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# Usage, knowledge and attitudes towards electronic cigarettes use among nursing students in Croatia: a cross-sectional study

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## Abstract

**Background** Evidence shows harmful effects of e-cigarettes on health. There is limited data on the use of e-cigarettes among nursing students. This study aimed to investigate the usage, knowledge, and attitudes towards e-cigarettes among nursing students in Croatia, as well as their views on the role of nurses in counseling patients and assisting with smoking cessation.

**Methods** This cross-sectional study was conducted via an online questionnaire among nursing students at 10 universities in Croatia in March/April 2024. Students were asked questions about socio-demographics, knowledge and attitudes towards e-cigarettes and their views on the role of nurses in counseling patients and assisting with smoking cessation.

**Results** The study included 1,039 participants; 89% were women, 43% were smokers; 53% used e-cigarettes and 76% used them for recreational purposes. 21% of participants agreed that e-cigarettes are an effective method for quitting smoking. More than half indicated that e-cigarettes could encourage non-smokers to start smoking. The majority (60%) reported that they had never received education on smoking cessation at university. Furthermore, 66% stated that they did not feel confident advising smokers about e-cigarettes. The majority (70%) considered physicians to be the most knowledgeable health experts to advise and educate users of e-cigarettes. There were no significant differences in attitudes between smokers and non-smokers on the use of e-cigarettes. Participants demonstrated insufficient knowledge about e-cigarettes. Non-smokers had more positive attitudes towards the role of nurses in combating smoking compared to smokers. Participants who had received education on smoking cessation were more willing to advise smokers and had clearer views on the risks and the importance of the nurse's role in the quitting process compared to those who had not received such education. Smoking status and age were significant predictors of counseling confidence.

**Conclusion** The study found a high prevalence of smoking and e-cigarette use among Croatian nursing students, along with limited knowledge and generally negative attitudes towards e-cigarettes. It highlighted gaps in education

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regarding the health risks of e-cigarettes and the lack of practical skills needed to help smokers quit, suggesting that nursing programs should update their curricula to better prepare students in these areas.

**Keywords** Electronic cigarettes, Nursing students, Knowledge, attitudes, practice, Tobacco use disorder, Cross-sectional studies, Smoking prevention

## Background

Electronic cigarettes or vaping products (e-cigarettes) can be used to deliver a range of substances, including nicotine, cannabinoids, flavorings, chemicals, and other compounds [1]. E-cigarettes were originally developed two decades ago as a tool to help people quit smoking and as a safer alternative for those who could not or did not want to stop using nicotine [1].

In the last decade, the popularity of e-cigarettes has increased. The global number of e-cigarette users was estimated at approximately 58 million in 2018 and 68 million in 2020 [2]. The use of e-cigarettes is becoming particularly common among young people [3, 4]. A study conducted among students in several European countries showed that the overall prevalence of e-cigarette use during one's lifetime was 43.7% (51.3% among men and 40.5% among women) [5].

A 2024 Cochrane review found that nicotine-containing e-cigarettes are more likely to increase quit rates compared to nicotine replacement therapy, and they are moderately more effective than non-nicotine e-cigarettes [6]. However, concerns about the safety of e-cigarettes remain significant. Several professional organizations worldwide have classified e-cigarette use as a serious public health concern [7]. Multiple potential risks of e-cigarettes have been identified [7–9].

Health professionals are expected to influence public health by promoting healthy behaviors and preventing risky practices. Therefore, they should receive proper training and support to deliver consistent and effective interventions for tobacco users [10].

Nurses, being the largest group of healthcare professionals, have numerous opportunities to engage with individuals facing health issues [11, 12]. However, when health professionals themselves smoke, it undermines their ability to advocate for healthy habits and effectively support smoking cessation efforts with their patients [11, 13].

Nilan et al. conducted a systematic review and meta-analysis to assess the prevalence of tobacco use among healthcare workers. The analysis included 229 studies with a total of 457,415 healthcare workers from 63 countries. The results showed that nurses had the highest pooled smoking prevalence at 24%, while pharmacists had the lowest at 14%. When examining smoking prevalence by gender, men nurses had a higher pooled prevalence (28%) compared to women nurses (18%) [14].

Furthermore, although numerous interventions have been implemented to decrease smoking prevalence and promote cessation, many nursing students still report smoking [15]. Research by Fernández-García et al. found that 15.8% of smokers began smoking during their early university years, with an increase in smoking rates over time. Despite the knowledge gained through academic training, a significant reduction in smoking behaviors among nursing students has not been observed [16].

On the other hand, there is evidence suggesting that incorporating tobacco cessation education into mandatory courses can improve nursing students' clinical skills and enhance their ability to assist patients in quitting smoking [17].

The nursing education system in Croatia is aligned with European standards and is designed to produce competent and highly skilled nursing professionals capable of delivering high-quality care. The education system includes undergraduate, graduate and PhD programs, which are offered by universities and higher education institutions across the country [18].

Smoking is a significant public health issue in Croatia, as shown by a study conducted in 2014 and 2015 by Croatian and international public health authorities. The study revealed that 31% of the population aged over 15 in Croatia smoked, with 35% of men and 27% of women being smokers [19]. However, there is a notable lack of research on tobacco smoking in Croatia, particularly regarding e-cigarette use. The 2019 ESPAD study provided some insights, showing that e-cigarette use is becoming increasingly common among Croatian youth. According to the study, 17% of students had tried e-cigarettes at some point in their lives, with slightly more boys (19%) than girls (15%) having experimented with them. Additionally, 15% of students reported using e-cigarettes in the past 12 months, and 13% had used them within the last 30 days [20].

The aim of this study was to investigate the use, knowledge and attitudes towards e-cigarettes among nursing students in Croatia, as well as their views on the role of nurses in counseling patients and assisting with smoking cessation.

