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# Knowledge and Attitudes regarding Covid-19 Vaccination among Medical and Non-medical Students in Bosnia and Herzegovina

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**Abstract**

**Objective.** The aim of this study was to investigate students' knowledge, attitudes and hesitancy regarding COVID-19 vaccination. **Methods.** A cross-sectional questionnaire-based survey was conducted among a total of 1282 medical students and 509 non-medical students at four public universities in Bosnia and Herzegovina: Tuzla, Sarajevo, Banja Luka, and Mostar. **Results.** A significantly higher rate of vaccination was observed in the group of medical students as well as a higher level of knowledge about vaccination in general and vaccines against the COVID-19 disease. Students who received the COVID-19 vaccine had a higher level of knowledge about vaccination in general and COVID-19 vaccines in particular compared to the non-vaccinated students in the medical and non-medical groups, respectively. Furthermore, vaccinated students, regardless of the course they are taking, showed generally stronger positive attitudes compared to non-vaccinated students, regarding the safety and effectiveness of the COVID-19 vaccine. Both groups of students believe that the rapid development of the vaccine is contributing to refusal or hesitancy to receive a vaccine against COVID-19. Social media/networks were the main sources of information about the COVID-19 vaccine. We did not find any contribution of social media to the reduced level of COVID-19 vaccine coverage. **Conclusion.** Education of students about the benefits of the COVID-19 vaccine will lead to its better acceptance as well as the development of more positive attitudes towards vaccination in general, especially having in mind that students are the future population of parents, who will make decisions about vaccinating their children.

**Key Words:** COVID-19 Vaccine Students ▪ Knowledge ▪ Attitudes ▪ Hasitancy.

## Introduction

At the beginning of the current COVID-19 pandemic, the development of a safe and effective vaccine against COVID-19 was expected to be a long-term solution to control the pandemic (1). According to the World Health Organization's report, as of March 16, 2023, a total of 760,360,956 infection cases had been confirmed globally, including 6,873,477 deaths (2). On December 31, 2020, the World Health Organization (WHO) announced that the Pfizer/BioNTech mRNA vaccine had been approved for emergency use, making it the first to be approved since the beginning of the pandemic (2).

Immunization programs face significant challenges in achieving targeted vaccination rates, and outbreaks of vaccine-preventable diseases are still frequently reported (3). Health experts attribute vaccine-preventable disease outbreaks to increasing hesitancy and negative attitudes toward

vaccination, suggesting that vaccination coverage rates are partly a reflection of individual vaccination attitudes and behaviors (4-6). One theory is that individuals will adopt a negative attitude towards vaccination when they feel threatened (7). In many cases, however, the necessity of vaccination is questioned due to the lack of awareness of the disease, poor knowledge of its potential consequences, and the perception of low susceptibility to the disease (8-10). A study of COVID-19 vaccination acceptance rates in different parts of the world found high acceptance rates in Malaysia, Indonesia, and China, whereas low acceptance rates were found in Italy, Russia, the United States, and France (11).

The decision to vaccinate can be influenced by doubts about the safety and protective effect of the vaccine, as well as the perceived benefits of vaccination (7). Such distorted attitudes can be formed due to misinformation regarding the risks posed by vaccination (12). Social norms and networks exert a strong influence on attitudes and behaviors related to vaccination, and individuals may align their vaccination decisions with the decisions of family members and members of their social network (4). This explains why negative attitudes towards vaccination sometimes cluster geographically (13).

While many studies have examined parents' knowledge, beliefs, and attitudes toward vaccination, perceptions and behaviors toward vaccination among young adults remain poorly described, with the exception of a few published studies focusing on specific vaccines for HPV infection and influenza (10, 14, 15). Young people represent the population of future parents who will make decisions about vaccinating their children. Also, young people represent future health workers who will educate the public about the benefits of vaccines, and counsel individuals who express doubts about vaccines. Regarding the student population, certain studies show that educational background affects attitudes about vaccination in general as well as about the vaccine against COVID-19 in particular.

The objective of this study was to examine and contrast the COVID-19 vaccination-related knowledge and attitudes of medical and non-medical students in Bosnia and Herzegovina. Additionally, the study aimed to identify the primary reasons why individuals were hesitant or refused to receive the COVID-19 vaccine.

