Perceptions of COVID-19 vaccines among osteopathic medical students (OMS)

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ABSTRACT

Background: Research has shown that physicians' recommendations are one of the top predictors for individuals to receive vaccines. This study examined the perceptions of new COVID-19 vaccines among the medical students at the New York Institute of Technology College of Osteopathic Medicine (NYITCOM) and the factors that influenced their opinions.

Objective: To measure NYITCOM students' perception of a new COVID-19 vaccine and the factors which drive their opinions.

Methods: An electronic survey of 37 questions was distributed to the Osteopathic Medical Students (OMS I-IV) of NYITCOM in October of 2020.

Results: 1770 total students received the survey, and 197 responded (11%). 45% (88/197) of the respondents reported that they would receive new COVID-19 vaccines if they were available at the time of the survey, while 19% (37/197) reported that they had not yet decided. Confidence in the US healthcare system, pharmaceutical trust, the United States Food and Drug Administration's (FDA)'s minimum effectiveness level, adequate vaccine testing, additional vaccine dose, and antivaccine acquaintances were significant predictors of intended vaccine uptake.

Conclusions: Our findings confirmed a low acceptance of the new COVID-19 vaccine among OMS students, which mirrored the general public's low acceptance rate. Better education of OMS about vaccination benefits and the vaccine development process may increase future immunization rates.

Introduction

On December 17, 2019, a case of pneumonia-like illness appeared in Wuhan, China. Later that month, the official health authorities diagnosed the person with a novel coronavirus, which was caused by the SARS-CoV-2 virus [1]. By the end of January 2020, the World Health Organization (WHO) declared the SARS-CoV-2 outbreak as a public health emergency of international concern as twenty countries around the globe reported confirmed COVID-19 cases [2,3]. The virus's spread was more aggressive than many other viral pathogens known [4]. Within a few months, SARS-CoV-2 was circulating the world, resulting in 118,000 cases and over 4000 deaths by March 11, 2020, when the WHO declared a COVID-19 pandemic [4].

According to the WHO report on January 11, 2020, the total number of confirmed cases was about 45 million, with more than 1.2 million deaths globally [5]. The United States of America (US) contributed about one-quarter of these confirmed cases and deaths at that time [6].

Since the start of this pandemic, most countries adapted drastic measures to save lives and contain the virus's spread, including lockdowns of cities, specific business closures, and social distancing [7]. Vaccination is one of the significant public health measures that has a great impact on reducing the mortality and morbidity associated with many contagious diseases [8]. Thus, a vaccine was thought of as the best hope to restore some normality in society [9]. However, vaccine development for a new infectious agent can take several years. The process requires three phases: clinical trials, approval from regulatory authorities, and large-scale manufacturing. To put timing into perspective, the current mumps vaccine was previously the fastest vaccine on record, developed in five years [10]. At the time of this study, several COVID-19 vaccines were in final phase three trials [5]. Moreover, 300 million doses of the new vaccines were expected to be available in the US by January 2021 [11]. Early studies have shown negative attitudes from the general public and healthcare workers toward the new COVID-19 vaccines [12–14]. One of the reasons cited about vaccine hesitancy was the rapid

speed at which vaccines were developed [15,16]. Additionally, the lack of a comprehensive plan to combat pandemics [17,18], conflicting messages from the scientific community [19], and easy access to misinformation have led to skepticism in the general public about the new vaccine's safety and effectiveness [20].

Polls have observed that a significant portion of the American public might not choose to receive COVID-19 vaccines when becoming available [21]. A study, conducted in August 2020, reported that 31.1% of Americans would refuse to get a new COVID-19 vaccine. A survey conducted by Reuters in May 2020 reported that a quarter of Americans share a similar view [16]. Participants voiced major concerns related to vaccine safety and effectiveness.

Vaccine uptake might be enhanced among the public if vaccines are recommended by healthcare professionals [22]. Thus, exploring the views of future physicians is paramount. This study offers an opportunity to understand future physicians' concerns and opinions about new vaccines. The study also provides insights on how medical students' views may vary by gender, race, and class year.