## Methods

### Ethics

The study protocol was approved by the Ethics Committee of the Catholic University of Croatia (Class: 602-04/23 – 11/045, Reg. No.: 498-15-06-23-004) and

subsequently by Ethics committees of all other universities that participated in the study. Written informed consent was obtained from all study participants. The study was conducted in accordance with the institutional Codes of Ethics. All methods were performed in accordance with the relevant guidelines and regulations.

### Study design

A cross-sectional study was conducted using an online questionnaire. The study began on March 5, 2024, with the first invitation sent to students. The first reminder was sent on March 12, 2024, and the second reminder on March 19, 2024.

### Participants

The participants were undergraduate (bachelor's) and graduate (master's) nursing students, regardless of their study status (full-time and part-time). An invitation to participate in the study was sent to 11 higher education institutions in Croatia. Ten institutions agreed to participate in the study: (1) Department of Nursing, Catholic University of Croatia in Zagreb; (2) Faculty of Dental Medicine and Health; Josip Juraj Strossmayer University of Osijek; (3) Faculty of Health Studies, University of Rijeka; (4) Department of Health Studies, University of Zadar; (5) Nursing and Clinical Nursing Studies, University of Dubrovnik; (6) Department of Nursing, University of Juraj Dobrila in Pula; (7) University Department of Health Studies, University of Split; (8) University of Applied Health Sciences in Zagreb; (9) Nursing Studies, Polytechnic of Bjelovar; (10) Department of Nursing, University North in Varaždin.

### Data collection

First, the link to the survey and accompanying files were sent to the nursing program coordinators in each institution. Then, the coordinators invited students via e-mail to participate in the study. Students accessed the questionnaire (Appendix 1) via online link to the Lime Survey platform. Before completing the questionnaire, students were asked to read the information sheet about the study (Appendix 2) and to provide in the online platform their informed consent to participate, after which they were able to access the questionnaire. The students were not offered any compensation or any other incentive to participate in the survey.

### Questionnaire

The questionnaire was adapted from the study conducted by Alsanea et al. [21]. The questionnaire was translated from English to Croatian. First, two individuals independently translated the questionnaire from English to Croatian. Then, a unified version of the Croatian translation was created. After that, two individuals independently

performed a back-translation into English, and the back-translation was compared with the original English version. The pre-final version of the Croatian translation was tested on eight students of the School of Medicine at the Catholic University of Croatia. After the pilot testing, minimal linguistic revisions were made to the questionnaire. The responses from the medical students in the pilot testing were not included in the study.

The first part of the questionnaire consisted of sociodemographic questions—such as their higher education institution, study status (full-time or part-time), year of study, education on smoking cessation topics at the university, gender, age, smoking status, e-cigarette use, and the purpose of their use. The second part of the questionnaire included 11 questions on students' knowledge and attitudes. Five knowledge-related questions were either multiple-choice questions with three possible answers or questions on a Likert scale. For multiple-choice questions, one answer was considered correct. For Likert scale-based questions, two answers were considered correct ("strongly agree" and "agree" were considered the same; "disagree" and "strongly disagree" were also considered the same), with the participant receiving one point if either of these options was selected. The total knowledge score for each student could range from 0 to 5. The remaining six questions in the second part pertained to perceptions and attitudes assessed using Likert scales or multiple-choice questions. To examine participants' attitudes toward the role of nurses in counseling patients and assisting with smoking cessation, three questions from the modified Croatian translation of the "19-item Helping Smokers Quit" questionnaire from the Master of Nursing thesis of Lovro Ačkar [22, 23] were added to the questionnaire.

### Data analysis

The analysis included descriptive statistics; categorical data were presented as frequencies and percentages. The Kolmogorov-Smirnov test was used to test the normality of the distribution of continuous variables. Continuous data with normal distribution were presented as mean and standard deviation (SD). T-test for independent samples and the chi-square test were used for comparisons among participants. The knowledge and attitudes of students were compared based on their smoking status. A significance level of  $P < 0.05$  was used. A logistic regression model was employed to determine the factors influencing participants' ability to provide effective smoking cessation counseling. The model included variables such as smoking status, age, gender, and knowledge acquired during university education. The software used for statistical analysis was SPSS (version 20, IBM, Chicago, USA).

## Results

We invited 4,398 students to participate in the study, of whom 1,039 (24%) completed the questionnaire. After the initial invitation, 715 (16%) participants completed the questionnaire. There were 854 (19%) responses after the first reminder, and 1,039 (24%) after the second reminder.

Table 1 shows the distribution of participants according to sociodemographic characteristics. There were more bachelor's than master's students in the sample. There was nearly equal number of full-time and part-time students. Most participants (89%) were women. The mean participants' age was 27 years (Table 1).

Most of the participants (60%) have never studied the topic of smoking cessation during their university nursing studies. Most of those who did, studied smoking cessation topics in their first year of bachelor's studies. When it comes to smoking and e-cigarette use, 12% of participants were former smokers, 45% had never smoked, and 43% were current smokers. Over 50% reported using e-cigarettes, with 76% using them recreationally and 24% using them as an aid to quit smoking (Table 1).

Regarding the statement about whether they support e-cigarettes as a smoking cessation method, 21% agreed, 24% said they did not know, and 55% disagreed. Most participants (76%) agreed with the statement that e-cigarettes could encourage smoking for non-smokers and a smoking addiction among conventional cigarette smokers, while 19% did not know and 5.7% disagreed. When it comes to perceiving e-cigarettes as a modern alternative to conventional cigarettes, 82% of participants agreed, while 14% did not know and 4.2% disagreed. When it comes to asking patients about e-cigarette use, only 23% agreed with this statement, 21% did not know, and 56% stated that they disagree. Only 12% of participants stated that they can confidently advise smokers, while 22% stated that they did not know. More than half (66%) could not advise smokers about e-cigarettes. The majority of participants (70%) believed that physicians should be the healthcare professionals responsible for education and counseling about e-cigarettes, while nurses were the second choice (25%) (Table 2). The analysis of responses to Likert scale questions concerning smoking status revealed similar attitudes among participants, regardless of whether they were former smokers, non-smokers, or

