Knowledge, attitudes, and practices among medical and non-medical students about immunization during the COVID-19 pandemic: A cross-sectional study

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ABSTRACT

INTRODUCTION Immunization is healthcare attainment and the most cost-effective protection for the individual and the entire population. However, despite increased COVID-19 vaccine supplies, there is hesitancy and refusal to vaccinate. We aim to assess medical and non-medical students' knowledge, attitudes, and practices regarding vaccination and COVID-19, at two major universities.

METHODS We conducted a cross-sectional study, surveying students at two universities in Sarajevo Canton and Rijeka, from 18 February to 1 May 2021 for sociodemographic characteristics, vaccine knowledge, attitudes, and practices. An anonymous self-administered questionnaire was used, and the data were statistically processed.

RESULTS There was a significant difference among groups of participants' attitudes toward vaccination (p=0.001). Significant differences in vaccine knowledge were revealed between two groups of students: medical and non-medical (p=0.001). The primary information sources for immunization among students were healthcare professionals, followed by the Internet and social networks, professional literature, TV and media, friends and families, and magazines.

CONCLUSIONS Our findings confirmed potential areas where targeted interventions could be implemented to improve knowledge about immunization and COVID-19.

INTRODUCTION

Vaccination and immunization are often used interchangeably; however, vaccination involves introducing a vaccine to protect against a specific disease, while immunization is the process of becoming protected against a specific disease through vaccination[1].

Vaccination is a major achievement in global health and is considered one of the greatest public health accomplishments of the 20th century[2]. It is highly cost-effective for preventing infectious diseases[3,4]. Over 20 life-threatening diseases have become preventable through vaccination, significantly improving quality of life[5-7]. Scientists worldwide tacitly agree with the consensus that vaccines are generally safe and effective[2]. However, vaccine hesitancy, defined as reluctance or refusal to receive vaccinations, remains a concern[8-10].

Available COVID-19 vaccines are effective against variants of the virus[3,4]; however, vaccine hesitancy towards COVID-19 vaccination persists[9,10]. In Croatia (RH), vaccination against COVID-19 is carried out with vaccines that are approved by the European Medicines Agency (EMA) (Pfizer, Moderna,

AstraZeneca—all manufacturers, and Johnson & Johnson), while in Bosnia and Herzegovina (BH), it is possible to be vaccinated with the previously named vaccines and some WHO-approved vaccines that are not approved by the EMA, such as Sinopharm and Sinovac.

According to the Croatian Institute of Public Health and the Central Bureau of Statistics, over 95% of the total number of infected people were successfully cured in the RH. The total number of vaccination doses administered per 100 people is 104.53 in RH and 62.15 in BH[11]. In Croatia (RH), approved vaccines by the European Medicines Agency (EMA) are used, while in Bosnia and Herzegovina (BH), WHO-approved vaccines not approved by the EMA are also administered. Specific entry requirements apply in each country[11].

Our study examines the impact of educational interventions on COVID-19 vaccination and vaccine hesitancy. Despite mandatory childhood vaccination policies against tuberculosis, diphtheria, tetanus, pertussis, poliomyelitis, Haemophilus influenzae type B, hepatitis B, measles, rubella, and parotitis in both countries (BH and RH) and a vaccine against pneumococci only in Croatia, there is limited systematic education on vaccine-preventable diseases[12,13]. We aim to assess knowledge, attitudes, and behaviors related to vaccine immunization among students[14-17]. The study focuses on COVID-19 vaccination awareness and explores correlations between knowledge, attitudes, and practices among medical and non-medical students at the University of Sarajevo (UNSA) in BH and the University of Rijeka (UNIRI) in RH. We compare medical and non-medical students, drawing comparisons with relevant studies[18].

METHODS

Study population and design

A cross-sectional, descriptive study was conducted in Sarajevo Canton and in Rijeka, from 18 February to 1 May 2021, among students of different affiliations from the UNSA and the UNIRI and through a created web-based survey – Google Forms. Among the latter, there were also students, mostly (85.3%) from Germany, who studied medicine in English (UNIRI-E). Eligibility criteria to participate in the survey were that they should be students of the two mentioned universities, social media users, understand the study purpose, and be willing to participate voluntarily.

The questionnaire

Data collection involved a structured self-administered questionnaire based on existing foreign instruments, designed using Google Forms after conducting a literature review[12-16]. The questionnaire, consisting of 31 questions, assessed students' knowledge, attitudes, and practices regarding vaccine immunization and the COVID-19 pandemic. The first part collected sociodemographic information such as age, sex, academic year, university attended, municipality of residence, vaccine immunization profile, and source of education. The second part assessed knowledge, attitudes, and practices related to vaccine immunization, including COVID-19.