## Materials and Methods

### *Participants*

This cross-sectional study was conducted in April and May 2022, and included a total of 1282 students from the medical group of faculties (faculties of pharmacy, medicine, veterinary medicine, dental medicine and health science) and 509 students from the non-medical group of faculties (faculties of electrical engineering, mechanical engineering, economics, science and mathematics) at four public universities in Bosnia and Herzegovina: the University of Tuzla, the University of Sarajevo, the University of Banja Luka and the University of Mostar.

### *Questionnaire*

The survey questionnaire comprised four sections: socio-demographics, inquiries regarding knowledge of and attitudes towards the COVID-19 vaccine, and reasons for vaccine hesitancy or refusal. The criteria for the question selection were based on previously published articles (16-19). Socio-demographic characteristics comprised the first part of the questionnaire, and included the students' gender, age, university status, and questions about COVID-19 vaccination and sources of information about COVID-19 vaccines. The second part of the questionnaire consisted of ten main questions regarding the participants' general knowledge of vaccines and specific knowledge of COVID-19 vaccines. The participants provided answers to ten questions related to the COVID-19 vaccine, with the answer options "*Yes/No/I don't know*" (seven questions) and multiple answers (three questions). For the purposes of statistical data processing, their answers were translated into true/false answers.

The third part of the questionnaire consisted of nine questions regarding the participants' attitudes toward the COVID-19 vaccine, and students rated the answers on a Likert scale, with numbers from 1 (representing the lowest degree of agreement) to 5 (representing the highest degree of agreement) (20). In order to check the reliability of the measurement scale, the calculation of the Cronbach alpha coefficient was applied. Cronbach's alpha for the group of questions that assessed students' attitudes about the COVID-19 vaccine was 0.662.

The fourth part of the questionnaire, regarding the participants' hesitancy/refusal of the COVID-19 vaccines, consisted of twelve questions, 6 medically-based and 6 non- medically based. Students rated the answers using a Likert scale with numbers from 1 (representing the lowest degree of agreement) to 5 (representing the highest degree of agreement). Cronbach's alpha for the group of questions examining the reasons for hesitancy/refusal of the COVID-19 vaccine was 0.822.

### *Data Collection*

The study was created as a cross-sectional study, based on filling out a survey questionnaire. The clarity, content comprehensibility and layout acceptability of the questionnaire were pretested on a small sample of students (N=10). For this purpose, the questionnaire was piloted with 10 medical students from the University of Tuzla.

Participation in the study was voluntary. The survey was conducted online, using the *SurveyMonkey* platform. The link to access the survey was delivered to students via email or a *Viber* group, along with an information leaflet and informed consent. The respondents were asked if they had read and understood the information leaflet, and gave consent for their anonymous answers to be saved and analyzed together with all the other answers. After the students had agreed to participate in the study, they could fill out the survey. The survey was set up by software so that it was not mandatory to answer all the questions in order to be able to submit the survey. Seven days after the initial invitation, students were sent an additional e-mail/message in the *Viber* group inviting them to fill out the survey, if they had not already done so. When the survey was closed, all the anonymous responses were entered into a single database. All data collected for this study were securely stored and will be destroyed five years after the end of the project.

### *Ethical Statement*

The study protocol and questionnaires were previously approved by the Ethics Committee for Scientific Research of the University of Tuzla (number 03/7-2185-1/22, April 18, 2022.)

## Statistical Analysis

The collected data were analyzed using the Statistical Package for Social Sciences (SPSS)/ WIN program (Release 21.0 SPSS Inc., Chicago, IL, USA). Qualitative data are presented as frequencies and percentages. The Chi-square test was used to examine differences between groups of categorical variables. The t-test was used to compare average knowledge score between the groups. The Mann–Whitney U test was used to compare the medians of two or more independent groups, when assessing attitudes and reasons for refusing/ hesitating regarding the COVID-19 vaccine. In all tests, values of $P \leq 0.05$ were considered statistically significant.

### *Data Availability*

The datasets generated and/or analyzed during the current study are available from the corresponding author on request.