**Table 1** Overview of the sociodemographic characteristics of the participants ( $N=1039$ )

Participant characteristics		N	%
<b>Gender</b>	Men	117	11
	Women	922	89
<b>Year of study</b>	The first year of bachelor's study	261	25
	The second year of bachelor's study	275	27
	The third year of bachelor's study	292	28
	The first year of master's study	104	10
	The second year of master's study	107	10
<b>Student status</b>	Part-time students	560	54
	Full-time students	479	46
<b>Age (years) <math>X \pm SD</math></b>		<b><math>X = 26.92</math></b>	<b><math>SD = 8.622</math></b>
<b>Studying smoking cessation topics</b>		<b>N</b>	<b>%</b>
	No, never	625	60
	Yes	414	40
<b>In which study year you studied smoking cessation topics?</b>			
	The first year of bachelor's study	231	22
	The second year of bachelor's study	112	11
	The third year of bachelor's study	44	4.2
	The first year of master's study	13	1.3
	The second year of master's study	14	1.3
<b>Smoking habit status</b>			
	Former smoker	120	12
	Non-smoker	472	45
	Smoker	447	43
<b>Have you ever used e-cigarettes?</b>			
	Yes	546	53
	No	493	47
<b>If you've ever used e-cigarettes, for which purpose was it?</b>			
	Recreational purposes	449	76
	Smoking cessation purposes	142	24

**Table 2** Nursing students' attitudes and perceptions of e-cigarettes

	N	%	X	SD
I support e-cigarettes as a smoking cessation method.				
Strongly agree	42	4.0	2.49	1.13
Agree	177	17		
I don't know	251	24		
Disagree	343	33		
Strongly disagree	226	22		
E-cigarettes could encourage smoking for non-smokers and a smoking addiction among conventional cigarette smokers.				
Strongly agree	297	29	3.97	0.86
Agree	487	47		
I don't know	196	19		
Disagree	50	4.8		
Strongly disagree	9	0.9		
E-cigarettes are mostly used as a modern alternative to conventional cigarettes, rather than as a smoking cessation method.				
Strongly agree	372	36	4.13	0.83
Agree	479	46		
I don't know	145	14		
Disagree	33	3.2		
Strongly disagree	10	1.0		
If I don't know enough/much about e-cigarettes, I shouldn't ask my patients if they have ever used them.				
Strongly agree	52	5.0	2.6	1.07
Agree	185	18		
I don't know	222	21		
Disagree	453	44		
Strongly disagree	127	12		
I can confidently advise smokers about e-cigarettes.				
Yes	126	12		
No	687	66		
I don't know	226	22		
In your opinion, who is the most knowledgeable healthcare professional for education and counseling about e-cigarettes, and who should also lead a smoking cessation program?				
Physician	725	70		
Pharmacist	27	2.6		
Nurses	264	25		
Dentists	23	2.2		

current smokers. There was no statistically significant difference between these three groups regarding their attitudes toward e-cigarettes (Table 3).

Table 4 presents participants' attitudes toward the role of nurses concerning smoking and smoking cessation. The majority (72%) agreed that nurses should be actively involved in helping patients quit smoking, while 23% did not know and 4.9% disagreed. More than half (68%) expressed that nurses needed additional education in this area, 23% did not know and 9.1% disagreed. Additionally, 52% indicated nurses should set a good example for patients by not smoking, while 33% did not know, and a smaller percentage (15%) disagreed with this statement (Table 4).

Table 5 highlights participants' attitudes toward the role of nurses in promoting non-smoking and smoking cessation, as well as the need for additional education, based on their smoking status. Former smokers (43%) were the most likely to strongly agree that nurses should set a good example by not smoking, compared to 35% of non-smokers and 25% of smokers, with a significant difference in attitudes among the groups ( $P < 0.001$ ). Additionally, most participants across all groups strongly agreed that nurses should actively help patients quit smoking and need more education on smoking cessation, with former smokers and non-smokers more likely to support this than smokers (Table 5).

Table 6 shows significant differences in knowledge about e-cigarettes based on smoking status. Smokers had the highest percentage of correct responses for the statement about e-cigarettes not being well-known for smoking cessation (53%) while 27% of smokers stated that they did not know. Also, smokers had the highest percentage of correct responses for the statement about e-cigarettes having harmful effects compared to conventional cigarettes (73%), and 8.0% did not know. Significance for between-group differences was  $p < 0.001$ . Non-smokers had the most correct answers (42%) for the statement on vaporized nicotine, while 53% of them stated that they did not know. Former smokers were most knowledgeable about potential carcinogens (1.7%) with 23% of them stating that they did not know. No significant differences were found between the groups regarding knowledge of long-term carcinogen exposure ( $p = 0.135$ ).

Table 7 indicates that those with a university education on e-cigarettes had more confidence in advising smokers and more knowledge of e-cigarettes' harmful effects, reducing uncertainty. However, for other statements, education on the topic does not make a significant difference in participants' attitudes.

Among the participants, 10% ( $N = 106$ ) did not answer any knowledge-related questions correctly. One correct answer was provided by 18% ( $N = 183$ ) of the total sample. Two questions were answered correctly by 29% ( $N = 305$ ), while 29% ( $N = 296$ ) correctly answered three questions. Four questions were correctly answered by 14% ( $N = 147$ ) participants. All five questions were correctly answered by 0.2% ( $N = 2$ ) of participants.

