowledge, beliefs, and vaccination status regarding human papillomavirus.

Subject and methods This study had a descriptive correlational design and was carried out with individuals in Turkey between November 2022 and February 2023. A total of 433 participants were involved in the study. A Descriptive Information Form, the Health Belief Model Scale (HBM) for Human Papilloma Virus and Vaccine, and the Human Papilloma Virus (HPV) Knowledge Scale were employed for data collection. SPSS 22.0, G*Power 3.1, and R programming language 4.1.3 programs were used to analyze the data.

Results In our study, it was found that increasing the HPV knowledge level of individuals ($t = 2.695$, $p = 0.007$) led to a statistical increase in "HPV HBM perceived susceptibility." It was found that increasing the HPV knowledge level of individuals ($t = 2.045$, $p = 0.041$) led to a statistical increase in "HPV HBM perceived severity." CART and RF methods are the most accurate methods for HPV HBM perceived susceptibility and HPV HBM perceived severity prediction, respectively. SHAP values (Shapley additive explanations) are the most significant variables that need to be included in the model to predict HPV HBM perceived susceptibility and HPV HBM perceived severity variables in the estimation of the model HPV knowledge variable.

Conclusion Increased knowledge about human papillomavirus was found to increase the susceptibility and severity of individuals regarding HPV. It is recommended that further studies be carried out on this topic, given that the extent and breadth of individuals' knowledge about HPV infection will have an effect on their HPV health beliefs.

Keywords Human papilloma virus · Health belief model · Knowledge

Introduction

Human papillomavirus (HPV) refers to a type of circular DNA virus that falls under the papillomavirus species within the papillomaviridae family. This non-enveloped virus has a double-stranded structure and is known for causing lesions in epithelial cells responsible for keratin synthesis (Sierra-Rojas et al. 2022). HPV infections are highly prevalent in the community, often with an asymptomatic course (Mihretie et al. 2022). HPVs cause cancer in multiple anatomical sites in men and women (Avcı and Bozdayı 2013; Senkomago et al. 2019). Mortality due to HPV-caused cancers is also higher in less developed countries (De Martel et al. 2017). HPV infection is an important health problem that threatens public health (Hershey and Velez 2009).

✉ Metin Yıldız
yildizz.metin@gmail.com

Büşra Yolcu
busrayolcu@sakarya.edu.tr

Nazlı Ünlü Bıdık
nazliunlu@sakarya.edu.tr

Gönül Gökçay
gonul.gokcay@ogr.sakarya.edu.tr

Aylin Şengan
aylin.sengan@ogr.sakarya.edu.tr

[1] Department of Midwifery, Sakarya University, Sakarya, Turkey

[2] Department of Nursing, Kafkas University, Kars, Turkey

The World Health Organization (WHO) considers HIV-associated conditions to be a global health issue and suggests including HPV vaccines in national vaccination initiatives (WHO 2016). According to the contemporary public health approach, it is very important to protect and improve the health of individuals before they become ill. In order to make health a social value and to solve health problems of individuals, individuals should be equipped with knowledge and skills and should be enabled to use health services effectively (Özvaris 2015). As an effective model that can be used at this point, the health belief model enables individuals to see the benefits of behavior change for situations that threaten their health and to decide whether to take action after this action (Abraham and Sheeran 2015). The health belief model, which has previously guided many studies in the field of health, has been used in subjects such as breast self-examination (BSE), diabetes, osteoporosis, mammography, and pap-smear (Hosseini et al. 2022). The HPV interpretation of the health belief model comprises subcomponents such as adaptability perception, seriousness perception, threat perception, benefit perception, and barrier perception. This multifaceted approach assesses various dimensions of HPV (Kim 2012). While awareness and knowledge of HPV has increased in the Western world, it has been found to be lower in other regions where the disease is more prevalent (Rogovskaya et al. 2013). Nevertheless, there are studies showing that knowledge about HPV-related cancers is increasing worldwide (Blasi et al. 2015).

Because there are at present few studies available on this topic, it is believed that the present study contributes to the literature. Its aim was to examine individuals' knowledge about HPV, health beliefs, and vaccination status.

Research questions

1. Does HPV knowledge level affect HPV HBM perceived benefit subdimension?
2. Does HPV knowledge level affect HPV HBM perceived susceptibility subdimension?
3. Does HPV knowledge level affect HPV HBM perceived severity subdimension?
4. Does HPV knowledge level affect HPV HBM perceived barriers subdimension?
5. Do demographic characteristics affect the level of HPV knowledge and beliefs about HPV?

Methods

Study design

Between November 2022 and February 2023, a descriptive and correlational study was carried out among individuals residing in Turkey. The reporting of this research article followed the STROBE guidelines (Vandenbroucke et al. 2007).

The study's population encompassed individuals from Turkey. In this research, a non-sampling approach was employed, aiming to encompass all individuals. Ultimately, 433 volunteers were incorporated into the study. Based on the results gathered from these 433 participants, a power analysis indicated that the study held a 99% power at a confidence level of 95% and a medium effect size (Cohen 1988).

Data collection

Data were collected with the form created by the researcher and scales related to HPV. The study's objective was elucidated at the outset of the form, and those who willingly consented to take part were requested to participate in the study subsequent to marking the consent checkbox.

Introductory Information Form

The researchers developed this form, which included questions about the participants' descriptive characteristics.

Health Belief Model Scale for Human Papilloma Virus and Vaccine

Kim developed the original version of this scale in 2012 (Kim 2012), and it was adapted into Turkish by Güvenç et al. in 2016 (Guvenc et al. 2016). It is a 14-item scale with 4 subdimensions, including a 4-item Perceived Violence subdimension, a 6-item Perceived Barriers subdimension, a 3-item Perceived Benefits subdimension, and a 2-item Perceived Sensitivity subdimension. Participants are asked to read each sentence carefully and determine how appropriate it is for them and to choose a score between 1 (never) and 4 (always). Güvenç et al. (Guvenc et al. 2016) found that the variance explanatory rate of the scale was 61.47% and the Cronbach alpha value was between 0.71 and 0.78 for the 4 subscales (Guvenc et al. 2016). The Cronbach's alpha value in the present study was determined between 0.74–0.84 for 4 subscales.