Methods

The study protocol was approved by The Educational Research Data Committee (ERDC) and the Institutional Review Board (IRB) of the New York Institute of Technology (protocol code BHS1575 on 09/23/2020).

The research team created an anonymous electronic survey by adapting a model of determinants developed by the Strategic Advisory Group of Experts (SAGE) on vaccine hesitancy, based on a systematic review of literature and immunization manager interviews [23]. The research team selected questions from previous studies to reflect on some of the themes identified by Larson et al. about vaccine hesitancy [7,24–27]. The study's contextual themes were media environment, influential leaders, historical influences, religion/culture/gender/socioeconomic/influences, politics or policies, and pharmaceutical industry. The study also included four out of six individual and group influences: experience with past vaccination, health beliefs, health system trust, and perceived vaccine risk/benefit. Finally, four out of the eight vaccine-specific influences—scientific evidence, mode of administration, vaccination schedule, costs—were included. The survey was distributed to all enrolled NYITCOM OMS on October 14, 2020, via an e-mail using the school's student listservs. Responses were collected over two weeks, with no incentive given to the participants for completing the survey, with the option not to complete the survey at any time.

The primary question of interest was whether participants would be willing to receive a COVID-19 vaccine, and thus all quantitative questions were assessed in relation to this question. The remaining 36 questions were categorized into demographic questions (age, gender, race/ethnicity, marital status, combined household income, class year, and campus location), contextual, individual and group, and vaccine-specific factors. The contextual questions have the answer options of Strongly Disagree, Disagree, Undecided/Neutral, Agree, Strongly Agree, and Prefer not to answer, while the follow-up questions have three answer possibilities: More Likely, Less Likely, and Prefer not to answer. An exception was a question about the participant's perceived risk of COVID-19, which had answer choices of Low Risk, Intermediate Risk, High Risk, and Prefer not to answer. We included an open-ended question if whether OMS felt that the Food and Drug Administration's (FDA) requirement that vaccines should have at least 50% effectiveness would be adequate for getting vaccinated. We used reflexive thematic analysis to assess the qualitative data for the question, "The FDA requirement that vaccines should have at least 50% effectiveness will be adequate for obtaining the new COVID-19 vaccine. If you agree or disagree, please explain why." Two raters independently assessed each response using inductive coding for common trends and breaking those trends into overarching themes.

For the purposes of descriptive analysis, we classified respondents as either "in favor" if they indicated they agree or strongly agree that they would get a vaccine or "not in favor" if they indicated they strongly disagree, disagree, or were undecided/neutral. Independence of the variables was tested with the Freeman-Halton extension of the Fisher's Exact test. The Fisher's Exact test was preferred over the Chi Squared test due to few expected responses in categories of Strongly Disagree or Disagree for most questions. In situations where the predicting variable had more than three categories excluding the prefer not to answer, a Monte Carlo simulation was performed with 10,000 iterations due to the computing power constraints imposed by the excessive number of iterations. Analysis was performed with SPSS 27 and statistical significance was set at $p < 0.05$ for each test. At the end of the study, internal validity and reliability were evaluated by comparing the open-ended question responses to the responses on the other measures, particularly the question about if the FDA requirement of 50% effectiveness for vaccines is adequate. For half of the participants responding to the open-ended question, this question was viewed first then compared to the other survey question responses to see if expected patterns of response were followed. For the other half, the survey question responses were viewed first then used to evaluate if the open-ended response matched those responses. This approach revealed that most participants responded consistently and in a predictable manner across the survey.