## Results

The socio-demographic characteristics of the participants are shown in Table 1. Females aged 21 to 22 were the main participants in both groups of students. Out of 1791 students surveyed, 1502 students (83.86%) answered the question whether

Table 1. Socio-demographic Characteristics and Vaccination Status of the Survey Participants

| Participant characteristics | | Medical group of faculties N (%) | Non-medical group of faculties N (%) |
|---|---|---|---|
| Gender | Female | 1030 (80.40) | 315 (62.0) |
| | Male | 229 (17.88) | 188 (37.0) |
| | Prefer not to say | 22 (1.72) | 5 (1.0) |
| Age | 18-20 | 433 (33.80) | 176 (34.58) |
| | 21-22 | 626 (48.87) | 213 (41.85) |
| | 23-25 | 159 (12.41) | 69 (13.55) |
| | >25 | 63 (4.92) | 51(10.02) |
| University | Tuzla | 676 (52.73) | 165 (32.48) |
| | Sarajevo | 331 (25.82) | 102 (20.08) |
| | Banja Luka | 49 (3.82) | 131 (25.79) |
| | Mostar | 226 (17.63) | 110 (21.65) |
| Study year | I | 320 (24.96) | 155 (32.63) |
| | II | 351(27.38) | 133 (28.0) |
| | III | 306 (23.87) | 101 (21.26) |
| | IV | 151 (11.78) | 86 (18.11) |
| | V | 137 (10.69) | - |
| | VI | 17 (1.33) | - |
| Have you been vaccinated against COVID-19? | Yes | 601 (54.88) | 157 (38.57) |
| | No | 494 (45.12) | 250 (61.43) |

they were vaccinated. In the group of medical faculties, 601 students (54.89%) were vaccinated out of the 1095 who answered this question. In the group of non-medical faculties, 157 students (38.57%) were vaccinated out of the 407 who answered this question. The vaccination rate in the group of students from medical faculties was significantly higher than the group of students from non-medical faculties ($\chi^2$=31.58, P<0.001).

Overall, medical students showed a higher level of knowledge about vaccines in general and COVID-19 vaccines in particular (mean correct response: 6.74/10, 67.4%, SD=0.69) compared to non-medical students (4.82, 48.19%, SD=0.54) (t=112.99, P<0.001) (Table 2). In addition, a higher level of knowledge was found in vaccinated students compared to non-vaccinated students in medical (vaccinated 4.16, 41.6%, SD=0.11 *vs* non-vaccinated 2.58, 25.83%, SD=0.10; t=613.32, P<0.001) and in the non-medical group (vaccinated 2.60, 25.96%, SD=0.075 *vs* non-vaccinated 2.34, 23.37%, SD=0.13; t=53.49, P<0.001) respectively.

Students rated their attitudes about COVID-19 vaccination on a Likert scale, with numbers from 1 (representing the lowest degree of agreement) to 5 (representing the highest degree of agreement). Out of nine attitudes evaluated, students from the medical group of faculties had a statistically significant higher average level of agreement in seven attitudes compared to students from non-medical faculties. When it comes to attitude 3 (*The best way to carry out COVID-19 vaccination is allowing free choice to receive the vaccine or not*) both groups showed a high degree of agreement in the sense that a person has the free choice to receive the vaccine or not.

However, in this case, students from non-medical faculties expressed a statistically significant higher degree of agreement with this attitude compared to students from the medical group of faculties (Table 3). Similarly in attitude 7 (*I am worried about the long-term side effects of COVID-19 vaccines*), students from non-medical faculties expressed a statistically significant higher level of concern when it comes to the long-term

Table 2. Distribution of the Answers to the Questions That Assessed Students' Knowledge and Differences between Medical and Non-medical Students