Logistic regression provided insight into the key factors influencing participants' ability to deliver effective smoking cessation counseling (Table 8). The logistic regression analysis revealed that smoking status and age were significant predictors of counseling confidence. Smoking status exhibited a strong positive association, with smokers being more likely to report confidence in providing cessation advice ( $OR = 3.734$ ,  $p < 0.001$ ). In contrast, age was a significant negative predictor, indicating that younger participants reported greater confidence ( $OR = 0.966$ ,

**Table 3** Attitudes toward e-cigarettes among participants based on their smoking status

		I would support E-cigarettes as a smoking cessation method for those who wish to quit smoking.					$\chi^2$	p
		Strongly agree	Agree	I don't know	Disagree	Strongly disagree		
Former smoker	N	3	21	31	38	27	10.99	0.202
	%	(2.5)	(18)	(26)	(32)	(23)		
Non-smoker	N	12	83	105	162	110		
	%	(2.5)	(18)	(22)	(34)	(23)		
Smoker	N	27	73	115	143	89		
	%	(6.0)	(16)	(26)	(32)	(20)		
		E-cigarettes could encourage smoking with non-smokers and smokers of conventional cigarettes.					$\chi^2$	p
		Strongly agree	Agree	I don't know	Disagree	Strongly disagree		
Former smoker	N	29	55	26	8	2	12.623	0.125
	%	(24)	(46)	(22)	(6.7)	(1.7)		
Non-smoker	N	121	223	100	23	5		
	%	(26)	(47)	(21)	(4.9)	(1.1)		
Ex-smoker	N	147	209	70	19	2		
	%	(33)	(47)	(16)	(4.3)	(0.4)		
		E-cigarettes are mostly used as a modern alternative to conventional cigarettes, rather than as a smoking cessation method.					$\chi^2$	p
		Strongly agree	Agree	I don't know	Disagree	Strongly disagree		
Former smoker	N	32	58	22	6	2	13.900	0.084
	%	(27)	(48)	(18)	(5.0)	(1.7)		
Non-smoker	N	167	214	75	11	5		
	%	(35)	(45)	(16)	(2.3)	(1.1)		
Smoker	N	173	207	48	16	3		
	%	(39)	(46)	(11)	(3.6)	(0.7)		
		If I don't know enough/much about E-cigarettes, I shouldn't ask my patients if they have ever used them.					$\chi^2$	p
		Strongly agree	Agree	I don't know	Disagree	Strongly disagree		
Former smoker	N	4	18	32	52	14	14.282	0.075
	%	(3.3)	(15)	(27)	(43)	(12)		
Non-smoker	N	15	89	90	216	62		
	%	(3.2)	(19)	(19)	(46)	(13)		
Smoker	N	33	78	100	185	51		
	%	(7.4)	(17)	(22)	(41)	(11)		

$p=0.009$ ). Gender and knowledge acquired during university were not statistically significant predictors in the model. The comparison between the null model ( $M_0$ ) and the full model ( $M_1$ ) demonstrated a significant improvement in fit ( $\Delta X^2 = 48.060$ ,  $p < 0.001$ ), confirming the relevance of the included predictors.

## Discussion

### Smoking and use of e-cigarettes

The results of this study indicate that smoking and e-cigarette use among nursing students in Croatia was alarmingly high in 2024. Nearly half of the participants (43%) reported being current smokers, and over half of the participants in our study reported using e-cigarettes, with 76% using them recreationally and 24% using them as a smoking cessation aid. These findings highlight that cigarette smoking and e-cigarette use among nursing students in Croatia represent a significant public health concern.

In general population, adult smoking prevalence in Croatia is 36% [24]. We do not have current data on the prevalence of smoking among healthcare professionals,

particularly nurses, at the national level in Croatia. However, the findings from this survey, indicating that nurses smoke at higher rates than the general population, are especially concerning. Healthcare professionals are expected to have greater awareness of the health consequences of smoking and to serve as role models by promoting healthier behaviors.

A very similar percentage of smokers was reported in a 2022 study by Čivljak et al. conducted among registered nurses employed at Sestre Milosrdnice University Hospital Center in Zagreb, where 44% of surveyed nurses reported to be current smokers [23]. Furthermore, a study of Kuzmić, conducted in 2023 among nurses in Croatia examined the knowledge, attitudes, and experiences of 139 nurses regarding smoking. Among the participants, 46% were current smokers, and 16% used e-cigarettes. The proportion of smokers in that study was similar to the results in our sample [25].

Another online study conducted in 2022 among 318 nurses in Croatia showed that the majority (63%) smoked cigarettes, nearly 20% used e-cigarettes, and 25% did not use any tobacco products [26]. Differences in the

**Table 4** Participants' attitudes and perceptions of the role of nurses concerning smoking behavior and smoking cessation

	N	%	X	SD
Nurses should set a good example for their patients by not smoking.				
Strongly agree	210	20	3.51	1.09
Agree	325	31		
Neutral	347	33		
Disagree	98	9.4		
Strongly disagree	59	5.7		
Nurses should be actively involved in helping patients quit smoking.				
Strongly agree	219	21	3.87	0.83
Agree	534	51		
Neutral	235	23		
Disagree	37	3.6		
Strongly disagree	14	1.3		
Nurses need additional education/training in the fight against smoking and smoking cessation.				
Strongly agree	192	19	3.74	0.92
Agree	511	49		
Neutral	241	23		
Disagree	69	6.6		
Strongly disagree	26	2.5		

prevalence of e-cigarette use described in our study and those two studies could be explained by differences in the way questions about e-cigarette use were asked. For example, in Ritoša's study, which was conducted among nurses in Croatia, the question was phrased as "I

consume tobacco in the form of (cigarettes/e-cigarettes/chewing tobacco or do not consume)" [26]. In Kuzmić's study, the question was phrased as "In what form do you consume tobacco products?" [25].

In our study, the question was phrased as "Have you ever used e-cigarettes? Yes/No." Therefore, in our study, the question did not pertain to current e-cigarette use but to the experience of e-cigarette use, which may have been in the past. To summarize, the high prevalence of smoking among nurses and nursing students in Croatia is a cause for concern. Therefore, particular attention should be given to interventions to aid nurses to quit smoking.

A systematic review by Duaso et al. published in 2017, which included 14 studies from the USA, Canada, and Europe, showed that the prevalence of smoking ranged from 4.0 to 47%. Fewer nurses in North America smoked compared to European countries [27].