Human Papilloma Virus (HPV) Knowledge Scale

The Human Papilloma Virus (HPV) Knowledge Scale was developed by Waller and colleagues (Waller et al. 2013) in 2013 and adapted into Turkish by Demir in 2019 (Demir 2019). There is a 16-item General HPV knowledge subdimension and high scores reflect a high level of general HPV knowledge. There is a 6-item knowledge of the current HPV vaccination program subdimension, and high scores indicate high knowledge of the conditions related to the administration of the HPV vaccine. There is a 5-item General HPV

vaccine knowledge subdimension and high scores reflect a high level of general knowledge about the protection of the HPV vaccine. There is a 6-item HPV screening test knowledge subdimension and high scores indicate a high level of knowledge about HPV screening tests. This scale has 33 items and 4 subdimensions. The total score obtainable ranges from 33 to 165. According to Demir's calculations, the Cronbach's alpha value of the scale was 0.96 (Demir 2019). The Cronbach's alpha reliability coefficient in the present study was 0.86.

Data analysis

SPSS-22 statistical software was used to analyze the data. As part of the data analysis process, essential normality tests were conducted. These tests revealed that the data showed a normal distribution, which was demonstrated by the kurtosis and skewness values being in the range –1.5 to +1.5 (Tabachnick et al. 2007). A variety of statistical tests were used to assess the data. These included the independent samples t-test, one-way ANOVA (analysis of variance), Games Howell post hoc analysis, Pearson correlation, Bonferroni correction, and simple linear regression. A p value of <0.05 was accepted as statistically significant. For the estimation of variables, R programming language version 4.1.3 was used. Machine learning algorithms often produce better results on large data sets, and often their capabilities in complex, nonlinear models are superior to SEM or traditional linear regression methods. Machine learning does not use linear regression or the parametric formulation sequence that SEM assumes. This enables data to be captured and predicted in a more general and flexible way. Also, machine learning can automatically model more complex interactions and data structures in the dataset. While mediation analysis usually measures linear relationships and interaction between a set of variables, machine learning can consider complex, nonlinear relationships between mediating variables and interactions. In addition, methodological innovations can be brought to mediation analysis with machine learning. For example, algorithms such as random forest or XGBoost can complement traditional methods for determining which variables are important in mediation analysis by measuring the significance level of each variable. This may provide greater comprehensiveness and robustness to the analyses. Çiftci and Yildiz used structural equation modeling and the machine learning approach (Çiftci and Yıldız 2023).

During the analysis process, several R packages were utilized for generating graphics and visualizations, including ggplot2, hrbrthemes, hexbin, GGally, and plotly. SHAP for xgboost and xgboost packages were employed to create SHAP graphics. To initiate machine learning techniques and make comparisons between them, 10-fold cross-validation was employed, using the caret package. Within the caret package, various regression methods were utilized for assessing performance, including knn for K nearest neighbor regression (KNN), svmRadial for support vector machine regression (SVM), avNNet for artificial neural network regression (ANN), rf for random forest (RF), xgbLinear for XGBoost, rpart for decision tree regression (CART), and glmnet for regression (REG). These methods aimed to determine the best performance of each individual approach.

Results

Of the individuals participating in the study, 61.7% were female, 61.4% were unmarried, 40.6% had graduated from higher education institutions, 47.1% had an income less than their expenditure, and 91.1% did not know anyone who had been diagnosed with HPV. Their mean age was 29.81±11.69 (years) (Table 1).

In our study, HPV HBM perceived benefit subdimension 2.47 ±0.73, HPV HBM perceived susceptibility subdimension 2.50 ±0.77, HPV HBM perceived severity subdimension 2.58 ±0.76, HPV HBM perceived barriers subdimension 2.77 ±0.61, human papillomavirus knowledge scale total score mean 8.99 ±6.15, general HPV knowledge 4.46 ±3.24, HPV screening test knowledge 1.48 ±1.39, general HPV vaccine knowledge 1.74 ±1.48, and knowledge about the current HPV vaccination program 1.30 ±1.34 (Table 2).

There was a significant difference ($p < 0.05$) between the mean score of the HPV HBM perceived benefit subdimension and the educational status, monthly income status and HPV acquaintance status of the individuals (Table 3).

A significant difference was found between the mean score of the HPV HBM perceived susceptibility subdimension and monthly income status and HPV acquaintance status ($p < 0.05$) (Table 3).

It was found that there was a significant difference between the mean score of the HPV HBM perceived severity subdimension and gender, monthly income status and HPV acquaintance status ($p < 0.05$) (Table 3).

No significant difference was found between the mean score of the HPV HBM perceived barriers subdimension and demographic characteristics ($p > 0.05$) (Table 3).

It was found that there was a significant difference between the HPV knowledge scale total point average of the individuals and their educational status and HPV acquaintance status ($p < 0.05$) (Table 3).

A significant positive correlation was found between the mean score of HPV HBM perceived benefit, severity subdimensions and HPV HBM perceived susceptibility subdimension and HPV HBM perceived seriousness subdimension ($p < 0.05$) (Table 4).

