2019 Novel Coronavirus Vaccination Among Medical Students

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Abstract
COVID-19 vaccination of medical students is essential since these students will have contact with patients and will become future healthcare leaders. Hence, we surveyed medical students at Texas Tech University Health Science Center in Lubbock, TX, and received 234 responses. The majority of students were vaccinated against COVID-19 (215/234; 91.8%) and reported pro-vaccine attitudes, such as support for a COVID-19 booster shot (191/234; 81.6%) and an annual COVID-19 vaccine (186/234; 79.5%). Among those who did not receive the COVID-19 vaccine, the most frequent reasons included waiting for more evidence (16/19; 84.2%) and concern about the side effects (15/19; 79.0%). These results indicate that medical students consider vaccination important and suggest that students can provide an important resource for patients and public education.

Keywords
COVID-19, SARS-CoV-2, vaccination, medical students

Dates received 2 September 2021; revised 19 October 2021; accepted 20 October 2021.

Introduction
The COVID-19 pandemic has generated important discussion about the need for vaccination, especially among healthcare professionals. Indeed, it is argued that healthcare professionals have the responsibility to both protect patients and set an example to the community by being vaccinated against SARS-CoV-2. However, vaccine hesitancy and skepticism among these professionals exist, suggesting a variety of views on vaccination which can send a mixed message to patients and the public. Several studies have examined vaccination rates and attitudes among healthcare workers, revealing a spectrum of vaccine acceptance, with 1 study in early 2021 finding hesitancy as high as 56%.4 Reasons for hesitancy in this group range from concern about safety and effectiveness to support of COVID-19 conspiracy theories.5

Medical students are also an important group in this discussion, as students both interact with patients and will become future healthcare leaders. Furthermore, attitudes during training may reflect the effectiveness of medical education about vaccines and may influence attitudes that these students will carry into medical practice. Students also serve as important sources of medical information for family and friends. Medical students represent a unique group that is both well-educated but not fully trained, thus creating a bridge between fully-trained medical professionals and educated but non-medical laypersons. Furthermore, students have undoubtedly experienced the effects of the COVID-19 pandemic due to alterations in medical education.6,7 However, studies on medical students’ attitudes toward vaccination are limited, with few measuring actual vaccination rates. This study intends to determine both the COVID-19 vaccination rate among medical students and their attitudes toward vaccination and reasons for vaccine hesitancy.

Methods
We conducted an anonymous online survey of medical students that was open from 13 July 2021 to 3 August 2021 using email distribution lists for all medical school classes at the Texas Tech University Health Sciences Center in Lubbock, TX, after getting approval from the Institutional Review Board (L21-088). An initial invitation email, as
well as 2 reminder emails at 1-week intervals, were sent to potential participants via a university administrator. Students were offered a chance to be randomly selected for a $20 gift card as an incentive. The distributed information was confidential and participants were permitted to terminate their participation at any time. Kobotoolbox (https://www.kobotoolbox.org/) and Excel were used to collect and analyze survey data. Class size was based on the standard class size (180) set by the university. Bivariate analysis was conducted to analyze the difference between those who got vaccinated and those who did not. A chi-squared test was used for categorical variables. It was considered significant if the P-value was <.05.

Results

A total of 234 students out 720 of medical students responded to the survey (Table 1). The majority of students (215/234; 91.9%) received the vaccine. Most vaccinated students experienced side-effects (130/215; 60.4%); the most common were relatively minor side-effects, including injection site pain (161/215; 74.9%), fatigue (142/215; 66.0%), fever/chills (130/215; 60.5%), and muscle aches (120/215; 55.8%). A majority of students had also been tested for COVID-19 (162/234; 69.2%) and 19.1% (31/162) of these students tested positive. Of note, 4 students tested positive for COVID-19 but did not receive the vaccine. Finally, there were no significant differences between the 2 groups regarding gender, medical student class, age, and the source of COVID-19 information (Table 3).