Furthermore, Nilan et al., in 2019, published a systematic review on the prevalence of tobacco use among healthcare workers. The review included data from 229 studies conducted across 63 countries, covering prevalence data on 457,415 health care workers collected between 2000 and 2014. Of these studies, 65 studies contained data on nurses. According to this study, the pooled prevalence of smoking among women nurses was 18%, and among men nurses it was 28% [14].

#### The knowledge and attitudes about e-cigarettes

The findings of our study indicate that knowledge of nursing students about e-cigarettes is insufficient. Only

**Table 5** Participants' attitudes towards nurses and smoking according to their smoking status

		Strongly agree	Agree	I don't know	Disagree	Strongly disagree	$\chi^2$	p
Nurses should set a good example for patients by not smoking.								
Former smoker	N	52	19	35	9	5	110.017	0.000
	%	(43)	(16)	(29)	(7.5)	(4.2)		
Non-smoker	N	163	143	124	32	10		
	%	(35)	(30)	(26)	(6.8)	(2.1)		
Smoker	N	110	48	188	57	44		
	%	(25)	(11)	(42)	(13)	(9.8)		
Nurses should actively help patients quit smoking.								
Former smoker	N	62	19	31	6	2	31.831	0.000
	%	(52)	(16)	(26)	(5.0)	(1.7)		
Non-smoker	N	243	129	86	12	2		
	%	(52)	(27)	(18)	(2.5)	(0.4)		
Smoker	N	229	71	118	19	10		
	%	(51)	(16)	(26)	(4.3)	(2.2)		
Nurses need additional education/training in the fight against smoking.								
Former smoker	N	61	25	26	3	5	26.754	0.001
	%	(51)	(21)	(22)	(2.5)	(4.2)		
Non-smoker	N	238	100	99	33	2		
	%	(50)	(21)	(21)	(7.0)	(0.4)		
Smoker	N	212	67	116	33	19		
	%	(47)	(15)	(26)	(7.4)	(4.3)		

**Table 6** Comparison of knowledge about e-cigarettes according to smoking status (bolded responses are correct)

E-cigarettes are well-known smoking cessation products (i.e. they help in reducing and quitting smoking)							
	Yes	No	I don't know	$\chi^2$	p		
Former smoker	24 (20%)	<b>51 (43%)</b>	45 (38%)	29.597	0.000		
Non-smoker	70 (15%)	<b>193 (41%)</b>	209 (44%)				
Smoker	90 (20%)	<b>235 (53%)</b>	122 (27%)				
E-cigarettes have no harmful effects (such as cough, heavy breathing, and eye irritation) compared to conventional cigarettes							
	They do	They don't	I don't know	$\chi^2$	p		
Former smoker	<b>80 (67%)</b>	25 (21%)	15 (13%)	37.190	0.000		
Non-smoker	<b>338 (72%)</b>	115 (24%)	19 (4.0%)				
Smoker	<b>328 (73%)</b>	61 (19%)	58 (8.0%)				
E-cigarettes only produce vaporized nicotine							
	Yes	No	I don't know	$\chi^2$	p		
Former smoker	8 (7.2%)	<b>43 (38%)</b>	69 (55%)	60.290	0.000		
Non-smoker	27 (5.7%)	<b>116 (42%)</b>	329 (53%)				
Smoker	84 (19%)	<b>144 (32%)</b>	219 (49%)				
Although e-cigarettes do not involve the combustion (burning) of tobacco, they do contain some potential carcinogens like those produced by conventional tobacco cigarettes.							
	Yes	No	I don't know	$\chi^2$	p		
Former smoker	90 (75%)	<b>2 (1.7%)</b>	28 (23%)	15.745	0.003		
Non-smoker	345 (73%)	<b>5 (1.1%)</b>	122 (26%)				
Smoker	373 (84%)	<b>5 (1.1%)</b>	69 (15%)				
Long-term use of e-cigarettes increases the (inhaled) dose of carcinogens							
	Strongly agree	Agree	I don't know/ Not sure	Disagree	Strongly disagree	$\chi^2$	p
Former smoker	<b>34 (28%)</b>	<b>52 (43%)</b>	29 (24%)	4 (3.3%)	1 (0.8%)	12.387	0.135
Non-smoker	<b>120 (25%)</b>	<b>227 (48%)</b>	114 (24%)	8 (1.7%)	3 (0.6%)		
Smoker	<b>136 (30%)</b>	<b>170 (38%)</b>	131 (29%)	6 (1.3%)	4 (0.9%)		

0.2% of participants correctly answered all the knowledge-assessing questions. Smokers and former smokers were more likely than non-smokers to correctly identify that e-cigarettes are not well-known smoking cessation products. Additionally, more students who smoked correctly recognized the harmful effects of e-cigarettes compared to non-smokers. However, non-smokers were more likely than smokers and former smokers to correctly answer that e-cigarettes do not only produce vaporized nicotine. Regarding the statement that long-term use of e-cigarettes increases the dose of inhaled carcinogens and cytotoxic substances, there were no statistically significant differences in knowledge between groups based on their smoking status. Over half of the students (66%) indicated they cannot confidently advise smokers about e-cigarettes. Furthermore, the majority of students had a negative attitude toward e-cigarettes as a smoking cessation method. When comparing students' attitudes based

on their smoking status, no statistically significant differences were found in the responses.

Multiple studies have explored nursing and medical students' knowledge and attitudes toward e-cigarettes, revealing varying levels of understanding. A 2021 study in the Philippines found that smokers among nursing students had more knowledge than non-smokers, though overall knowledge was insufficient [28]. Those findings were similar to our study.

In Saudi Arabia, medical and dental students exhibited slightly better knowledge about e-cigarettes than their peers, and non-smokers generally had greater knowledge than smokers [21]. Those findings are in contrast with our study in Croatia, where non-smokers did not demonstrate significantly greater knowledge about e-cigarettes. In fact, more smokers answered two questions correctly than non-smokers. In contrast, a study conducted at the University of Jordan showed a high level of knowledge about e-cigarettes [29].