Table 1 Descriptive characteristics of individuals ($n = 433$)

Demographic characteristics		*n*	%
Gender	Female	267	61.7
	Male	166	38.3
Marital status	Married	167	38,6
	Single	266	61.4
Education status	Primary school graduate	73	16.9
	Secondary education graduate	141	32.6
	Higher education graduate	176	40.6
	Postgraduate graduate	43	9.9
Monthly income	My income is less than my expenses	204	47.1
	My income is equal to my expenses	182	42.0
	My income is more than my expenses	47	10.9
Having an acquaintance diagnosed with HPV	Yes	17	3.9
	No	416	91.1
Age	$\overline{X}$±SD(Min-Max)		
	29.81±11.69 (18-78)		

Table 2 Individuals' health belief model scale subscales regarding human papillomavirus infection and vaccination, human papillomavirus knowledge scale total and subscale mean scores ($n = 433$)

Scales	$\overline{X}$±SD	Min	Max
HPV HBM perceived benefit subdimension	2.47 ±0.73	1.00	4.00
HPV HBM Perceived susceptibility subdimension	2.50 ±0.77	1.00	4.00
HPV HBM Perceived severity subdimension	2.58 ±0.76	1.00	4.00
HPV HBM Perceived barriers subdimension	2.77 ±0.61	1.40	4.00
Mean Total Score of human papillomavirus knowledge scale	8.99 ±6.15	0.00	22.00
General HPV knowledge subdimension	4.46 ±3.24	0,00	11.00
HPV screening test knowledge subdimension	1.48 ±1.39	0.00	5.00
General HPV vaccine information subdimension	1.74 ±1.48	0.00	5.00
Information on the current HPV vaccination program subdimension	1.30 ±1.34	0.00	4.00

A significant negative correlation was found between the mean score of the HPV HBM perceived benefit, susceptibility, severity subdimensions and the HPV HBM perceived barriers subdimension ($p < 0.05$) (Table 4).

A significant positive correlation was found between the HPV knowledge scale total scores and HPV HBM perceived susceptibility and severity subdimension ($p < 0.05$) (Table 4).

When the analysis results of the regression model reveal the effect of HPV knowledge level on HPV HBM perceived susceptibility subdimension are examined, statistical estimates of the regression model show that the model is significant and usable ($F(1,431) = 7.265$, $p = 0.007$). HPV knowledge level explains 1.7% ($R^2 = 0.017$) of the total variance of the HPV HBM perceived susceptibility subdimension. When the t-test results regarding the significance of the regression coefficient in the regression model are examined; it can be said that an increase in the HPV knowledge level of the participants ($t = 2.695$, $p = 0.007$) causes a statistical increase in the level of "HPV HBM perceived susceptibility" (Table 5).

When the analysis results of the regression model to reveal the effect of HPV knowledge level on HPV HBM perceived severity subdimension are examined, the statistical estimates of the regression model show that the model is significant and usable ($F(1,431) = 4.182$, $p = 0.041$). HPV knowledge level explains 1.0% ($R^2 = 0.010$) of the total variance of the HPV HBM perceived severity subdimension. When the t-test results regarding the significance of the regression coefficient in the regression model are analyzed, it can be said that an increase in the HPV knowledge level of the participants ($t = 2.045$, $p = 0.041$) causes a statistical increase in the level of "HPV HBM perceived severity" (Table 5).

The analysis included the variables HPV HBM perceived susceptibility and HPV HBM perceived severity, along with demographic factors such as age, gender, marital status, education level, monthly income, presence of HPV familiarity, and HPV knowledge. To determine the optimal parameter settings for the algorithms, the training data was utilized and the results are depicted in Fig. 1.

Table 3 Comparison of the mean scores of the health belief model scale subscales regarding human papillomavirus infection and vaccination according to demographic characteristics (n = 433)

Demographic characteristics			HPV SIM perceived benefit subdimension		HPV SIM perceived susceptibility subdimension		HPV SIM perceived severity subdimension		HPV SIM perceived barriers subdimension		HPV Knowledge scale total mean score	
		n	$\overline{X}$±SD	Test and significance	$\overline{X}$±SD	Test and significance	$\overline{X}$±SD	Test and significance	$\overline{X}$±SD	Test and significance	$\overline{X}$±SD	Test and significance
Gender	Woman	267	2.51±0.74	t=1.417	2.55±0.78	t=1.803	2.66±0.75	t=2.878	2.82±0.58	t=1.816	9.31±6.10	t=1.374
	Men	166	2.40±0.72	p=0.157	2.41±0.76	p=0.072	2.45±0.75	**p=0.004**	2.70±0.66	p=0.070	8.47±6.22	p=0.170
Marital status	Married	167	2.47±0.73	t=-0.009	2.48±0.74	t=-0.404	2.56±0.71	t=-0.526	2.71±0.63	t=-1.617	9.10±6.49	t=0.297
	Single	266	2.47±0.74	p=0.993	2.51±0.80	p=0.687	2.60±0.78	p=0.599	2.81±0.60	p=0.107	8.92±5.94	p=0.767
Education status	Primary school graduate	73	2.25±0.66	F=4.569 **p=0.004**	2.33±0.65	F=1.803 p=0.146	2.41±0.69	F=2.599 p=0.052	2.76±0.65	F=0.756 p=0.375	9.19±6.67	F=5.652 **p=0.001**
	Secondary education graduate	141	2.62±0.73		2.59±0.80		2.70±0.71		2.72±0.58		7.64±5.62	
	Higher education graduate	176	2.42±0.73		2.49±0.79		2.57±0.79		2.82±0.62		9.28±6.20	
	Postgraduate graduate	43	2.53±0.80		2.48±0.82		2.55±0.84		2.77±0.61		11.83±5.69	
Post hoc analyses			Bonferroni 1<2		–		–		–		Bonferroni 4>2	
Monthly income	My income is less than my expenses	204	2.35±0.74	F=6.103 **p=0.002**	2.38±0.77	F=6.031 **p=0.003**	2.48±0.76	F=4.289 **p=0.014**	2.85±0.62	F=2.914 p=0.055	8.81±6.41	F=0.431 p=0.650
	My income is equal to my expenses	182	2.61±0.73		2.65±0.76		2.71±0.76		2.72±0.60		8.98±5.93	
	My income is more than my expenses	47	2.46±0.62		2.43±0.75		2.54±0.67		2.66±0.58		9.74±5.91	
Post hoc analyses			Bonferroni 1<2		Bonferroni 1<2		Bonferroni 1<2					
Having an acquaintance diagnosed with HPV	Yes	17	2.09±0.74	t=-2.144	2.11±0.83	t=-2.076	2.16±0.76	t=-2.364	2.83±0.81	t=0.391	12.35±6.16	t=2.309
	No	416	2.48±0.73	**p=0.033**	2.51±0.77	**p=0.038**	2.60±0.75	**p=0.019**	2.77±0.60	p=0.696	8.85±6.12	**p=0.021**