Attitudes and behaviors regarding COVID-19 and other vaccinations were generally supportive. The majority also had received childhood immunizations (233/234; 99.58%), supported vaccination against other illnesses (229/234; 97.9%), would recommend the COVID-19 vaccine to a family or friend (211/234; 90.2%), believed in the need for COVID-19 vaccination (209/234; 89.3%), supported a COVID-19 booster shot (191/234; 81.6%), and would receive an annual COVID-19 vaccine (186/234; 79.5%) (Table 2). Less support was reported for vaccine mandates for healthcare workers (153/234; 65.4%) and medical students (146/234; 62.4%). Of those who were not vaccinated, the most common reasons included waiting for more evidence (16/19; 84.2%), concerns about side-effects (15/19; 79.0%), felt vaccines were insufficient studied (15/19; 79.0%), mistrust in public health information (11/19; 57.9%), low self-risk assessment for COVID-19 infection (10/19; 52.6%), and no requirement for vaccination (7/19; 36.8%) (Table 2). The majority of respondents received information about COVID-19 vaccination from professional sources, including public health websites (202/234; 86.3%), medical professionals (180/234; 76.9%), medical school professors/faculty (137/234; 58.6%), and medical/academic journals (118/234; 50.4%). Significant differences were noted between vaccinated and unvaccinated students in belief about receiving other vaccines, prior testing for COVID-19 infection, and prior testing for COVID-19 antibodies (Table 3).

Discussion

Vaccination rates in medical students present concerns both for both patients and public safety and may reflect the attitudes of future physicians. Most students in this survey received the COVID-19 vaccine and expressed support of COVID-19 vaccination and vaccination generally. Interestingly, far fewer students expressed support for vaccine mandates than were vaccinated (65.4% and 62.4% vs 95.1%), suggesting that support for mandates and willingness to personally vaccinate may not always be linked. Similarly, Janssen et al9 noted that among healthcare workers who were willing to be vaccinated, only 60% supported mandatory vaccinations. Next, only 1 student in this survey had not received any childhood vaccines, suggesting that the vast majority of students, including those who chose not to vaccinate, did not come from families that were opposed to vaccination. Reasons for not vaccinating centered around concerns of safety/credibility, mistrust in public information, and not feeling at risk for COVID-19. This is similar to prior studies of medical students, in which concerns about safety and side-effects were often the most frequent reasons for vaccine hesitancy.9-11 Some students expressed uncertainty regarding vaccination questions, including the need to receive the COIVD-19 vaccine (5.6%), the need for annual (14.5%) and booster (12.8%) COVID-19 vaccinations, mandates for healthcare workers/medical students (19.7% and 20.9%, respectively), and recommendations to family members (6.0%). Of those who did not vaccinate, 36.84% stated that they would consider vaccinating in the future, and 26.3% were unsure. This suggests that many students who did not have strictly “pro-vaccine” attitudes or behavior likely demonstrate vaccine hesitancy rather than outright opposition. Furthermore, it is possible that additional training, information, and clinical exposure will motivate those who are uncertain about vaccination to have more “pro-vaccine” attitudes and behaviors. For example, there was 1 instance of a student who had not received childhood vaccinations who received the COVID-19 vaccine, suggesting that family attitudes about or childhood exposure to vaccines do not necessarily predict future vaccination behaviors. Finally, there was a significant difference between vaccinated and unvaccinated groups regarding COVID-19 testing, suggesting that those who are vaccinated are more likely to have been tested for COVID-19. This may be due to increased adherence to public health guidelines as well as concern for personal safety or the safety of contacts such as family, friends, and patients.
Table 1. Demographics of Survey Respondents.