Results

NYITCOM has 1770 medical students enrolled in total. 50.4% of the students are female, distributed between preclinical (OMS I-II) and clinical (OMS III-IV) at two different campuses (Jonesboro, AR and Old Westbury, NY). 71.6% (1268/1770) of the students were on the New York campus, and 28.4% (502/1770) were on the Arkansas campus. The racial/ethnic makeup of the school was 44.2% White, 38.2% Asian, 4.6% Black or African-American, 2.5% from multiple races, 0% American Indian or Alaskan Native, and 0% Native Hawaiian or other Pacific Islander. The total response rate of the survey was 11%. 64.5% of the participants (127/197) were from the Old Westbury campus, and 34.5% (68/197) were from the Jonesboro campus. 57.9% (114/197) of the study participants were female. Our study sample's gender, racial/ethnic, and campus location characteristics were consistent with the general student population at NYITCOM.

Table 1 summarizes the characteristics of the participants at the two campuses. The highest response rate was among OMS II 36.5% (72/197), and the lowest rate was among OMS IV 10.7% (21/197). The percent participating dropped for students in their last years, likely due to their busy academic and clinical schedule. The drop was more marked for the students in their final year, which may have caused a more significant selection bias for that year, such that students who had witnessed poor outcomes with COVID-19 might have been more likely to participate in the study.

Table 2 summarizes the responses to the main survey question for all groups, gender, race, and class. Gender, racial, and class differences were not significant predictors for willingness to obtain a vaccine ($p = 0.483$, $p = 0.288$, and $p = 0.275$ respectively).

Willingness to obtain a vaccine is dependent on confidence in the US healthcare system ($p < 0.001$), with those agreeing that they have trust in the US healthcare system being more likely to receive the vaccine. It is also dependent on the belief that the FDA requirement of 50% efficacy is sufficient ($p < 0.001$) and the belief that the vaccine has been adequately tested ($p < 0.001$), with those agreeing that the vaccine has been adequately tested and 50% efficacy is sufficient being more willing to obtain the vaccine. Those who thought pharmaceutical companies prioritized profits over public interest tended to be less willing to receive the new COVID-19 vaccine as those two variables were also dependent ($p < 0.001$). As expected, those who were willing to receive more than one dose to reach immunity of a vaccine were more likely to be willing to get the vaccine in general ($p < 0.001$). Willingness to get the vaccine was also influenced by the participants knowing others who would not

Table 1
Participants demographics N = 197.

Variable	Number (%)
Age	
18–19	0 (0.0%)
20–29	172 (87.3%)
30–39	15 (7.6%)
40–49	6 (3.0%)
Prefer not to answer	4 (2.0%)
Gender	
Female	114 (57.9%)
Male	79 (40.1%)
Other	1 (0.5%)
Prefer not to answer	2 (1.0%)
Ethnicity	
White	114 (57.9%)
Black or African-American	6 (3.0%)
American Indian or Alaskan Native	0 (0.0%)
Asian	48 (24.4%)
Native Hawaiian or other Pacific Islander	0 (0%)
From multiple races	10 (5.1%)
Other	10 (5.1%)
Prefer not to answer	9 (4.6%)
Marital status	
Married	32 (16.2%)
Widowed	0 (0%)
Divorced	3 (1.5%)
Separated	0 (0.0%)
Never married	159 (80.7%)
Prefer not to answer	3 (1.5%)
Household income	
Below 10 K	65 (33.0%)
10–50 K	25 (12.7%)
51–100 K	25 (12.7%)
101–150 K	11 (5.6%)
151–200 K	8 (4.1%)
Above 200 K	16 (8.1%)
Prefer not to answer	47 (23.9%)
Class year	
OMS I	67 (34.0%)
OMS II	72 (36.5%)
OMS III	32 (16.2%)
OMS IV	21 (10.7%)
Prefer not to answer	5 (2.5%)
Campus location	
Jonesboro	68 (34.5%)
Old Westbury	127 (64.5%)
Prefer not to answer	2 (1.0%)

Table 2
Distribution of responses on whether respondent would take COVID-19 vaccine among different demographics.