| Questions used to assess students' knowledge | Correct answer | Students | | Total number | Chi square | P value |
|---|---|---|---|---|---|---|
| | | Medical N (%) | Non-medical N (%) | | | |
| Smallpox and polio have been eliminated in Europe thanks to vaccination | Yes | 929 (80.02) | 235 (52.81) | 1606 | 118.03 | <0.001 |
| | No | 232 (19.98) | 210 (47.19) | | | |
| Vaccines are only important for children | Yes | 1034 (88.99) | 335 (75.28) | 1607 | 47.89 | <0.001 |
| | No | 128 (11.01) | 110 (24.72) | | | |
| Vaccines can protect me from diseases that are quite dangerous | Yes | 1036 (89.16) | 293 (65.70) | 1608 | 123.71 | <0.001 |
| | No | 126 (10.84) | 153 (34.30) | | | |
| A larger part of the population needs to be vaccinated against a certain disease in order to prevent an outbreak of that disease | Yes | 1019 (88.0) | 273 (61.35) | 1603 | 87.32 | <0.001 |
| | No | 139 (12.0) | 172 (38.65) | | | |
| The production and marketing of vaccines is a safe and controlled process | Yes | 753 (64.80) | 137 (30.79) | 1607 | 149.30 | <0.001 |
| | No | 409 (35.20) | 308 (69.21) | | | |
| The vaccine against COVID-19 can cause infection with the corona virus | Yes | 418 (35.88) | 98 (21.97) | 1611 | 28.02 | <0.001 |
| | No | 747 (64.12) | 348 (78.03) | | | |
| The vaccine against COVID-19 weakens human immunity | Yes | 612 (52.58) | 137 (30.79) | 1609 | 60.56 | <0.001 |
| | No | 552 (47.42) | 308 (69.21) | | | |
| What type of vaccine is Pfizer vaccine? | Yes | 887 (77.67) | 282 (66.51) | 1556 | 19.77 | <0.001 |
| | No | 255 (22.33) | 142 (33.49) | | | |
| What type of vaccine is Astra Zeneca vaccine? | Yes | 624 (54.98) | 202 (47.98) | 1566 | 5.76 | <0.05 |
| | No | 511 (45.02) | 219 (52.02) | | | |
| What type of vaccine is Sinopharm vaccine? | Yes | 435 (38.84) | 107 (24.76) | 1540 | 23.33 | <0.001 |
| | No | 685 (61.16) | 313 (75.24) | | | |

side effects of COVID-19 vaccines (Table 3). What needs to be emphasized is the response of both examined groups of students in attitude 6 (*The rapid development of the COVID-19 vaccine contributes to the refusal or hesitation of the population regarding vaccination using this vaccine*). Both groups show an extremely high degree of agreement with this attitude, i. e. both groups believe that the rapid development of a vaccine contributes to refusal or hesitancy regarding the COVID-19 vaccine, although students from the medical group of faculties expressed a statistically significant higher degree of agreement with this attitude.

When the attitudes of vaccinated medical students were examined in comparison to unvaccinated students, it was found that vaccinated medical students evaluated six attitudes statistically significantly more positively, except attitudes 3, 6 and 7 where the non-vaccinated students showed a statistically significantly higher degree of agreement with the attitudes that students should have free choice to be vaccinated (Mann-Whitney U=86703.50, P<0.001), that the rapid development of the vaccine contributes to the hesitancy of the population regarding vaccination with this vaccine (Mann-Whitney U=135633.00, P<0.05) and the attitude related to concern due to the long-term side effects of COVID-19 vaccines (Mann-Whitney U=86819.50, P<0.001).

When the attitudes of vaccinated non-medical students were examined in comparison to unvaccinated students, it was found that vaccinated non-medical students evaluated six attitudes statistically significantly more positively, except attitudes 3 and 7 where non-vaccinated students showed a statistically significantly higher degree of agreement with the attitude that students should have the free choice to get vaccinated (Mann-Whitney

Table 3. Descriptive Statistics in Attitudes regarding the Covid-19 Vaccination and Differences in Attitudes between Medical and Non-medical Students

| Student's attitudes | Students | Mean | SD* | Median | IQR† | Mann -Whitney U | P value |
|---|---|---|---|---|---|---|---|
| The vaccine against COVID-19 is safe | Medical | 3.17 | 1.11 | 3 | 1 | 182304.50 | <0.001 |
| | Non-medical | 2.76 | 1.31 | 3 | 2 | | |
| The COVID-19 vaccine is effective | Medical | 3.19 | 1.08 | 3 | 1 | 181798.00 | <0.001 |
| | Non-medical | 2.78 | 1.23 | 3 | 2 | | |
| The best way to carry out COVID-19 vaccination is to choose freely whether to receive the vaccine or not | Medical | 3.57 | 1.36 | 4 | 2 | 186552.00 | <0.001 |
| | Non-medical | 3.95 | 1.33 | 5 | 2 | | |
| The best way to implement COVID-19 vaccination is the mandatory vaccination of the entire population | Medical | 2.87 | 1.42 | 3 | 2 | 171293.50 | <0.001 |
| | Non-medical | 2.27 | 1.36 | 2 | 2 | | |
| The best way to carry out COVID-19 vaccination is mandatory vaccination of certain groups of people (health workers, people with chronic diseases, people over 60 years old, etc.) | Medical | 3.22 | 1.35 | 3 | 2 | 197082.00 | <0.001 |
| | Non-medical | 2.92 | 1.38 | 3 | 2 | | |
| The rapid development of the COVID-19 vaccine contributes to the refusal or hesitation of the population regarding vaccination with this vaccine | Medical | 3.85 | 1.19 | 4 | 2 | 198670.50 | <0.001 |
| | Non-medical | 3.59 | 1.29 | 4 | 2 | | |
| I am concerned about the long-term side effects of the COVID-19 vaccines | Medical | 3.26 | 1.31 | 3 | 2 | 204286.00 | <0.01 |
| | Non-medical | 3.45 | 1.39 | 4 | 3 | | |
| Mass vaccination of COVID-19 may lead to the end of the pandemic | Medical | 3.38 | 1.25 | 3 | 1 | 177607.50 | <0.001 |
| | Non-medical | 2.9 | 1.35 | 3 | 2 | | |
| The COVID-19 vaccine will bring life back to pre-pandemic levels | Medical | 3.09 | 1.24 | 3 | 2 | 184599.50 | <0.001 |
| | Non-medical | 2.69 | 1.30 | 3 | 2 | | |