| Variable | Category | Number | Percentage |
|----------|----------|--------|------------|
| 1. Age   | <25      | 154    | 65.81      |
|          | 25-30    | 74     | 31.62      |
|          | 30-40    | 5      | 2.14       |
|          | >40      | 1      | 0.42       |
| 2. Gender| Male     | 86     | 36.75      |
|          | Female   | 147    | 62.82      |
|          | Prefer not to disclose | 1 | 0.42 |
| 3. Medical student class | MS1 | 89 | 38.03 |
|          | MS2      | 67     | 28.63      |
|          | MS3      | 36     | 15.38      |
|          | MS4      | 42     | 17.94      |
| 4. Did you get the COVID-19 vaccine? | Yes | 215 | 91.88 |
|          | No       | 19     | 8.12       |
| 5. If you received the COVID-19 vaccine, which one did you receive? | Pfizer | 58 | 26.98 |
|          | Moderna  | 148    | 68.84      |
|          | Johnson & Johnson | 9 | 4.18 |
| 6. If you received the Moderna or Pfizer COVID-19 vaccine, did you receive the second dose? | Yes | 204 | 99.03 |
|          | No       | 2      | 0.97       |
| 7. If you received the COVID-19 vaccine, did you have any side effects? | Yes | 195 | 90.69 |
|          | No       | 20     | 9.3        |
| 8. If you had side effects from the COVID-19 vaccine, which side effects did you have? (Select all that apply) | Fever/chills | 130 | 60.47 |
|          | Injection site pain | 161 | 74.88 |
|          | Injection site redness/swelling | 40 | 18.6 |
|          | Fatigue  | 142    | 66.04      |
|          | Headache | 89     | 41.39      |
|          | Muscle aches | 120 | 55.81 |
|          | Anaphylaxis | 0 | 0 |
|          | Palpitations | 5 | 2.32 |
|          | Blood clots | 0 | 0 |
|          | Myocarditis/pericarditis | 0 | 0 |
| 9. Have you ever been tested for COVID-19? | Yes | 162 | 69.23 |
|          | No       | 72     | 30.77      |
| 10. If you have been tested for COVID-19, have you ever tested positive for COVID-19? | Yes | 31 | 19.14 |
|          | No       | 131    | 80.86      |
| 11. If you tested positive for COVID-19, when did you test positive? (Select all that apply) | Before the first dose of COVID-19 vaccine | 25 | 80.65 |
|          | Between the first and second dose of COVID-19 vaccine (Moderna and Pfizer) | 2 | 6.45 |
|          | After the first dose (Johnson & Johnson) | 0 | 0 |
|          | After the second dose of vaccine (Moderna and Pfizer) | 0 | 0 |
|          | Tested positive and did not receive vaccine | 4 | 12.9 |
| 12. Have you ever been tested for COVID-19 antibodies? | Yes | 36 | 15.38 |
|          | No       | 198    | 84.62      |
| 13. If you have been tested for COVID-19 antibodies, when did you test positive? | Before the first dose of COVID-19 vaccine | 6 | 16.67 |
|          | Between the first and second dose of COVID-19 vaccine (Moderna and Pfizer) | 3 | 8.33 |
|          | After the first dose (Johnson & Johnson) | 1 | 2.78 |
|          | After the second dose of vaccine (Moderna and Pfizer) | 11 | 30.56 |
|          | Tested positive and did not receive vaccine | 2 | 5.56 |
Table 2. Attitudes Regarding Vaccination.