Variable	Responses	Intended Vaccine Uptake	
		In favor	Not in favor
Gender	Female	46	66
	Male	42	37
	Other	0	1
Ethnicity	White	56	56
	Black or African-American	1	5
	Asian	19	29
	From multiple races	5	5
	Other	5	5
Class	OMS I	26	40
	OMS II	33	39
	OMS III	19	12
	OMS IV	8	13

receive the vaccine, as those who said they knew people against it being more likely to refuse the vaccine themselves (p = 0.015). However, the participant's assessment of their individual risk was not related to

willingness to obtain the COVID-19 vaccine (p = 0.776). Table 3 below shows the distribution of responses for these variables in relation to the vaccine uptake variable.

Thematic analysis further revealed common thought patterns amongst the participants (Table 4). Of the 112 participants (56.9%) who chose to answer this question, the common themes identified in their responses were categorized as "Safety over Efficacy," "Minimum Efficacy Level," "Trust of Administration and Vaccine Rollout," and "More Info." Those responding with comments categorized as "Safety over Efficacy" had primary fears around short-term and long-term effects and believed those trumped efficacy level in importance. Responses around "Minimum Efficacy Level" primarily debated the threshold itself for efficacy (mainly if 50% was too low or too high for an experimental vaccine). Responses for "Trust of Administration and Vaccine Rollout" showed varying levels of trusting the federal government and pharmaceutical companies with regards to creating, testing, and approving the vaccine. Responses for "More Info" needed more information around the vaccine approval process, the current status of the vaccine, and the specifics of the question itself. Table 4 below lists some direct quotes from the question as representative comments for each theme.

Discussion

Our study observed that the acceptance of a COVID-19 vaccine was low among NYITCOM medical students. This finding is consistent with the polls, conducted around the study's time, showing low vaccine acceptance among the public. The most recent data from two national surveys sponsored by the US Centers for Disease Control and Prevention (CDC), the national public health agency of the United States, conducted between September and December 2020, showed that 49.1% of the population intended to get vaccinated [28]. Additionally, we found that the survey participants shared similar vaccination concerns as the general public. The most common concerns were low vaccine effectiveness, lack of long-term adverse effects data, and minimal knowledge regarding the virus and the vaccine development process. Similar concerns were identified by Rio et al.'s cross-sectional survey exploring COVID-19 vaccine hesitancy among healthcare workers in Yale Medicine and Yale-New Haven Health system [29].

The low response rate might be explained that students with strong feelings about vaccination might have participated to express their attitudes, especially those who were not in favor of vaccination. Additionally, the lack of monetary incentive might not encourage the rest of the students to respond to the survey. Moreover, the survey was long, and the lack of a reminder of taking the survey might have impacted the participation rate. The high overall participation rate among female students throughout OMS I-IV was consistent with the literature. Studies have observed that women are more likely to complete a survey than their male counterparts, which is attributed to the fact that women are often observed as the primary decision-makers not only for themselves, but also for their families [30].

Gender, race, and academic class were not significant predictors of intended vaccine uptake in our study. These findings were consistent with the available literature at the time of this study [31,32]. However, even though the differences across the four classes were not statistically significant, the participation rate of OMS-IV was relatively low, making up only 11% of the sample. This opens the possibility that there was a significant bias among fourth-year students or because of the sample size. Thus, after controlling for other variables, there might be a positive correlation between willingness to take the vaccine and year in medical school, but with the power of this study we could not find one.

Confidence in the healthcare system measures the system competency to provide the highest quality of care possible to its patients [7]. Our study observed that medical students with high confidence in the US healthcare system are more likely to get a new COVID-19 vaccine (p < 0.001), a finding mirrored in the literature. Furthermore, research was conducted in Sierra Leone in 2015 to assess knowledge, attitudes, and

Table 3
Distribution of responses of intended vaccine uptake across different variables.