Further, the questionnaire included 10 items on a five-point agreement scale (from 1='strongly disagree' to 5='strongly agree') designed as a Likert scale assessing misconceptions about potential vaccination risk. The questionnaire, previously validated and assessed for reliability by using Cronbach's alpha test, was shared by link through student affairs offices and social media groups (Facebook, WhatsApp). It included an introduction to the study, eligibility criteria, a confidentiality declaration, and anonymity. It took approximately 5–7 minutes to complete. A reminder was given to complete the questionnaire within four weeks. The responding student population was 377 from UNSA and 789 from UNIRI, which is approximately 1.4% and 4.64% of the total estimated student population of this university, respectively. Student knowledge was quantified by questions that had one correct response and were scored with one point. The mean of students' total scores was calculated along with the standard deviation, which was compared between medical and non-medical students using the Student's t-test. The distribution of the scores was tested by the Kolmogorov-Smirnov test, with $p=0.05$.

Statistical analysis

Completed questionnaires were extracted from Google Forms and exported to Microsoft Excel 2010 for cleaning and coding. The cleaned data were exported to Statistical Package for Social Science (SPSS) version 25 software (IBM Corporation, Armonk, New York). Basic standard methods of descriptive statistics, or summarizing features of data collection, were applied. A chi-squared test was performed to assess differences in proportions of qualitative variables between groups, and a t-test was used to detect differences between quantitative variables. The level of significance was set to $p<0.05$.

RESULTS

A total of 1166 students from the UNSA in BH, and UNIRI in RH responded to the survey. The majority of the responders were female (n=774), with a mean age of 22.58 ± 2.62 years (UNSA) and 23.33 ± 1.71 years (UNIRI). In the study were 392 male participants, with a mean age of 23.08 ± 3.34 years (UNSA) and 24.27 ± 2.98 years (UNIRI). There was a significant difference in sex distribution ($\chi^2=25.01$, $p<0.001$). Regarding the distribution of participants according to the academic year of study, the most prevalent group of students belonged to the second academic year (34.7%) (UNSA) and the first academic year (27.1%) (UNIRI), respectively. The demographic characteristics of the participants were analyzed depending on the place of residency, with the largest number of participants coming from the urban area (70% UNSA vs 54.9% UNIRI), and significant demographic

Table 1. Attitudes, vaccination status and sources of information among medical and non-medical students about immunization during the COVID-19 pandemic, February–May 2021 (N=1166)

Question	Response	UNSA students				UNIRI students				UNIRI-E students		χ^2 p
		Medical		Non-Medical		Medical		Non-Medical		Medical		
		n	%	n	%	n	%	n	%	n	%	
What is your attitude about vaccination?	Negative	16	9.5	33	15.9	20	6.0	105	26.2	4	7.3	125.84 <0.0001
	Hesitant	51	30.2	64	30.9	50	15.0	109	27.2	2	3.6	
	Positive	102	60.4	110	53.1	263	79.0	187	46.6	49	89.1	
What is your vaccination status?	Partially vaccinated	16	9.5	22	10.6	26	7.8	76	19.0	29	52.7	108.63 <0.0001
	I don't know	2	1.2	3	1.4	3	0.9	20	5.0	0	0.0	
	Fully vaccinated	151	89.3	182	87.9	304	91.3	305	76.1	26	47.3	
Do you think that you are sufficiently informed about vaccination?	Yes	77	45.6	75	36.2	173	52.0	149	37.2	33	60.0	106.06 <0.0001
	Partially	3	1.8	5	2.4	2	0.6	5	1.2	10	19.2	
	No	89	52.7	127	61.4	158	47.4	247	61.6	12	21.8	
What are your experiences with vaccination until now?	Negative	8	4.7	9	4.3	5	1.5	21	5.2	2	3.6	25.797 0.001
	No defined attitude	6	3.6	13	6.3	3	0.9	26	6.5	1	1.8	
	Positive	155	91.7	185	89.4	325	97.6	354	88.3	52	94.5	
Do media have a great influence on the formation of attitudes about vaccination?	Yes	144	85.2	178	86.0	276	82.9	283	70.6	40	72.7	34.05 <0.0001
	No	19	11.2	22	10.6	40	12.0	84	20.9	13	23.6	
	I don't know	6	3.6	7	3.4	17	5.1	34	8.5	2	3.6	
Do you think that vaccination should be mandatory?	Yes	116	68.6	131	63.3	252	75.7	179	44.6	30	54.5	105.76 <0.000148
	No	22	13.0	37	17.9	31	9.3	139	34.7	20	36.4	
	I'm not sure	31	18.3	39	18.8	50	15.0	83	20.7	5	9.1	