For bold $p<0.05$

In Fig. 2, the root mean square error (RMSE) and mean absolute error (MAE) values are displayed, illustrating the outcomes of estimating the most precise metric values derived from the training data using the test data. Upon examination of the metric values, it is evident that the CART method excels as the most accurate approach for predicting HPV HBM perceived susceptibility, whereas the RF method demonstrates superior accuracy for predicting HPV HBM perceived severity (Fig. 2).

Table 4 The relationship between the health belief model scale subscales regarding human papilloma virus infection and vaccination and the total scores of the human papillomavirus knowledge scale ($n = 433$)

		(1)	(2)	(3)	(4)	(5)
(1) HPV HBM perceived benefit subdimension	r	–				
	p	–				
(2) HPV HBM perceived susceptibility subdimension	r	.717				
	p	.001				
(3) HPV HBM perceived severity subdimension	r	.737	.749			
	p	.001	.001			
(4) HPV HBM perceived barriers subdimension	r	–.443	–.471	–.496		
	p	.001	.001	.001		
(5) Mean total score of human papilloma virus knowledge scale	r	.083	.129	.098	.015	
	p	.085	.007	.041	.753	

Table 5 Results of regression analysis between individuals' health belief model scale subscales regarding human papilloma virus infection and vaccination and human papillomavirus knowledge scale total scores ($n = 433$)

Dependent samples	Independent samples	*B*	*SD*	*β*	*t*	*p**
Perceived benefit	(Constant)	2.384	0.063		37.939	0.001
	HPV knowledge scale	0.010	0.006	0.083	1.729	0.085
		R = 0.083 R^2= 0.007 F = 2.988 p = 0.085 Durbin-Watson = 1.370				
Perceived susceptibility	(Constant)	2.354	0.066		35.718	0.001
	HPV knowledge scale	0.016	0.006	0.129	2.695	0.007
		R = 0.129 R^2=0.017 F = 7.265 p = 0.007 Durbin-Watson = 0.834				
Perceived severity	(Constant)	2.478	0.065		38.395	0.001
	HPV knowledge scale	0.012	0.006	0.098	2.045	0.041
		R = 0.098 R^2=0.010 F = 4.182 p = 0.041 Durbin-Watson = 1.425				
Perceived barriers	(Constant)	2.764	0.053		52.495	0.001
	HPV knowledge scale	0.002	0.005	0.015	0.315	0.753
		R = 0.015 R^2= 0.000 F = 0.099 p = 0.753 Durbin-Watson = 1.512				

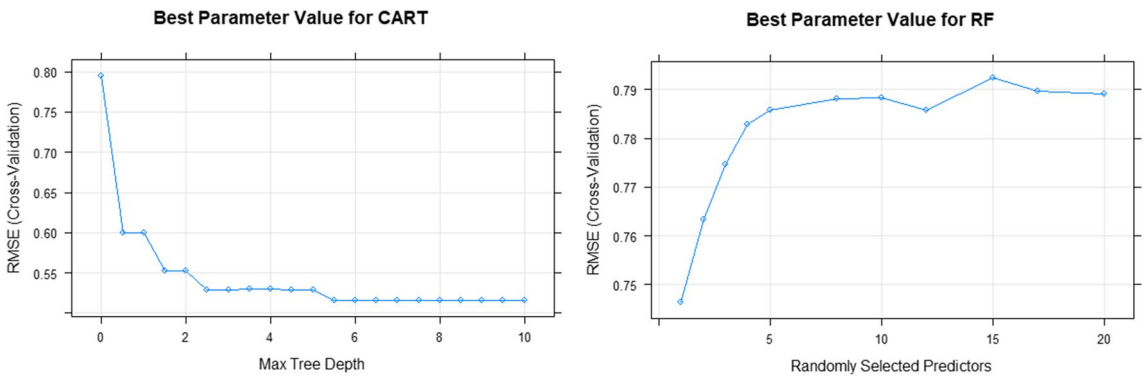

Fig. 1 Decision tree regression (CART) and random forest regression (RF) algorithm models used for the estimation of compliance with HPV HBM perceived susceptibility and HPV HBM perceived severity

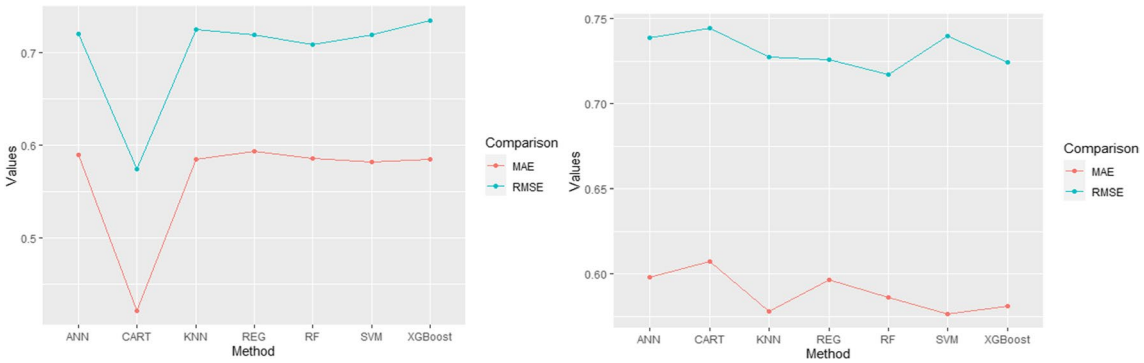

Fig. 2 The metric values of the methods according to the estimation of the test data (respectively, HPV HBM perceived susceptibility and HPV HBM perceived severity)

Figure 3 presents a visual representation of the test data predicted by the methods, depicted using red lines, while the actual test data is represented by blue lines. The proximity of the red lines to the blue lines indicates the success of the prediction model; the closer they are, the more accurate the predictions (Fig. 3).