Variable	Responses	Intended Vaccine Uptake	
		In favor	Not in favor
I trust the US healthcare system	Strongly Disagree	2	22
	Disagree	13	27
	Undecided/Neutral	19	25
	Agree	40	26
	Strongly Agree	14	7
I trust pharmaceutical industry	Strongly Disagree	7	2
	Disagree	25	7
	Undecided/Neutral	18	18
	Agree	27	58
	Strongly Agree	11	32
I believe the FDA minimal effectiveness requirement of 50% is adequate	Strongly Disagree	4	19
	Disagree	18	32
	Undecided/Neutral	28	27
	Agree	29	18
	Strongly Agree	7	8
My personal perceived COVID-19 risk	Low risk	39	46
	Intermediate risk	40	47
	High risk	9	12
I have antivaccine acquaintances	Yes	52	78
	No	33	24
I believe that vaccines are going through adequate testing as of October 2020	Strongly Disagree	6	48
	Disagree	35	38
	Undecided/Neutral	38	18
	Agree	6	2
	Strongly Agree	2	1
I would take more than one shot of the vaccine if deemed necessary	Strongly Disagree	0	8
	Disagree	0	9
	Undecided/Neutral	8	26
	Agree	43	47
	Strongly Agree	37	16

practices related to the country's healthcare system. The study reported that public confidence in a healthcare system is associated with a high level of education. Highly educated individuals might be more aware and more resistant to misinformation about the availability of health services even during a crisis [33]. It could also assist them in navigating the healthcare system to receive the services they need. Another survey conducted in France to explore healthcare workers' perceptions of a new COVID-19 vaccine observed that mistrust of health institutions played a role in the lower vaccine uptake among these employees, and information regarding vaccine safety and effectiveness did not significantly impact their vaccine perceptions [14].

Our study found that mistrust in the pharmaceutical companies is associated with a lower rate of vaccine acceptance (p < 0.001). This

finding is consistent with the literature, as a similar survey developed by SAGE was used to assess vaccine hesitancy among healthcare students in different fields (nursing, pharmacy, medicine, midwifery, physiotherapy) in France. In this study, 30% of participants reported mistrust in the pharmaceutical industry [26], which was one of the driving factors behind vaccine hesitancy. Moreover, implementing a relatively new mRNA technology that is not well-understood among medical students might further negatively impact this trust.

The FDA's requirement of 50% effectiveness to approve a new COVID-19 vaccine is one of the factors that predicted intentions to get vaccinated (p < 0.001). Many of the medical students who are not in favor of a new COVID-19 vaccine did not feel the 50% FDA effectiveness was adequate. Leng et al.'s study on individual preferences for the

Table 4
Some comments provided by the participants.

Theme	Representative Quotes
Minimum Efficacy Level	"50% effectiveness is not sufficient for herd immunity, even if 100% of the population takes the vaccine."
	"If a vaccine is mandatory, it should be effective enough to improve the herd immunity threshold above the threshold in which the transmission is reduced to the point in which the diagnosis is steadily endemic at minimum and obviously preferably waning. If a vaccine is not required, and if the vaccine is safe, then any level of effectiveness is going to be beneficial at some level."
More Info	"That amount may be enough to help decrease mortality and morbidity due to COVID-19. More research should be performed to determine if another vaccine is more effective after the prototype is released."
	"There isn't enough research and development time put into the vaccine to observe long term clinical implications that are commonly associated with vaccination. Also, current literature does not support a well understood pathophysiology or immunologic mechanism to the development of resistance against the virus or the full effect of the virus on the body."
Trust of Administration and Vaccine	"Current administration is pushing development too quickly for proper safety standards, testing, and long-term side effects."
Rollout	"Of course, pharma companies are pushing to get the money."
Safety Over Efficacy	"I will not be a guinea pig for a vaccine that has indeterminable long-term side effects for a disease that—according to the CDC—has a 0.003% mortality rate in those aged 0–19 years old, 0.02% in those aged 20–49 years old, 0.05% in those aged 50–69 years old, and 5.4% in those aged 70+ years old."
	"DNA/RNA recombinant vaccines may have effects on the genome that cannot be elucidated in the short span of a clinical trial."