*Standard deviation; †Interquartile range.

U=12678.50, P<0.001) and with the attitude related to concern about the long-term side effects of the COVID-19 vaccine (Mann-Whitney U=12237.50, P<0.001). Vaccinated and non-vaccinated students at non-medical faculties showed an equally high level degree of agreement with attitude six (that the rapid development of the vaccine contributes to the hesitancy of the population regarding vaccination against COVID-19).

During the survey, students who were not vaccinated answered the question about the reasons for not being vaccinated. Only 9.54% had contraindications for vaccination and the others were hesitant (29.84%) or did not want to receive the vaccine (60.62%). Students rated the contribution of the reasons for reluctance/refusal to receive the vaccine on a Likert scale from 1 (representing the least degree of agreement) to 5 (representing the highest degree of agreement). Twelve questions, that is, the reasons why students were hesitant to receive the vaccine, were divided into two groups, medically based (reasons 1-4, reasons 6 and 7) and medically unfounded reasons (reason 5, reasons 8-12) (Table 4).

As can be seen from Table 4, the reasons that most contribute to students' reluctance/refusal to receive the COVID-19 vaccine are the first four reasons, which can be considered medically based (reason 1: *the COVID-19 vaccine is not safe due to its rapid development;* reason 2: *the COVID-19 vaccine can cause a fatal outcome*; reason 3: *the COVID-19 vaccine can cause long term genetic defects*; reason 4: the *adverse effects of the COVID-19 vaccine are not well known due to the relatively short time of administration of the vaccine*). In fact, reason 4, in both investigated groups, contributed the most to students' reluctance/refusal to receive the vaccine, and no statistically significant difference

Table 4. Descriptive Statistics on Reasons of Refusal/reluctance COVID-19 Vaccine and Differences in Reasons between Medical and Non-medical Students