In the prediction model, all variables underwent a comparison of their performance using machine learning algorithms. The significance of these variables in the model was quantified through Shapley values, specifically Shapley additive explanations (SHAP). In order to ensure unbiased comparison in terms of performance criteria, the SHAP values of variables were examined in the context of the best-performing model. SHAP values provide insights into the contribution or significance of each variable in predicting the model's outcomes. As depicted in the graphical representation, the variable with the utmost importance for accurately predicting both HPV HBM perceived susceptibility and HPV HBM perceived severity is HPV knowledge (Figs. 4 and 5).

Discussion

This section of the study discusses the findings with reference to the previous literature.

The mean total score of the human papillomavirus knowledge scale was 8.99 ± 6.15. Considering our average scale scoring, it was observed that the level of knowledge of the society about HPV was not at very high levels. There are studies similar to our average in the literature (Aslan and Bakan 2021; Çakir et al. 2021; Özakar Akça et al. 2016; Genc Koyucu 2022).

When the difference between the HPV knowledge scale total score mean and educational status was examined, it was found that the mean score of individuals with postgraduate degrees was higher than those with secondary education ($p < 0.05$). In the study conducted by Akça and colleagues, unlike our study, it was observed that HPV knowledge was not related to educational status (Özakar Akça et al. 2016).

When the relationship between the HPV knowledge scale total scores and the HPV recognition status was examined, it was observed that those who were familiar in our study scored higher than those who did not ($p < 0.05$). Aldohaian et al. (2019), whose research was carried out in Saudi Arabia and focused on cervical cancer screening, stated that the knowledge score of women who had heard pap-smear before was higher. Dany et al. (2015) showed that the knowledge scores of those individuals who had previously heard something about HPV vaccination were higher. As stated in the studies, a relationship was found between hearing the pap-smear

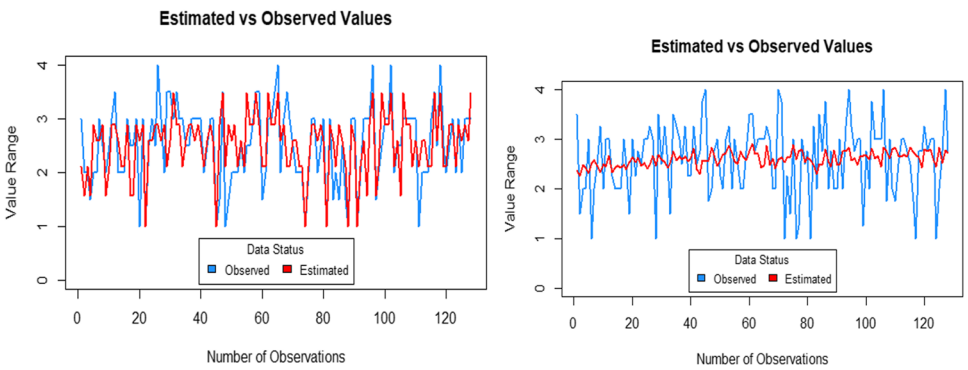

Fig. 3 HPV HBM perceived susceptibility and HPV HBM perceived severity prediction with test data

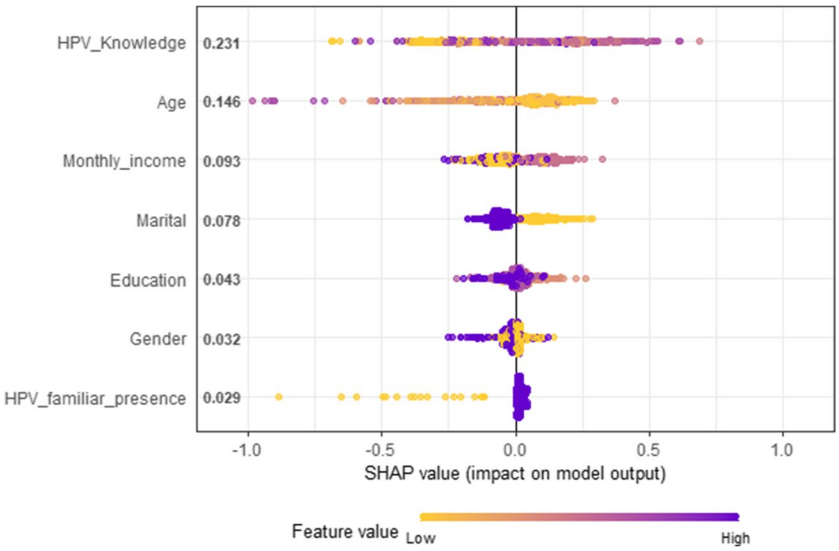

Fig. 4 Determining the contributions of variables to the model for HPV HBM perceived susceptibility estimation with Shapley values