Continued

Table 1. Continued

Question	Response	UNSA students				UNIRI students				UNIRI-E students		χ^2 p
		Medical		Non-Medical		Medical		Non-Medical		Medical		
		n	%	n	%	n	%	n	%	n	%	
What source of vaccination data do you use?	Magazines	48	28.4	66	31.9	24	7.2	58	14.5	4	7.3	-
	Television/media	51	30.2	72	34.8	34	10.2	146	36.4	4	7.3	
	Internet/social networks	91	53.8	119	57.5	99	29.7	198	49.4	16	29.1	
	Family and friends	41	24.3	96	46.4	18	5.4	53	13.2	4	7.3	
	Scientific literature and faculty	67	39.6	82	39.6	94	28.2	60	15.0	5	9.1	
	Healthcare professionals	115	68.0	127	61.4	125	37.5	146	36.4	24	43.6	
	I am not informed	0	0.0	3	1.4	3	0.9	19	4.7	3	5.5	
Which of the mandatory vaccines do you consider dangerous and/or unnecessary?	BCG	7	4.1	19	9.2	8	2.4	9	2.2	2	3.6	-
	COVID vaccines (not required)	2	1.2	2	1.0	2	0.6	7	1.7	1	1.8	
	Dtap-IPV-HiB	9	5.3	23	11.1	4	1.2	15	3.7	0	0.0	
	Hepatitis B	6	3.6	21	10.1	2	0.6	11	2.7	0	0.0	
	MRP	16	9.5	19	9.2	3	0.9	16	4.0	1	1.8	

UNSA: University of Sarajevo. UNIRI-E: University of Rijeka (studies in English).

differences were found (χ^2=40.26, p<0.001).

More than two-thirds of students have shown a positive attitude about mandatory vaccination (χ^2=105.76, p<0.001). A total of 89.3% of medical students from the UNSA were fully vaccinated, and 91.3% of medical students from the UNRI. When students were asked whether they were considered sufficiently informed regarding vaccination, a significant difference was observed (χ^2=106.06, p<0.0001). Additionally, there was a significant difference in the participant attitude towards vaccination (χ^2=125.84, p<0.0001), which was predominantly positive in the UNIRI group of students (n=450; 61.3%). The most powerful information source for UNSA and UNIRI students was healthcare professionals, followed by the Internet and social networks, professional literature, TV and media, friends and families, and magazines (Table 1).

More than a third of students believed that after vaccination, they will be immune to the disease. Between 35% and 40% of students believed vaccines will have long-term negative consequences. Furthermore, roughly 40% believed that administering more vaccines at once will increase the risk of side effects. Approximately one-quarter of students believed that vaccines cause autism.

In terms of pharmaceutical companies creating infections to increase profits, 46.4% of UNIRI students studying medicine in English agreed with the statement, compared to 16.0% of medical students at the University of Sarajevo (p<0.001) (Table 2).

Table 3 summarizes the assessment of all self-reported COVID-19 preventive behaviors and risk perceptions. Prior to this study, every fifth UNIRI student and nearly every fourth UNSA student tested positive for COVID-19. We discovered that approximately 20–30% of them were concerned about COVID vaccines and their potential negative impact on their health.

Only 29.7% of 377 UNSA students believed that vaccines against COVID-19 are safe, while 41% of UNIRI students believe the same. UNIRI students studying medicine in

Table 2. Attitudes and knowledge regarding vaccination among medical and non-medical students about immunization during the COVID-19 pandemic, February–May 2021 (N=1166)