| Variable                                                                 | Category                                      | Number | Percentage |
|--------------------------------------------------------------------------|-----------------------------------------------|--------|------------|
| 1. Do you believe in the need to get vaccinated for COVID-19?             | Yes                                           | 209    | 89.32      |
|                                                                           | No                                            | 12     | 5.13       |
|                                                                           | Unsure                                        | 13     | 5.55       |
| 2. Do you believe in the need to be vaccinated against other diseases (eg, hepatitis B, measles, mumps, etc.)? | Yes                                           | 229    | 97.86      |
|                                                                           | No                                            | 2      | 0.85       |
|                                                                           | Unsure                                        | 3      | 1.28       |
| 3. Did you receive any childhood vaccinations?                            | Yes, all of them                              | 224    | 95.73      |
|                                                                           | Yes, some of them                             | 9      | 3.85       |
|                                                                           | No                                            | 1      | 0.42       |
|                                                                           | Unsure                                        | 0      | 0          |
| 4. Did you receive an influenza vaccine (“flu shot”) last year?           | Yes                                           | 207    | 88.46      |
|                                                                           | No                                            | 23     | 9.83       |
|                                                                           | Unsure                                        | 4      | 1.71       |
| 5. If you chose not to get the COVID-19 vaccine, please indicate why (select all that apply) | Concerned about side-effects                  | 15     | 78.95      |
|                                                                           | Don’t believe vaccine is effective             | 5      | 26.31      |
|                                                                           | Don’t believe COVID-19 is a health risk        | 6      | 31.58      |
|                                                                           | Don’t trust public health information regarding COVID-19/vaccinations | 11   | 57.89     |
|                                                                           | Vaccines weren’t studied enough                | 15     | 78.95      |
|                                                                           | Had a friend/relative who had a serious reaction to the vaccine | 5 | 26.31 |
|                                                                           | Believe that natural infection/immunity is better | 5 | 26.31 |
|                                                                           | Do not feel at risk for COVID-19 infection     | 10     | 52.63      |
|                                                                           | Believe that diet/alternative medicine is better prevention for COVID-19 | 5 | 26.31 |
|                                                                           | Believe that herd immunity is preferable to mass vaccination | 2  | 10.53 |
|                                                                           | Believe that masks/social distancing/hygiene are better prevention | 0 | 0 |
|                                                                           | Had side-effects from previous vaccines (non-COVID-19) | 3 | 15.79 |
|                                                                           | Had a friend/relative who had a serious reaction to a vaccine (not COVID-19) | 1 | 5.26 |
|                                                                           | Concerned vaccination would interrupt daily schedule | 3 | 15.79 |
|                                                                           | Vaccine not available/too expensive            | 0      | 0          |
|                                                                           | Waiting until more evidence about the vaccine is available | 16 | 84.21 |
|                                                                           | Already had COVID-19 infection                 | 4      | 21.05      |
|                                                                           | Not required to be vaccinated                  | 7      | 36.84      |
|                                                                           | Other                                          | 4      | 21.05      |
|                                                                           | Yes                                           | 7      | 36.84      |
|                                                                           | No                                            | 7      | 36.84      |
|                                                                           | Unsure                                        | 5      | 26.32      |
| 6. If you have not had the COVID-19 vaccine, are you considering getting the COVID-19 vaccine in the future? | Yes                                           | 191    | 81.62      |
|                                                                           | No                                            | 13     | 5.56       |
|                                                                           | Unsure                                        | 30     | 12.82      |
| 7. If a COVID-19 “booster” shot was available in the future, would you plan to get it? | Yes                                           | 186    | 79.49      |
|                                                                           | No                                            | 14     | 5.98       |
|                                                                           | Unsure                                        | 34     | 14.53      |
| 8. If an annual COVID-19 vaccine became available (similar to the annual influenza vaccine), would you plan to get it? | Yes                                           |        |            |
|                                                                           | No                                            |        |            |
|                                                                           | Unsure                                        |        |            |
Table 2. (continued)