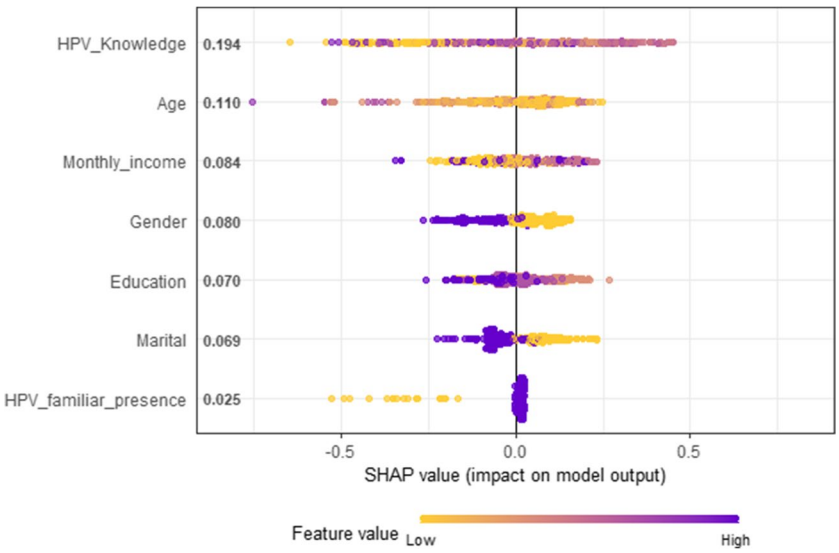

Fig. 5 Determining the contributions of variables to the model for HPV HBM perceived severity estimation with Shapley values

test, hearing the HPV test, hearing the HPV vaccine and HPV knowledge levels. It is an expected result that the knowledge scores of women who heard the tests were found to be higher than women who had not heard the tests before.

Considering the subdimensions of the health belief model scale regarding human papillomavirus infection and vaccination, when the literature is examined, similar averages are observed with our study (Altintas et al. 2022; Tunaman et al. 2022).

Upon assessing the mean score of the perceived benefit subdimension within the health belief model scale concerning human papillomavirus infection and vaccination, based on educational status, a significant distinction emerged. Specifically, individuals with primary education exhibited a lower mean score compared to those with secondary education ($p < 0.05$). In the study conducted by Bal and Şahiner (2020), in parallel with our study, the scores obtained from the benefit subdimension decreased as the educational status decreased. Upon analyzing the mean score of the perceived benefit subdimension within the health belief model scale concerning human papillomavirus infection and vaccination, with respect to monthly income status, a notable distinction was evident. Specifically, individuals whose income was less than their expenses exhibited a lower mean score in comparison to those whose income equaled their expenses ($p < 0.05$). Similar studies are found in the literature (Kim 2018). Based on the attained outcomes, it is inferred that possessing a higher income status could potentially lead to a positive impact on elevating the scores achieved by mitigating factors that hinder the perception of benefit.

Upon investigating the connection between the mean score of the perceived benefit subdimension within the health belief model scale concerning human papillomavirus infection and vaccination, in relation to the HPV acquaintance status, it was

observed that individuals without HPV acquaintance scored higher compared to those who were familiar with HPV ($p < 0.05$). Çakir et al. (2021), Schaefer Ziemer and Hoffman (2012), and Tiro et al. (2007) found different results. This situation suggests that the group in our study was not aware of the benefit of HPV vaccination.

Upon investigating the mean score of the perceived susceptibility subdimension within the health belief model scale concerning human papillomavirus infection and vaccination, in relation to monthly income status, it was observed that the mean score of individuals whose income was less than their expenses was lower than that of those whose income equaled their expenses ($p < 0.05$). Income status affecting the perspective of individuals toward HPV and cervical cancer is an important health problem in low- and middle-income countries compared to high-income countries (Yapça et al. 2015; Öztürk and Gürsoy 2020). Consideration of income status in studies conducted on the sensitivity of individuals toward HPV suggests that it would be beneficial for both individuals and the country.

Upon investigating the correlation between the mean score of the perceived susceptibility subdimension within the health belief model scale concerning human papillomavirus infection and vaccination, and the familiarity with HPV, it was observed that individuals without HPV acquaintance scored higher compared to those who were familiar with HPV ($p < 0.05$). Unlike our study, Schaefer Ziemer and Hoffman (2012) and Manhart et al. (2011) found the susceptibility score of those familiar with HPV to be higher. This situation suggests that the familiarity of acquaintances will increase the sensitivity of individuals to the disease and the fact that the course of the disease in their acquaintances was not at a desirable level (Schaefer Ziemer and Hoffman 2012; Manhart et al. 2011).

Upon analyzing the variation in the mean score of the perceived severity subdimension within the health belief model scale concerning human papillomavirus infection and vaccination, based on monthly income status, it was discovered that the mean score of individuals whose income was less than their expenses was lower than that of those whose income equaled their expenses ($p < 0.05$). Women who described their economic status as good and very good had a higher perception of seriousness than women who described their economic status as moderate and poor. In a previous study conducted by Kim (2018), the idea that the vaccine is offered free of charge increased the perception of seriousness as well as the perception of benefit (Kim 2018).

A significant positive correlation was identified between the mean score of the perceived benefit subdimension within the health belief model scale related to human papillomavirus infection and vaccination, and both the perceived susceptibility and perceived severity subdimensions. In contrast, a significant negative correlation was found with the perceived barriers subdimension ($p < 0.05$). Similar results can be found in previous research (Dağabakan 2020; Gürdal 2022).

A significant positive correlation was established between the mean score of the perceived susceptibility subdimension within the health belief model scale concerning human papillomavirus infection and vaccination, and the perceived severity subdimension. Conversely, a negative correlation was observed with the barriers subdimension ($p < 0.05$). This is thought to be due to the lack of easy access to HPV vaccine (Arı 2021).

A significant negative correlation was found between the mean score of the perceived severity subscale of the health belief model regarding human papillomavirus infection and vaccination and the perceived barriers subscale ($p < 0.05$). Şen (2016) obtained the same result.

A significant positive correlation was identified between the mean total score of the human papillomavirus knowledge scale and both the perceived susceptibility subdimension and perceived severity subdimension within the health belief model concerning human papillomavirus infection and vaccination ($p < 0.05$). Similar results were also obtained in the research conducted by Gürdal in 2021 (Gürdal 2022). This supports that individuals' level of knowledge about human papillomavirus plays an important role in their attitudes toward vaccination.

Grandahl et al. (2018) found a significant relationship between HPV and cervical cancer knowledge and perception of benefit, perception of susceptibility, and perception of severity. It was expected that sensitivity, seriousness, and perception of benefit would increase with increasing knowledge levels. Therefore, to increase the rate of HPV testing and vaccination and to improve health beliefs positively, education programs about HPV should be organized for the whole population, primarily for risk groups.