**Table 7** Comparison of the participants' education and attitudes toward smoking cessation education

<b>E-cigarettes are well-known smoking cessation products (i.e. they aid in monitoring and ultimately quitting smoking)</b>		Yes	No	I don't know	$\chi^2$	<b>p</b>
Participants who were educated on smoking cessation topics	N	157 (15%)	78 (7.5%)	179 (17,2%)	2.295	0.317
Participants who weren't educated on smoking cessation topics	N	219 (21%)	106 (10%)	300 (29%)		
<b>E-cigarettes produce only vaporized nicotine.</b>						
Participants who were educated on smoking cessation topics	N	52 (5.0%)	124 (12%)	238 (23%)	1.300	<b>p</b> 0.522
Participants who weren't educated on smoking cessation topics	N	67 (6.4%)	179 (17%)	379 (37%)		
<b>Although E-cigarettes do not involve the combustion (burning) of tobacco, they do contain some potential carcinogens like those produced by conventional tobacco cigarettes.</b>						
Participants who were educated on smoking cessation topics	N	335 (32%)	4 (0.4%)	75 (7.2%)	3.956	<b>p</b> 0.138
Participants who weren't educated on smoking cessation topics	N	473 (46%)	8 (0.8%)	144 (14%)		
<b>I am confident in my ability to advise smokers on e-cigarettes.</b>						
Participants who were educated on smoking cessation topics	N	60 (5.8%)	254 (24%)	100 (9.6%)	7.370	<b>p</b> 0.025
Participants who weren't educated on smoking cessation topics	N	66 (6.4%)	433 (42%)	126 (12%)		
<b>E-cigarettes have no harmful effects (such as cough, heavy breathing, and eye irritation) compared to conventional cigarettes.</b>						
Participants who were educated on smoking cessation topics	N	321 (31%)	32 (3.1%)	61 (5.9%)	11.703	<b>p</b> 0.003
Participants who weren't educated on smoking cessation topics	N	425 (41%)	60 (5.8%)	140 (14%)		
<b>I would support using cigarettes as a smoking cessation method for those who wish to quit smoking</b>						
Participants who were educated on smoking cessation topics	N	19 (1.8%)	62 (6.0%)	139 (13%)	2.723	<b>p</b> 0.605
Participants who weren't educated on smoking cessation topics	N	23 (2.2%)	115 (11%)	204 (9.6%)		
<b>Long-term use of e-cigarettes increases the dose of inhaled carcinogens and cytotoxic substances.</b>						
Participants who were educated on smoking cessation topics	N	19 (1.8%)	62 (6.0%)	139 (13%)	2.723	<b>p</b> 0.605
Participants who weren't educated on smoking cessation topics	N	23 (2.2%)	115 (11%)	204 (9.6%)		

**Table 7** (continued)

Participants who were educated on smoking cessation topics	N	123	188	95	6	2	5681	0.224
	%	(12%)	(18%)	(9.1%)	(0.6%)	(0.2%)		
Participants who weren't educated on smoking cessation topics	N	167	261	179	12	6		
	%	(16%)	(25%)	(17%)	(1.2%)	(0.6%)		
<b>E-cigarettes can encourage smoking with non-smokers and a smoking addiction with conventional cigarette smokers.</b>								
Participants who were educated on smoking cessation topics	N	128	203	58	20	5	11.522	0.021
	%	(12.3%)	(19.5%)	(5.6%)	(1.9%)	(0.5%)		
Participants who weren't educated on smoking cessation topics	N	169	284	138	30	4		
	%	(16.3%)	(27.3%)	(13.3%)	(2.9%)	(0.4%)		
<b>E-cigarettes are mostly used as a modern alternative to conventional cigarettes, rather than as a smoking cessation method</b>								
Participants who were educated on smoking cessation topics	N	151	204	46	9	4	7.757	0.101
	%	(15%)	(20%)	(4.4%)	(0.9%)	(0.4%)		
Participants who weren't educated on smoking cessation topics	N	221	275	99	24	6		
	%	(21%)	(27%)	(9.5%)	(2.3%)	(0.6%)		
<b>If I am not educated enough on e-cigarettes, I shouldn't be asking my patients whether they are using them.</b>								
Participants who were educated on smoking cessation topics	N	22	54	194	89	55	11.215	0.024
	%	(2.1%)	(5.2%)	(19%)	(8.6%)	(5.3%)		
Participants who weren't educated on smoking cessation topics	N	30	131	259	133	72		
	%	(2.9%)	(13%)	(25%)	(13%)	(6.9%)		
<b>Nurses should actively aid patients in smoking cessation.</b>								
Participants who were educated on smoking cessation topics	N	111	220	72	10	1	28.237	> 0.001
	%	(11%)	(21%)	(6.9%)	(1.0%)	(0.1%)		
Participants who weren't educated on smoking cessation topics	N	108	314	163	27	13		
	%	(10%)	(30%)	(16%)	(2.6%)	(1.3%)		
<b>Nurses should set an example for their patients by being non-smokers.</b>								
Participants who were educated on smoking cessation topics	N	89	141	132	34	18	5.964	0.202
	%	(8.6%)	(14%)	(13%)	(3.3%)	(1.7%)		
Participants who weren't educated on smoking cessation topics	N	121	184	215	64	41		
	%	(12%)	(18%)	(21%)	(6.2%)	(3.9%)		
<b>Nurses require additional education/training in smoking prevention and smoking cessation.</b>								
Participants who were educated on smoking cessation topics.	N	89	205	205	90	24	7.826	0.098
	%	(8.6%)	(20%)	(20%)	(8.7%)	(2.3%)		
Participants who weren't educated on smoking cessation topics.	N	103	306	306	151	45		
	%	(9.9%)	(30%)	(30%)	(15%)	(4.3%)		