Item	Response	UNSA students				UNIRI students				UNIRI-E students		χ2 p
		Medical		Non-Medical		Medical		Non-Medical		Medical		
		n	%	n	%	n	%	n	%	n	%	
I think that I cannot get the disease if I have been vaccinated	Disagree	130	76.9	152	73.4	247	74.2	304	75.8	43	79.6	1.453 0.835
	Agree	39	23.1	55	26.6	86	25.8	97	24.2	11	20.4	
Some of the vaccines can cause long-term adverse effects	Disagree	109	64.5	151	72.9	268	80.5	287	71.6	45	80.4	17.58 0.0015
	Agree	60	35.5	56	27.1	65	19.5	114	28.4	11	19.6	
Giving more vaccines at the same time increases the risk of side effects	Disagree	110	65.1	135	65.2	267	80.2	285	71.1	41	73.2	19.93 0.001
	Agree	59	34.9	72	34.8	66	19.8	116	28.9	15	26.8	
The number of scientific data about usefulness of vaccination is insufficient	Disagree	136	80.5	174	84.1	237	71.2	328	81.8	35	62.5	25.32 <0.001
	Agree	33	19.5	33	15.9	96	28.8	73	18.2	21	37.5	
Vaccines cause more harm than good	Disagree	103	60.9	135	65.2	106	31.8	251	62.6	10	17.9	118.33 <0.001
	Agree	66	39.1	72	34.8	227	68.2	150	37.4	46	82.1	
Mandatory vaccination is an encroachment on domain of human rights	Disagree	130	76.9	158	76.3	233	70.0	320	79.8	39	69.6	10.806 0.028
	Agree	39	23.1	49	23.7	100	30.0	81	20.2	17	30.4	
The pharmaceutical industries are creating infections with the goal of increasing earnings	Disagree	142	84.0	166	80.2	190	57.1	321	80.0	30	53.6	79.268 <0.001
	Agree	27	16.0	41	19.8	143	42.9	80	20.0	26	46.4	
Vaccines are a trigger for autism and autoimmune diseases	Disagree	125	74.0	156	75.4	246	73.9	310	77.3	40	71.4	1.837 0.768
	Agree	44	26.0	51	24.6	87	26.1	91	22.7	16	28.6	

UNSA: University of Sarajevo. UNIRI-E: University of Rijeka (studies in English).

English have the most informed views on vaccines.

There was a significant difference in students' attitudes toward the utility of vaccination (χ^2=14.5, p<0.001) and the pharmaceutical industry's desire to make a profit (χ^2=34.9, p<0.001).

One of the study's goals was to see if there were any differences in student attitudes, knowledge, and perceptions about vaccination between medical and non-medical students. Both groups demonstrated a lack of knowledge. Even so, there were statistically significant differences between medical (mean=2.51, SD=1.23) and non-medical students (mean=2.03, SD=1.30), t-test=6.35, p<0.001 (Table 4).

Table 3. Attitudes and practices regarding COVID-19 among medical and non-medical students about immunization during the COVID-19 pandemic, February–May 2021 (N=1166)

Question	Response	UNSA students				UNIRI students				UNIRI-E students		χ^2 p
		Medical		Non-Medical		Medical		Non-Medical		Medical		
		n	%	n	%	n	%	n	%	n	%	
Have you been COVID-19 positive?	Yes	32	18.9	56	27.1	75	22.5	77	19.2	15	27.3	80.984 <0.001
	No	109	64.5	121	58.5	205	61.6	256	63.8	33	60.0	
	I don't know	26	15.4	28	13.5	53	15.9	65	16.2	0	0.0	
	I am not sure	2	1.2	2	1.0	0	0	3	0.7	7	12.7	
Do you fear for your own health if you do not receive the COVID-19 vaccine?	Yes	42	24.85	72	34.78	96	28.83	44	10.97	22	40.0	81.841 <0.0001
	No	105	62.13	99	47.83	187	56.16	313	78.05	31	56.4	
	I don't know	22	13.02	36	17.39	50	15.02	44	10.97	2	3.6	
I have been informed enough about the COVID-19 vaccine by the media and health professionals	Strongly disagree	44	26.0	84	40.6	40	12	82	20.4	7	12.7	105.17 <0.0001
	Disagree	49	29.0	55	26.6	83	24.9	124	30.9	6	10.9	
	Neither agree nor disagree	46	27,2	41	19.8	103	30,9	119	29.7	21	38.2	
	Agree	28	16.6	18	8.7	82	24.6	59	14.7	15	27.3	
	Strongly agree	2	1.2	9	4.3	25	7.5	17	4.2	6	10.9	
What do you consider current COVID-19 vaccines safe?	Yes	44	26.04	66	31.8	181	54.35	111	27.68	36	65.5	103.54 <0.0001
	No	53	31.4	70	33.8	54	16.2	152	37.9	3	5.5	
	I don't know	72	42.60	71	34.30	98	29.43	138	34.41	16	29.1	

UNSA: University of Sarajevo. UNIRI-E: University of Rijeka (studies in English).