Conclusion

Increased knowledge about human papillomavirus was found to increase individuals' susceptibility and severity of HPV. Considering that the level of knowledge about HPV infection will affect individuals' HPV health beliefs, further studies are recommended. The level of HPV knowledge and attitudes in different groups and the variables affecting them should be analyzed.

Limitations of the study

The study was carried out in a single center, and this is one of its limitations. As a result, it is only possible to generalize the findings to those individuals who volunteered to participate.

Author's contributions Data collection: G.G; Data analyses; MY, G.G; Writing: M.Y., G.G, A.Ş., B.Y., N.Ü.B.

Funding No financial support was received by any of the authors for the research of this article.

Data availability Data can be shared when necessary.

Declarations

Ethical principles The Scientific Research Ethics Committee of the university gave permission to conduct the study. Only willing volunteers were involved in the research. The Helsinki Declaration of Human Rights was adhered to during the course of the study in order to protect the individual rights of the participants.

Ethics approval Permission was obtained from Sakarya University Ethics Committee.

Consent to participate Participants were asked to participate after ticking the box at the beginning of the questionnaire.

Consent for publication There is no obstacle to the publication of the study.

Conflicts of interest The authors report no actual or potential conflicts of interest.

References

Abraham C, Sheeran P (2015) The health belief model. In: Conner M, Norman P (eds) Predicting and changing health behavior. McGraw-Hill, New York, pp 30–69

Aldohaian AI, Alshammari SA, Arafah DM (2019) Using the health belief model to assess beliefs and behaviors regarding cervical cancer screening among Saudi women: a cross-sectional observational study. BMC Womens Health 19(1):6

Altintas RY, Erciyas ŞK, Ertem G (2022) Sağlık bilimleri fakültesi öğrencilerinin serviks kanseri ile Human Papilloma Virüs enfeksiyonu aşılamasına ilişkin sağlık inanç düzeylerinin belirlenmesi. Dokuz Eylül Üniversitesi Hemşirelik Fakültesi Elektronik Dergisi 15(1):40–49. https://doi.org/10.46483/deuhfed.792977

Arı H (2021) Hemşirelerin human papilloma virüs hakkındaki bilgileri, inançları ve aşılanma durumları. Başkent Üniversitesi Sağlık Bilimleri Enstitüsü

Aslan G, Bakan AB (2021) Identification of the knowledge level of students receiving health education about the human papilloma virus, screening tests, and human papilloma virus vaccination. J Community Health 46:428–433. https://doi.org/10.1007/s10900-020-00888-8

Avcı GA, Bozdayı G (2013) İnsan papilloma virüsü. Kafkas Tıp Bilimleri Dergisi 3:136–144. https://doi.org/10.5505/kjms.2013.52724

Bal MD, Şahiner NC (2020) The effect of health belief model based training on cervical cancer screening behaviors. Clin Exp Health Sci 10(3):223–227. https://doi.org/10.33808/clinexphealthsci.733948

Blasi PR, King D, Henrikson NB (2015) HPV vaccine public awareness campaigns: an environmental scan. Health Promot Pract 16(6):897–905. https://doi.org/10.1177/1524839915596133

Cohen J (1988) Set correlation and contingency tables. Appl Psychol Meas 12(4):425–434 https://psycnet.apa.org/doi/10.1177/01466216880120041O

Çakir AT, Porsuk İ, Çalbiyik F, Taner G, Nogay AE, Aslan ME, Demir S, Cüneyt C, Altiner E, Kılıç ŞŞ (2021) Üniversite Öğrencilerinin HPV, HPV Tarama Testi ve HPV Aşısına İlişkin Bilgi Düzeylerinin Değerlendirilmesi: Kesitsel Bir Çalışma. Batı Karadeniz Tıp Dergisi 5(3):472–480. https://doi.org/10.29058/mjwbs.974567

Çiftci N, Yıldız M (2023) The relationship between social media addiction, happiness, and life satisfaction in adults: analysis with machine learning approach. Int J Ment Health Addiction. https://doi.org/10.1007/s11469-023-01118-7

Dağabakan Ş (2020) Çukurova Üniversitesi sağlık bilimleri fakültesi öğrencilerinin HPV aşısına yönelik bilgi, tutum ve davranışlarına broşürle bilgilendirmenin etkisi. Çukurova Üniversitesi Tıp Fakültesi Uzmanlık Tezi Adana

Dany M, Chidiac A, Nassar AH (2015) Human papillomavirus vaccination: assessing knowledge, attitudes, and intentions of college female students in Lebanon, a developing country. Vaccine 33(8):1001–1007

De Martel C, Plummer M, Vignat J, Franceschi S (2017) Worldwide burden of cancer attributable to HPV by site, country and HPV type. Int J Cancer 141(4):664–670. https://doi.org/10.1002/ijc.30716

Demir F (2019) Human Papilloma Virüsü (Hpv) Bilgi Ölçeği'nin Türkçe Geçerlik Ve Güvenirliği, Sağlık Bilimleri Üniversitesi, Gülhane Sağlık Bilimleri Enstitüsü, Halk Sağlığı Hemşireliği Anabilim Dalı. Yayınlanmamış Yüksek Lisans Tezi

Genc Koyucu R (2022) Ebelik öğrencilerinin human papilloma virüs ile ilgili bilgi durumlarının analizi: Tanımlayıcı anket çalışması. Androl Bul 24:118–126. https://doi.org/10.24898/tandro.2022.50103

Grandahl M, Chun Paek S, Grisurapong S, Sherer P, Tyden T, Lundberg P (2018) Parents' knowledge, beliefs, and acceptance of the HPV vaccination in relation to their socio-demographics and religious beliefs: a cross-sectional study in Thailand. PloS One 13(2):e0193054