| Variable | Category | Number | Percentage |
|----------|----------|--------|------------|
| 9. Where do you receive information about COVID-19 vaccines? (Select all that apply) | Public health websites (eg, CDC) | 202 | 86.32 |
| | News media | 121 | 51.71 |
| | Social media | 88 | 37.61 |
| | Podcasts/radio talk shows | 35 | 14.96 |
| | Medical professionals | 180 | 76.92 |
| | Medical/academic journals | 118 | 50.42 |
| | Medical school professors/faculty | 137 | 58.55 |
| | YouTube | 30 | 12.82 |
| | Blogs | 9 | 3.85 |
| | Friends/family | 74 | 31.62 |
| | Other | 9 | 3.85 |
| 10. Do you believe that vaccines should be mandated for healthcare workers? | Yes | 153 | 65.38 |
| | No | 35 | 14.96 |
| | Unsure | 46 | 19.66 |
| 11. Do you believe that vaccines should be mandated for medical students? | Yes | 146 | 62.39 |
| | No | 39 | 16.67 |
| | Unsure | 49 | 20.94 |
| 12. Do you believe that social distancing and/or masks are effective at preventing the spread of COVID-19? | Yes | 189 | 80.77 |
| | No | 18 | 7.69 |
| | Unsure | 27 | 11.54 |
| 13. Would you recommend getting the COVID-19 vaccine to a family member/friend? | Yes | 211 | 90.17 |
| | No | 9 | 3.85 |
| | Unsure | 14 | 5.98 |

Table 3. Bivariate Analysis of Demographics and Vaccination Attitudes.

| Age | Received COVID-19 vaccine | Did not received COVID-19 vaccine | P-Value |
|-----|---------------------------|----------------------------------|---------|
| <20 | 1                         | 0                                | .748    |
| 20-25 | 138                     | 15                               |         |
| 25-30 | 70                       | 4                                |         |
| 30-40 | 5                        | 0                                |         |
| >40 | 1                         | 0                                |         |
| Gender |                           |                                  |         |
| Male | 82                       | 4                                | .312    |
| Female | 132                     | 15                               |         |
| Prefer not to disclose | 1                         | 0                                |         |
| Medical school class |                           |                                  |         |
| MS1 | 79                       | 10                               | .335    |
| MS2 | 61                       | 6                                |         |
| MS3 | 34                       | 2                                |         |
| MS4 | 41                       | 1                                |         |
| Have you ever been tested for COVID-19? |                           |                                  |         |
| Yes | 153                      | 9                                | .031*   |
| No | 62                       | 10                               |         |
| Have you ever been tested for COVID-19 antibodies? |                           |                                  |         |
| Yes | 30                       | 6                                | .041*   |
| No | 185                      | 13                               |         |

(continued)
The rates of vaccination in this survey are higher than those observed or predicted for medical students at earlier points in the pandemic. For example, a survey of U.S. medical students by Lucia et al. before approval of the COVID-19 vaccine found that 23% were unwilling to receive the vaccine immediately after FDA approval. A study of Ugandan medical students noted similar rates of hesitancy in March 2021, soon after the availability of the AstraZeneca vaccine in that country. Furthermore, a study of students in India from February to March 2021 noted a 64.5% vaccination rate, with 27.9% of those who agreed to vaccination having yet to receive the vaccine. Higher rates observed in our study may be due to increased confidence in the vaccine over time, the training and educational environment, or differences in the type of vaccine available across countries. Of note, a similar study surveyed residents and fellows at the same institution and found similar rates of COVID-19 vaccination (77/81; 95.1%), which may reflect institutional or geographic attitudes about vaccination. Finally, while many studies have examined healthcare worker attitudes and rates regarding COVID-19 vaccination, far fewer studies have examined medical students, meaning that additional studies will be needed to establish reliable trends and compare differences across groups and regions.

In summary, we found a high rate of vaccination among medical students at the surveyed institution. However, any degree of vaccine hesitancy in a group that is both well-educated and interacts with potentially vulnerable patient populations raises concerns. Vaccine hesitancy may also limit training opportunities for students and potentially indicates the attitudes students will have as future physicians and healthcare leaders. While people will understandably have concerns about vaccination, special emphasis may be needed to promote vaccination in this group. This and similar studies can help identify reasons for this hesitancy and allow administrators and educators to address them.

**Declaration of Conflicting Interests**

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.
Funding
The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This research was supported by Texas Tech University Health Sciences Center, Department of Internal Medicine.

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