**Table 7** (continued)

According to your opinion, who should be the most knowledgeable healthcare professional responsible for educating and advising e-cigarette users, as well as leading smoking cessation programs?					$\chi^2$	P
Participants who were educated on smoking cessation topics	Physician	N	276		7.213	0.065
		%	(27%)			
Participants who weren't educated on smoking cessation topics	Physician	N	449			
		%	(43%)			
	Pharmacist		7	(0.7%)		
	Nurses		121	(12%)		
	Dentists		10	(1.0%)		
			20	(1.9%)		
			143	(14%)		
			13	(1.3%)		

When it comes to the attitudes and perceptions of nursing students toward e-cigarettes, slightly more than half of the students would not support the use of electronic cigarettes as a smoking cessation method. Over two-thirds of students indicated that e-cigarettes can encourage smoking among non-smokers and lead to nicotine addiction in smokers of conventional tobacco cigarettes. A meta-analysis and systematic review conducted by Soneji et al. provides consistent and strong evidence linking the use of electronic cigarettes with a high likelihood of initiating and continuing usage of tobacco cigarettes among adolescents and young adults [30].

Over 80% of the students indicated that e-cigarettes are used more as a modern alternative to conventional tobacco cigarettes than as a smoking cessation method, while more than half of the students disagreed with the statement that if they lack sufficient knowledge about electronic cigarettes, they should not ask the patient whether they have or haven't used them. Additionally, 63% of students who participated in the study from Saudi Arabia believe that electronic cigarettes are a modern alternative to tobacco cigarettes [21]. More than half of the students (66%) were not confident in their ability to advise smokers about e-cigarettes.

More than two-thirds (70%) of the students indicated that physicians should be the most knowledgeable healthcare professionals to educate and advise users of electronic cigarettes and lead smoking cessation programs, while less than one-third (25%) of the students indicated that this role should belong to nurses. Research evidence suggest that interventions conducted by nurses are of high quality and proven effectiveness, and the support they provide increases the chances of smoking cessation among those who have developed nicotine addiction [11, 31].

In this study, a comparison of students' attitudes based on smoking status revealed that there was no statistically significant difference in the attitudes of students toward the use of e-cigarettes, in our sample. On the other hand, a study conducted in the Philippines found different results. Comparing students' attitudes toward e-cigarettes, non-smoking students had more negative attitudes toward e-cigarettes and their use. Former smokers also had more negative attitudes toward electronic cigarettes and their use, while students who were current smokers had more positive attitudes and supported the use of e-cigarettes [28].

Furthermore, this study showed a comparison of nursing students' attitudes based on smoking status regarding their views on nurses with statistically significant differences among the groups for all three questions among the observed student groups. Non-smokers were the most likely to agree that nurses should set a good example for patients by not smoking, followed by slightly more

**Table 8** Logistic regression analysis results about the key factors influencing participants' ability to deliver effective smoking cessation counseling

Predictor variable	B	SE	Z ratio	Wald $\chi^2$	p	Odds Ratio (95% CI)
Age	-0.034**	0.013	-2.632	6.925	0.009	0.966 (0.942,0.991)
Gender	-0.339	0.278	-1.216	1.479	0.224	0.713 (0.413,1.230)
Smoking status	1.318**	0.230	5.735	32.890	<0.001	3.734 (3.380,5.858)
Education on smoking prevention	0.310	0.195	1.588	2.522	0.112	1.364 (0.930,2.000)

**Summary statistics**Model  $\chi^2=48.060$ ,  $p<0.001$ Nagelkerke  $R^2=0.087$ Hosmer and Lemeshow test  $\chi^2=9.00$  (DF=8;  $p=0.342$ )

N=1039

\* $p<0.01$ 

than half of the students who were former smokers. As expected, smokers had a more negative attitude, with only a third indicating that their non-smoking behavior serves as a good example for patients.

A study conducted by Čivljak et al. on nurses in Zagreb, Croatia, found similar results when comparing the smoking status of the nurses. Nurses who were smokers had more negative attitudes and did not believe that their non-smoking behavior set an example for patients [23].

In our study, non-smoking students were the most likely to agree with the statement that nurses should be actively involved in aiding patients to quit smoking. Students who were smokers or former smokers were slightly less likely to agree with this statement. Given that nurses are healthcare professionals who spend the most time with patients, their active role in patient health education and implementing smoking cessation interventions can greatly contribute to a patient's attempt to quit smoking [32].

Most non-smokers and former smokers in this study agreed that nurses needed additional education and training in smoking cessation, while a lesser number of smokers felt that nurses required additional education. According to a 2022 study conducted in Zagreb, Croatia, only 1.6% of nurses reported receiving education on smoking cessation interventions in the past two years, and 18% reported having received such education during their professional careers [23].

A study conducted in the Czech Republic demonstrated that nurses were significantly more willing and involved in implementing smoking cessation interventions and in helping and advising patients after attending smoking cessation education courses or seminars [22].

More than half of the nursing students in Croatia who participated in this study (60.2%) reported that they did not receive education on smoking cessation during their

university studies. Comparing the knowledge and attitudes of students based on whether they had learned about smoking cessation during their education, it can be concluded that a quarter (24%) of students who had received such education felt they could not confidently advise smokers about electronic cigarettes, while the same was true for 42% of those who had not received this education. Additionally, only a small number of students who had been educated on smoking cessation failed to recognize or incorrectly believed that electronic cigarettes have no harmful effects compared to traditional tobacco cigarettes, whereas this belief was more common among students who had not been educated on smoking cessation. More students (13%) who had not been educated agreed with the statement that they should not ask a patient about their use of electronic cigarettes if they did not have enough knowledge about them themselves, compared to only 5.2% of educated participants. A study conducted in Greece showed that nursing education on smoking cessation topics and interventions is closely linked to students' readiness and more positive attitudes toward getting involved in the process of implementing smoking cessation interventions and patient education [32].

Moreover, a study conducted in China emphasized the importance of integrating mandatory courses on smoking cessation into nursing education, as this increases clinical knowledge and skills needed for helping patients quit smoking [17].