| Reason of refusal/reluctance | Students | Mean | SD* | Median | IQR† | Mann -Whitney U | P value |
|---|---|---|---|---|---|---|---|
| The COVID-19 vaccine is not safe due to its rapid development | Medical | 3.50 | 1.12 | 3 | 1 | 44049.00 | >0.05 |
| | Non-medical | 3.66 | 1.24 | 4 | 2 | | |
| The COVID-19 vaccine can cause death | Medical | 3.29 | 1.11 | 3 | 1 | 39861.00 | <0.001 |
| | Non-medical | 3.64 | 1.28 | 4 | 2 | | |
| The COVID-19 vaccine can cause long term genetic defects | Medical | 3.33 | 1.01 | 3 | 1 | 38840.00 | <0.001 |
| | Non-medical | 3.68 | 1.13 | 4 | 2 | | |
| The adverse effects of the COVID-19 vaccine are not well known due to the relatively short time of administration of the vaccine | Medical | 3.89 | 1.11 | 4 | 2 | 47422.00 | >0.05 |
| | Non-medical | 3.88 | 1.21 | 4 | 2 | | |
| Anti-vaxxer theories spreading on social media influence my attitudes towards the COVID-19 vaccine | Medical | 2.35 | 1.20 | 2 | 2 | 47663.00 | >0.05 |
| | Non-medical | 2.36 | 1.31 | 2 | 2 | | |
| The COVID-19 vaccine can cause autism | Medical | 2.65 | 1.01 | 3 | 1 | 40129.50 | <0.001 |
| | Non-medical | 2.98 | 1.10 | 3 | 0 | | |
| The COVID-19 vaccine can cause sterility | Medical | 3.08 | 1.00 | 3 | 0 | 39347.00 | <0.001 |
| | Non-medical | 3.41 | 1.02 | 3 | 1 | | |
| People around me told me not to get vaccinated against COVID-19 | Medical | 2.53 | 1.26 | 2 | 2 | 48017.50 | >0.05 |
| | Non-medical | 2.52 | 1.33 | 2 | 2 | | |
| The COVID-19 pandemic was created in order for pharmaceutical companies to make huge profits from vaccines | Medical | 3.02 | 1.16 | 3 | 2 | 36233.00 | <0.001 |
| | Non-medical | 3.56 | 1.25 | 4 | 2 | | |
| The SARS COV-2 virus is a biological weapon | Medical | 3.23 | 1.07 | 3 | 1 | 40273.50 | <0.001 |
| | Non-medical | 3.56 | 1.09 | 3 | 2 | | |
| Authorities are fabricating death tolls and implementing vaccinations against COVID-19 to control the population | Medical | 3.15 | 1.13 | 3 | 2 | 38187.50 | <0.001 |
| | Non-medical | 3.56 | 1.17 | 3 | 2 | | |
| 5G antennas are linked to the COVID-19 pandemic | Medical | 2.17 | 1.21 | 2 | 2 | 43997.50 | >0.05 |
| | Non-medical | 2.37 | 1.29 | 2 | 2 | | |

*Standard deviation; †Interquartile range.

in the average values of students' answers was found regarding this reason.

Both medical and non-medical students showed the lowest degree of agreement with the medically unfounded reasons (reason 5: *Anti-vaxxer theories spreading on social media influence my attitudes towards the COVID-19 vaccine;* reason 8. *People around me told me not to get vaccinated against COVID-19;* and reason 12: *5G antennas are linked to the COVID-19 pandemic*). At the same time there was no statistically significant difference in the average values of their answers regarding these reasons.

The main sources of information about the COVID-19 vaccine were social media/ social networks (Figure 1). When the students were classified according to the type of study (medical, non-medical) and according to whether they had received the COVID-19 vaccine, social networks remained the main source of information in all subgroups. It was found that vaccinated students gave greater importance to the WHO as a source of information compared to non-vaccinated students in both groups of students (69.88% vaccinated students vs. 50.51% unvaccinated in the medical group; 67.52% vaccinated students vs. 41.60% unvaccinated in

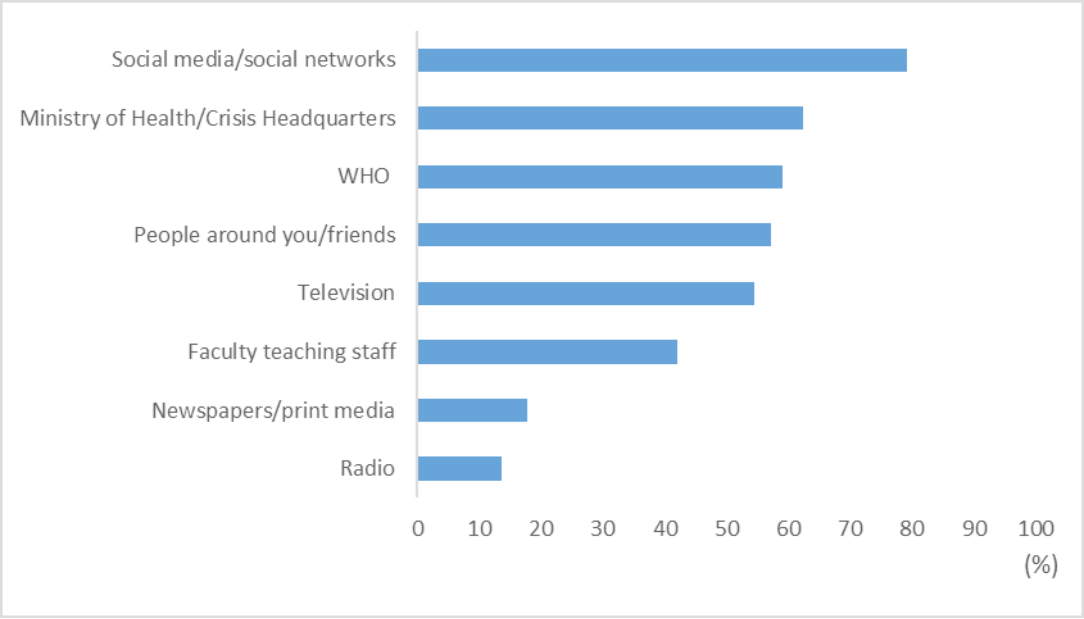


Figure 1. Sources of information about the COVID-19 vaccine.