COVID-19 vaccine in China found that when the vaccine's effectiveness went from 40% to 85%, vaccine uptake probability increased from 0% to 45.68% [34]. Hypothetically, increasing the effectiveness of COVID-19 vaccines from 50% to 70% or 90% has been associated with an increased probability of receiving a new vaccine [11]. One study in Iran showed that the main reason for flu vaccine acceptance among health care workers was vaccine effectiveness [35], a finding backed by a similar cross-sectional study assessing flu vaccine attitudes for the same population in Iran [35].

The perceived risk of COVID-19 did not significantly predict intentions of getting a new COVID-19 vaccine ($p = 0.776$), which is inconsistent with current trends, as increased perceived susceptibility to COVID-19 is generally associated with high vaccine uptake [34,36]. Our target population's young age might contribute to this finding, as the average age of participants was 25.9 years. According to a CDC report in August 2020, individuals 18–29 years old had the lowest hospitalization and death rates among other adult age groups [37].

Another factor is the number of antivaccine acquaintances, which is significantly associated with low vaccine acceptance in our study ($p = 0.015$). This finding is also consistent with the literature. A recent study conducted in China to assess individual preferences for a COVID-19 vaccine demonstrated that high vaccine uptake is associated with an increased number of vaccinated acquaintances through peer influence [34]. Leng et al. reported that when the percentage of vaccinated family members increased from 30% to 90%, the probability of getting a new COVID-19 vaccine increased to 12.38% from 0% [34].

Adequate vaccine testing was a significant predictor of intended vaccine uptake among the study's participants ($p < 0.001$). Students who believe that COVID-19 vaccines went through adequate testing are more likely to receive a shot. Our finding is consistent with the literature. A cross-sectional survey explored the attitudes of French healthcare workers toward the upcoming vaccines found that the perceptions of the vaccine safety concerns from the rapid development of the vaccine were more harmful than the perceived damage caused by the current pandemic [14]. Another study that explored similar attitudes among Americans showed that more extended testing is positively associated with vaccine acceptance [27].

The acceptance of COVID-19 vaccines was also influenced by the students' willingness to get more than one dose of the vaccine to achieve an adequate level of protection ($p < 0.001$); those in favor of additional doses of vaccines are more likely to receive the initial doses. Our finding is inconsistent with the limited literature at the time of this study. Pogue et al. found that acceptance of yearly COVID-19 vaccine did not predict the overall attitude toward intended vaccine uptake [27]. Medical students are more aware than the general public that additional doses of a vaccine are part of vaccine-induced immunity to sustain a long-term immunity.

Limitations

Our study has several limitations. First, it was based on participants' intentions, which do not necessarily translate into behavior. Additionally, our study was based on the FDA's rule requiring 50% effectiveness for vaccine approval, and there was no vaccine available at the time of the survey. Our findings could change in the future due to the availability of more information about the virus' mechanism of spread and treatment. More data on vaccine safety and effectiveness will also be obtained as COVID-19 vaccines are distributed to the population. The Fisher's exact test procedure assumes that the general level of support for obtaining the vaccine and distribution on each of the other questions is consistent between samples with only the possibility of the distribution of responses within the intersection of the variables (within the table) varying. Therefore, if the general support level for the vaccine was off in the study that could invalidate some predictors. Lastly, the small sample size and its geographic limitation to one academic institution might impact the generalizability to other medical schools.

Conclusions

This study identified several variables that influenced intended vaccine uptake among osteopathic medical students at NYITCOM. The findings showed that specific factors (i.e., lack of confidence in the US health system, concerns about pharmaceutical profits, possible low vaccine effectiveness, antivaccine acquaintances, adequate vaccine testing, and the belief of more than one shot might be necessary) have significantly predicted the intentions of vaccine uptake. These factors should be the focus of vaccination campaigns. Additionally, medical education about the vaccine development process and the new mRNA technology might increase vaccine uptake.

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Ethical Approval

The study design and procedures were granted ethical approval from The Educational Research Data Committee and the Institutional Review Board of the New York Institute of Technology (protocol code BHS1575) on 09/23/2020.

Declaration of competing interest

None.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijosm.2021.10.008.

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