**Predictors of confidence regarding smoking cessation counseling**

Results of the logistic regression analyses highlight several factors that could influence participants' confidence to provide effective smoking cessation counseling. Smoking status was a significant positive predictor, as smokers

demonstrated higher confidence in counseling compared to non-smokers. However, this finding also raises concerns about potential biases in counseling. Namely, it is possible that smokers could unconsciously project their own experiences onto patients, potentially affecting the quality of advice provided.

Age was identified as a significant negative predictor, with younger participants reporting higher confidence levels in conducting counseling sessions. This could reflect a generational shift in educational approaches or attitudes toward smoking cessation, where younger individuals are more exposed to contemporary evidence-based practices. Alternatively, this finding might suggest that younger participants perceive counseling as less intimidating, possibly due to differences in self-perception or exposure to training during their education. Future studies should explore the mechanisms underlying this age-related confidence gap and its implications for counseling effectiveness.

In contrast, gender and knowledge acquired during university were not found to be significant predictors in the logistic regression model. The lack of statistical significance for university-acquired knowledge may indicate that the formal education on smoking cessation is either insufficient or not effectively retained by students. This emphasizes the need to reevaluate and potentially enhance smoking cessation training within medical curricula, incorporating practical, hands-on experiences to build confidence and competence among healthcare professionals.

These findings underscore the importance of targeted interventions that address specific predictors of counseling confidence. For example, structured mentorship programs or continuing education tailored to older healthcare professionals may help bridge the confidence gap observed with age. Furthermore, interventions to improve the content and delivery of smoking cessation training during formal education could enhance counseling efficacy across all demographics.

Overall, our results contribute to a deeper understanding of the factors influencing smoking cessation counseling and offer actionable insights for improving training and practice. Further research is needed to validate these findings across different settings and to explore additional variables, such as cultural attitudes or workplace support, that may impact counseling outcomes.

### **Strengths and limitations**

The strength of the study is the large sample size, which included more than a thousand students from ten higher education institutions in Croatia. In our study, 89% of participants were women, which aligns with the demographics of nursing students and nurses in Croatia. Thus, the results contribute to a better understanding of the

level of knowledge among nursing students regarding new and alternative smoking methods. Additionally, the results provide insight into students' attitudes and perceptions toward the use of e-cigarettes. Furthermore, the results allowed us to understand the smoking habits of students, their use of e-cigarettes, and whether they are aware of topics related to the harmful effects of smoking and topics of smoking cessation interventions. The results may encourage the development of mandatory courses in nursing programs to educate nursing students about smoking cessation and new alternative nicotine consumption methods and their dangers, as smoking remains a global public health problem.

The study had several limitations; it examined the knowledge and attitudes of nursing students only about e-cigarettes, even though other types of alternative nicotine delivery devices are available on the market, which differ from e-cigarettes in technology and nicotine delivery methods. Furthermore, nursing students may feel embarrassed about smoking or vaping, which could make them less likely to report their use honestly. The data was self-reported and not biochemically verified.

Additionally, some questions in the questionnaire could have been worded more clearly. The questionnaire was adopted from a previous study [21] and during pilot-testing, no major issues with the understanding of questions were flagged. However, it is possible that the first item assessing knowledge ("E-cigarettes are well-known smoking cessation products (i.e. they help in reducing and quitting smoking)") was confusing to some participants. Namely, it is possible that for some participants it was unclear whether the question is focusing on whether e-cigarettes are well-known, or whether e-cigarettes are effective for smoking cessation. Likewise, the last item assessing knowledge ("Long-term use of e-cigarettes increases the (inhaled) dose of carcinogens") uses the word "increases", but it does not mention what this is in comparison to. I.e. it could have been unclear to the participants whether this refers to an increase compared to everyday exposure of non-smokers or an increase compared to smoking.

### **Suggestions for future research**

Future research could include questions that would examine the use of different types of nicotine delivery devices, such as heated tobacco devices or products like tobacco pouches. It is also necessary to examine students' knowledge and attitudes towards such devices and aids, as these products are becoming more popular, and more users are beginning to use these devices or nicotine delivery products. Research on interventions that could be introduced at higher education institutions to help nursing students quit smoking during their studies would also be very useful.

## Conclusion

The study found a high prevalence of smoking and e-cigarette use among Croatian nursing students, along with limited knowledge and generally negative attitudes toward e-cigarettes. Furthermore, the results indicated that a significant number of nursing students in this study lacked knowledge and confidence in advising patients about smoking cessation and e-cigarettes, despite a notable proportion of them being current or former smokers. Additionally, there is a clear need for enhanced education on smoking cessation and the health risks of e-cigarettes, as well as the role of nurses in promoting non-smoking behavior. Enhancing nursing curricula to address these gaps could better equip future nurses to counsel patients on smoking cessation and e-cigarette use, contributing to improved public health outcomes.

## Supplementary Information

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Supplementary Material 1

Supplementary Material 2

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## Author contributions

LK, MČ: Study design. LK, LP, MM, SZ, KI, DM, ZP, NS, MN, IB, SČ, MČ: data collection and analysis. LK, MČ, IM, LP: manuscript writing. All authors: critical revisions of the manuscript for intellectual content. All authors: approved final version of the manuscript.

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## Data availability

The data collected within the study are available from the corresponding author on request. The participants were not asked to consent to publishing raw study data in an open-access form.

## Declarations

### Ethics approval and consent to participate

The study protocol was approved by the Ethics Committee of the Catholic University of Croatia (Class: 602-04/23 – 11/045, Reg. No.: 498-15-06-23-004) and subsequently by Ethics committees of all other universities that participated in the study. Written informed consent was obtained from all study participants. The study was conducted in accordance with the institutional Codes of Ethics. All methods were performed in accordance with the relevant guidelines and regulations.

### Consent for publication

All authors consented to the publication of the study.

### Competing interests

The authors declare no competing interests.

## Clinical trial registration number

Not applicable. This study was not a clinical trial.

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