Table 4. Differences in attitudes and knowledge of medical and non-medical students regarding immunization during the COVID-19 pandemic, February–May 2021 (N=1166)

Item	Response	Medical students		Non-medical students		χ^2	p
		n	%	n	%		
I think that I cannot get the disease if I have been vaccinated	Disagree	420	75.5	456	74.8	0.096	0.757
	Agree	136	24.5	154	25.2		
Some of the vaccines can cause long-term adverse effects	Disagree	421	75.7	439	72.0	2.116	0.146
	Agree	135	24.3	171	28.0		

Continued

Table 4. Continued

Item	Response	Medical students		Non-medical students		χ^2	p
		n	%	n	%		
Giving more vaccines at the same time increases the risk of side effects	Disagree	418	75.2	420	68.9	5.76	**0.016**
	Agree	138	24.8	190	31.1		
The number of scientific data about usefulness of vaccination is insufficient	Disagree	407	73.2	503	82.5	14.548	**<0.001**
	Agree	149	26.8	107	17.5		
Vaccines cause more harm than good	Disagree	218	39.2	387	63.4	68.428	**<0.001**
	Agree	338	60.8	223	36.6		
Mandatory vaccination is an encroachment on domain of human rights	Disagree	401	72.1	479	78.5	6.441	**0.011**
	Agree	155	27.9	131	21.5		
The pharmaceutical industries are creating infections to increase their profit	Disagree	360	64.7	489	80.2	34.919	**<0.001**
	Agree	196	35.3	121	19.8		
Vaccines are a trigger for autism and autoimmune diseases	Disagree	410	73.7	467	76.6	1.238	0.266
	Agree	146	26.3	143	23.4		
Correct responses	Mean (SD)	2.51 (1.23)		2.03 (1.30)		**t-test** 6.352	**p <0.001**

DISCUSSION

This study aimed to evaluate students' knowledge, attitudes, and practices regarding the COVID-19 pandemic and immunization programs[18]. Vaccine hesitancy, caused by a loss of confidence in vaccines and public institutions, poses challenges for public health authorities[2]. The objective of this study was to emphasize the importance of targeted interventions to modify the knowledge, practices, and attitudes of medical students in relation to their future roles in immunization programs[15-18]. The survey included 1166 students from two universities in Bosnia and Herzegovina and the Republic of Croatia, representing different study years and affiliations. The research aimed to evaluate the knowledge, attitudes, and preventive behaviors of medical students compared to non-medical students in relation to immunization and the COVID-19 pandemic[18]. Assessing medical students' knowledge and preventive behaviors is crucial, as they are at the frontline in the fight against the pandemic[15-17].

The initial results showed a predominantly positive attitude toward vaccination programs among all participants (56.5% in BH and 61.3% in RH). The questionnaire also assessed the coverage of mandatory vaccines, considering the influence of anti-vaccination propaganda, particularly prevalent on the internet[14]. Literature search results highlighted the significant presence of anti-vaccination websites in online search results and Facebook pages dedicated to opposing vaccination[19-21]. Nonetheless, the majority of students in the study were fully vaccinated ($p<0.0001$), indicating a positive trend despite anti-vaccination propaganda[21]. These findings align with the positive attitudes of Serbian medical students toward immunization[22,23]. Healthcare professionals were identified as the most influential source of vaccination information, followed by the internet and social networks, professional literature, TV and media, and friends and family[24]. Similar studies have confirmed the strong influence of social media and the news media in shaping vaccination attitudes[25,26].

Limited data are available on the vaccination-related knowledge, practices, and attitudes of students in Southeast Europe[13]. Medical students demonstrated more knowledge about vaccination, as expected. There were significant differences in vaccine knowledge between medical and non-medical students ($p<0.001$)[27]. However, a substantial number of students from both medical faculties expressed the belief that vaccines cause more harm than good, highlighting the need for interventions to improve vaccination education in both clinical and preclinical courses.

Strengths and limitations

The strengths of this study are the comprehensive questionnaire, the multicentric international study, and the comparison of two populations with different educational backgrounds. The limitations of the study are that the majority of students were female and that the results are cross-sectional and hence cannot attribute causality. Furthermore, the results may be subject to reporting bias.

CONCLUSIONS

The results of this study indicate that there is an evident need to further educate young people about vaccination. Bosnia and Herzegovina, and Croatia, are faced with a problem of high-risk populations regarding vaccination hesitance[28], thus, vaccination knowledge and attitudes of medical students are of particular interest. The outcomes of this research could be useful for medical educators to ensure that medical students have better knowledge compared to students of other faculties.

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CONFLICTS OF INTEREST
The authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest and none was reported.

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DATA AVAILABILITY
The data supporting this research are available from the authors on reasonable request.

AUTHORS' CONTRIBUTIONS
Conceptualization: SMV, OCP and AV. Methodology: SMV, OCP and AJ. Software: AJ, SS, SVS and ID. Formal analysis: OCP. Investigation: SMV, OCP and AJM. Resources: OCP and AK. Data curation: EA. Writing of the original draft: HČ. Writing, reviewing and editing: SMV, OCP, ATJR, IŠ and AV. All authors read and agreed to the final version of the manuscript.

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