Guvenc G, Seven M, Akyuz A (2016) Health belief model scale for human papilloma virus and its vaccination: adaptation and psychometric testing. J Pediatr Adolesc Gynecol 29(3):252–258. https://doi.org/10.1016/j.jpag.2015.09.007

Gürdal Y (2022) Kadın doğum polikliniğine başvuran kadınların HPV ve HPV aşısına yönelik sağlık inançları. Bezmi Alem Üniversitesi Yüksek Lisans Tezi

Hershey JH, Velez LF (2009) Public health issues related to HPV vaccination. J Public Health Manage Practice 15(5):384–392. https://doi.org/10.1097/PHH.0b013e3181a23de6384-392

Hosseini FS, Joveini H, Jahromi VK, Sharifi N (2022) Prevention of self-medication in women of reproductive age based on a health belief model: a quasi-experimental study. J Educ Commun Health 9(1):18–25. https://doi.org/10.34172/jech.2022.4

Kim HW (2012) Knowledge about human papillomavirus (HPV), and health beliefs and intention to recommend HPV vaccination for girls and boys among Korean health teachers. Vaccine 30(36):5327–5334. https://doi.org/10.1016/j.vaccine.2012.06.040

Kim J (2018) The relationship of health beliefs with information sources and HPV vaccine acceptance among young adults in Korea. Int J Environ Res Public Health 15(4):673. https://doi.org/10.3390/ijerph15040673

Manhart LE, Burgess-Hull AJ, Fleming CB, Bailey JA, Haggerty KP, Catalano RF (2011) HPV vaccination among a community sample of young adult women. Vaccine 29(32):5238–5244

Mihretie GN, Liyeh TM, Ayele AD, Belay HG, Yimer TS, Miskr AD (2022) Knowledge and willingness of parents towards child girl HPV vaccination in Debre Tabor Town, Ethiopia: a community-based cross-sectional study. Reprod Health 19(1):1–12. https://doi.org/10.1186/s12978-022-01444-4

Özakar Akça S, Selen F, Büyükgönenç LA (2016) Hemşirelerin human papilloma virüs (HPV) enfeksiyonu ve HPV aşısı hakkındaki bilgi düzeyleri: eğitim ve araştırma hastanesi örneği. Hemşirelikte Eğitim ve Araştırma Dergisi 13(2):116–121

Öztürk Y, Gürsoy E (2020) Kadınların pap smear tarama testini yaptırmalarının önündeki engeller. STED. 29(1):61–68

Özvaris ŞB (2015) Toplumsal Cinsiyet, Çalişma Yaşami ve Kadin Sağliği. Ttb Mesleki Sağlık Ve Güvenlik Dergisi 15(56):37–43

Rogovskaya SI, Shabalova IP, Mikheeva IV, Minkina GN, Podzolkova NM, Shipulina OY, Sultanov SN, Kosenko IA, Brotons M, Buttmann N (2013) Human papillomavirus prevalence and type-distribution, cervical cancer screening practices and current status of vaccination implementation in Russian Federation, the Western countries of the former Soviet Union, Caucasus region and Central Asia. Vaccine 31:46–58. https://doi.org/10.1016/j.vaccine.2013.06.043

Schaefer Ziemer K, Hoffman MA (2012) Beliefs and attitudes regarding human papillomavirus vaccination among college-age women. J Health Psychol 18(10):1360–1370

Sierra-Rojas JC, Reyes-Carreto R, Vargas-De-León C, Camacho JF (2022) Modeling and mathematical analysis of the dynamics of HPV in cervical epithelial cells: transient, acute, latency, and chronic infections. Comput Math Meth Med. https://doi.org/10.1155/2022/8650071

Şen D (2016) Ankara Üniversitesi Tıp Fakültesi Aile Hekimliği polikliniklerine başvuran hemşirelerin human papilloma virüs enfeksiyonu ve aşılamasına ilişkin sağlık inançları. Ankara Üniversitesi Tıp Fakültesi Uzmanlık Tezi

Senkomago V, Henley SJ, Thomas CC, Mix JM, Markowitz LE, Saraiya M (2019) Human papillomavirus–attributable cancers—United States, 2012–2016. Morb Mortal Wkly Rep 68(33):724. https://doi.org/10.15585/mmwr.mm6833a3

Tabachnick BG, Fidell L S, Ullman JB (2007) Using multivariate statistics (Vol. 5). Pearson

Tiro JA, Meissner HI, Kobrin S, Chollette V (2007) What do women in the US know about human papillomavirus and cervical cancer? Cancer Epidemiol Prevent Biomark 16(2):288–294

Tunaman SG, Eryilmaz N, Kosretas B (2022) The knowledge levels and health beliefs of vocational school of health services students about human papilloma virus (Hpv) nd vaccine. İnönü Üniversitesi Sağlık Hizmetleri Meslek Yüksek Okulu Dergisi 10(1):180–198. https://doi.org/10.33715/inonusaglik.1053013

Vandenbroucke JP, Elm EV, Altman DG, Gøtzsche PC, Mulrow CD, Pocock SJ (2007) Strobe Initiative. Strengthening the reporting of observational studies in epidemiology (STROBE): explanation and elaboration. Ann Intern Med 147(8):W-163. https://doi.org/10.1136/bmj.39335.541782.AD

Waller J, Ostini R, Marlow LA, McCaffery K, Zimet G (2013) Validation of a measure of knowledge about human papillomavirus (HPV) using item response theory and classical test theory. Prev Med 56(1):35–40. https://doi.org/10.1016/j.ypmed.2012.10.028

WHO (2016) Guide to introducing HPV vaccine into national immunization programs. In: Geneva, Switzerland: the WHO Document Production Services

Yapça Ö, Delibaş İ, Elif ONAT (2015) Ardışık 3342 Pap-Smear Sonucunun Değerlendirilmesi: Retrospektif Çalışma. Çağdaş Tıp Dergisi 5(4):234–238