the non-medical group). Also, vaccinated students gave greater importance to the WHO as a source of information compared to non-vaccinated students in both groups of students. Medical students gave more importance to teaching staff as a source of information than non-medical students, which is to be expected given the nature of the studies they attend (53.91% of vaccinated and 51.52% unvacinated medical students vs. 15.29% vaccinated and 14.80% unvaccinated non-medical students).

## Discussion

This study analyzed the differences in knowledge and attitudes regarding COVID-19 vaccination between medical and non-medical students. Out of 1791 students surveyed, 83.86% answered the question about whether they had been vaccinated. The vaccination rate in the group of medical faculties was significantly higher compared to the group of students from non-medical faculties. Medical students showed a higher level of knowledge about vaccines in general and COVID-19 vaccines in particular compared to non-medical students, which was to be expected given the nature of the studies they attend. Furthermore, our study shows that a higher level of knowledge is positively reflected in a higher rate of vaccination, regardless of whether it is a question of medical or non-medical students. This result is consistent with the result showing vaccination rates among medical and non-medical students, according to which medical students have a higher vaccination rate compared to non-medical students. In addition, a higher level of knowledge was found amongst vaccinated students compared to non-vaccinated students in both the medical and non-medical groups. Research conducted in Bulgaria showed that medical students had a more positive attitude towards the COVID-19 vaccination, a higher rate of vaccination against COVID-19 and showed a higher rate of trust in information about the COVID-19 vaccines provided by the WHO and national health organizations, in relation to non-medical students (21). A study conducted in China on a student population showed that the approval rate of medical students towards the safety and effectiveness of the vaccine against COVID-19 was higher than that of non-medical students (22). A cross-sectional study conducted among the students at a tertiary care center in North India, showed that medical students had

sufficient knowledge, an optimistic attitude, and moderate levels of concern towards COVID-19. Vaccine hesitancy was much lower among medical students when compared to non-medical students (23). The Coronavirus Disease 2019 (COVID-19) pandemic has persisted despite reductions in disease severity, hospitalizations and deaths since the introduction of multiple vaccines that protect against COVID-19 and pharmaceuticals to treat its symptoms (24, 25). However, vaccine hesitancy and refusal continue to impede the effectiveness of these interventions (26, 27). Drivers of vaccine hesitancy include lower education, mistrust in science and governments (28-30), and misinformation (31, 32).

Medical students, as well as vaccinated students regardless of the course they are taking, showed more positive attitudes compared to non-medical students and unvaccinated students, regarding the safety and effectiveness of the COVID-19 vaccine, regarding the attitude that mass vaccination will lead to the end of the pandemic, and the attitude that COVID-19 vaccine will bring life back to pre-pandemic levels. However, both medical and non-medical students showed a high level of agreement with the attitude that the COVID-19 vaccination should be based on free choice. Both medical and non-medical students, regardless of whether they had been vaccinated, expressed a high degree of agreement with the attitude that the rapid development of COVID-19 vaccines contributes to vaccine refusal or hesitancy, and with the attitude related to concerns about possible long-term side effects of COVID-19 vaccines.

A survey of medical students at two universities in Egypt (N=2133) showed that the most frequently reported barriers to COVID-19 vaccination were insufficient information about the adverse effects of the vaccine (74.4%) and insufficient information about the vaccine itself (72.8%) (33). A study among medical students (N=167) in southeast Michigan found that 98% believed that COVID-19 vaccination was critical to reducing community spread. Although 98% of students believed they were most likely to be exposed to COVID-19, 23% said they would not receive a COVID-19 vaccine immediately after U.S. Food and Drugs Administration (FDA) approval. Medical students' concerns about the serious side effects of the COVID-19 vaccine were closely related to their confidence in the information they received regarding the COVID-19 vaccine (34). Vaccine hesitancy is a critical barrier to COVID-19 vaccine uptake in high-income countries or regions, where vaccine-specific factors associated with increased vaccine hesitancy have been found to lead to beliefs that the vaccine is not safe/effective, and increased concern about the rapid development of COVID-19 vaccines (35). Balan et al.'s survey conducted in Romania found that more than 88% of students expressed a favorable attitude towards COVID-19 vaccination (36). However, healthcare students in Romania who declined to receive the SARS-CoV-2 vaccine, cited the rapid development of the vaccine as the primary reason ($P<0.001$). According to Bagić et al.'s study conducted in Croatia, the primary reasons for vaccine hesitancy were concerns over the safety of SARS-CoV-2 vaccines (reported by 82% or 627/765 of participants), as well as a general lack of trust in vaccines (reported by 71% or 543/765 of participants) (37). Our research shows that the reasons given by the students for hesitation/refusal to receive the COVID-19 vaccine are similar to other research, i.e. distrust in the vaccine due to its rapid development, and a lack of information about side effects.

Extensive anti-vaccine content is frequently shared across social media (38-40). The existing evidence suggests that exposure to such content may directly influence vaccination opinions and drive up vaccine hesitancy (41). Betsch et al. and Nan et al. have demonstrated that exposure to vaccine-critical websites and blogs negatively impacts the intention to be vaccinated (42, 43). When it comes to our research, the leading source of information about the COVID-19 vaccine were social media (N=1390 or 79.16%) followed by the Ministry of Health (N=1095 or 62.36%), the WHO (N=59.00% or 1036), friends (N=57.18% or 1004) and television (N=54.50% or 957) (Figure 1). These results could have been expected having in mind

that the survey participants were young people who also are the main social media users. When the students were classified according to the type of study (medical, non-medical) and according to whether they had received the COVID-19 vaccine, social media/networks remained the main source of information in all subgroups. Our research did not identify the link between social media and the decline in COVID-19 vaccine coverage that was reported by Marinos et al. (44) The authors found that respondents who received information on COVID-19 vaccines from social media had lower COVID-19 vaccine coverage. Riad et al. (45) also found that higher dependence on media and social media platforms was significantly associated with lower COVID-19 vaccine acceptance ($P<0.01$).

## Conclusion

This study examined the knowledge and attitudes of medical and non-medical university students regarding COVID-19 vaccination in Bosnia and Herzegovina. The results showed that medical students had a significantly higher vaccination rate and better knowledge about vaccines, including COVID-19 vaccines, than non-medical students. In terms of attitudes, medical students had a statistically significant higher level of agreement in seven out of nine attitudes compared to non-medical students. Both groups showed a high degree of agreement that the rapid development of the COVID-19 vaccine contributes to hesitancy regarding vaccination, although medical students expressed a statistically significantly higher degree of agreement with this attitude. Concerns about the long-term side effects of COVID-19 vaccines were also expressed, particularly by non-medical students. The main reasons for not being vaccinated were hesitation and a lack of willingness to receive the vaccine. The study provides unique insights into the factors influencing vaccination decisions among university students in Bosnia and Herzegovina, highlighting the need for targeted educational interventions to increase vaccine uptake.

**What Is Already Known on This Topic:**

*Previous studies in several countries have found that vaccine hesitancy remains a concern despite the high rate of a declared positive attitude towards COVID-19 vaccination. Some of the factors that have been identified as contributing to vaccine hesitancy among students include concerns over vaccine safety, distrust of the healthcare system, and information circulating on social media. Additionally, research has indicated that medical students tend to have a better understanding of vaccine efficacy and safety, as well as a higher likelihood of getting vaccinated, compared to non-medical students.*

**What This Study Adds:**

*The study provides novel insights into the trends and beliefs regarding vaccination among students, specifically in the context of COVID-19 vaccination in Bosnia and Herzegovina. The results highlight that medical students have a significantly higher vaccination rate compared to non-medical students, and also have a higher level of knowledge and more positive attitudes towards COVID-19 vaccination. The study also revealed that both groups of students share a concern regarding the rapid development of the COVID-19 vaccine, which contributes to vaccine hesitancy. Additionally, societal and cultural factors, such as personal beliefs, mistrust in authorities, and misinformation play a role in vaccine hesitancy among the surveyed students. Overall, the study sheds light on the need to address these factors in order to promote vaccination uptake and mitigate the negative impact of vaccine hesitancy on public health.*

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