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Factors impacting COVID-19 vaccination intention among medical students

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ABSTRACT

Medical students represent a significant part of the health-care community and are active members of the coronavirus disease 2019 (COVID-19) response. This study aimed to evaluate various factors associated with COVID-19 vaccine intention among medical students via an online anonymous survey. A total of 370 students completed the online survey, with 229 (61.89%) not vaccinated for COVID-19. Of students not yet vaccinated, 45 (19.65%) were unsure or did not intend to accept the vaccine, while 184 (80.35%) intend to be vaccinated within 6 months. Overall, female gender, health status, clinical science enrollment, and the practice of COVID-19 preventative behaviors significantly correlated with the intention to be vaccinated within 6 months. Greater perceived risk for contracting COVID-19, lesser beliefs that the COVID-19 vaccination trials were rushed, and greater beliefs that being vaccinated would help complete their medical education were uniquely associated with the intention to be vaccinated within 6 months. Collectively, this study identified several factors that influenced medical students' intention to receive the COVID-19 vaccination. This information may be used in future immunization strategies to increase the vaccination rates among this group of future medical professionals.

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1. Introduction

The novel coronavirus disease 2019 (COVID-19) was declared an emergency epidemic by the World Health Organization on January 30, 2020.¹ Through unprecedented collaboration between government agencies and the pharmaceutical industry, three COVID-19 vaccines were developed and tested within 11 months of the first identified COVID-19 case. The first of these vaccines were made available to the public in the month of December 2020.² As of July 22, 2021, the Center for Disease Control and Prevention (CDC) reported that in the United States (US), 162,174,165 (48.8%) were fully vaccinated and 187,216,168 (56.4%) received at least one dose of the COVID-19 vaccine.³ Currently, the COVID-19 pandemic surges on with recent the latest variant, Omicron, proving to be more quickly transmissible than their predecessors.⁴ With new COVID-19 strains predominating in unvaccinated and immunocompromised populations, prevention of disease transmission by promotion of vaccination and boosters is imperative.⁵ The CDC affirms vaccination as the best public health protection measure to decrease COVID-19 transmission and possibility of new variant emergence.⁶ As medical students represent a significant part of the health-care community and are active members of the COVID-19 response, we aim to explore the factors influencing international medical students' intention of receiving COVID-19 vaccination.

Currently, no studies exist that investigate Caribbean, international medical student COVID-19 vaccine intention; however, recent studies analyzed the influence of factors on the acceptance of the COVID-19 vaccine in other populations university and medical students. A recent survey of 168 US

medical students found that only 53% indicated willingness to participate in a clinical trial, and 23% of the students were unwilling to receive the vaccine immediately upon Food and Drug Administration approval. The researchers attributed these findings to a lack of trust in information from public health experts, politicization of the vaccine, and concerns about side effects.⁷ Another study surveyed 10,843 Iranians and applied the Theory of Planned Behavior to evaluate specific constructs such as attitude, subjective norm, perceived behavioral control, and intention related to COVID-19 vaccination. Fear of COVID-19 was significantly positively associated with behavioral control, subjective norm, attitude, and perceived COVID-19 infectability to explain COVID-19 vaccination uptake.⁸ A study among Chinese university students used Protection Motivation Theory assessed the role that various information places on the perception of COVID-19 vaccination. Receiving information regarding COVID-19 from a medical professional had a greater association with vaccination acceptance than information received from colleagues or online. Additionally, the perceived severity of COVID-19 positively correlated with COVID-19 vaccine acceptance.⁹ A recent cross-sectional survey on Chinese university students found that increased students' knowledge regarding COVID-19 vaccination and risk perception were positively associated with their attitudes toward COVID-19 vaccine uptake. Additionally, positive student attitudes regarding COVID-19 vaccine uptake and the presence of past influenza vaccination uptake are positively associated with the intention to be vaccinated for COVID-19.¹⁰

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Collectively, these studies suggest that successful vaccination campaigns must evaluate distinct factors, such as demographics, beliefs, past vaccinations, and behaviors, in order to increase vaccination among future medical professionals. The current study utilizes the longstanding behavioral theories, the Theory of Planned Behavior and Protection Motivation Theory, to explore the constructs of attitude, subjective norms, intention, and perceived severity, to assess their relation to COVID-19 vaccination among international, Caribbean medical students, respectively. Our objective is to explore and identify behavioral theoretical constructs and potential factors impacting COVID-19 vaccination intention among international medical students, a population previously unstudied. With the survey findings, we aim to aid in recommendations and development of vaccination policy and programs that may increase COVID-19 vaccination in international medical students and future health-care professionals.

2. Materials and methods

2.1. Study design

We employed a 22-item anonymous online survey to evaluate factors affecting medical students at a Caribbean medical school intention to be vaccinated. No known validated scales evaluating COVID-19 vaccination acceptance in medical students were available upon commencement of the research project. An original survey was developed based on current literature on vaccination intention with items related to influenza vaccine uptake, belief in vaccine effectiveness, vaccine convenience, vaccine price, risk perception, personal COVID-19 diagnosis, viral transmission preventive measure practice, vaccine adverse effects, and rushed clinical trials.^{7,11–17} We generated original questions related to professional responsibility, and herd immunity. We created original questions based on the Theory of Planned Behavior constructs including attitude, subjective norm, perceived behavioral control, and intention.¹⁸ Additionally, we selected constructs from the Protection Motivation Theory to develop questions related to threat appraisal and perceived risk.¹⁹ Ethical approval was granted by the medical school's Institutional Review Board (IRB) before the survey was administered (IRB approval: IRB study #: 2021–2).

2.2. Participants

One-thousand, seven-hundred and thirty-five students from a Caribbean medical school were contacted to fill out the survey. Students at Caribbean medical schools have completed a postgraduate degree prior to acceptance. Depending on the year of medical school and campus of enrollment at the time of the survey, students may be living in the USA, UK, Sint Maarten or their home country.

2.3. Measures

The survey consisted of two sections: demographics and factors potentially impacting vaccination. Basic demographic information was collected that included medical school year, age

range, race/ethnicity, country of permanent residence, and living arrangements within the past 12 months. Additional information included perceptions regarding personal health status, social norms, risk, professional responsibility, experience with COVID-19 illness, vaccination conveniences (price, transportation), vaccine adverse effects, rushing of vaccination trials, history of influenza vaccination, practice of COVID-19 preventative behaviors (e.g. hand-washing, social distancing), perceived effectiveness of vaccinations in controlling the spread of the virus, and belief the vaccine aids in developing herd immunity on intention to get vaccinated within 6 months (Supplementary Table 1).

2.4. Data collection

An online platform, Qualtrics XM (2021), was used to create and distribute the electronic survey from March 19, 2021 to April 7, 2021.²⁰ Eligible students needed to be currently enrolled in the medical science or clinical science years of medical school. An incentive was provided for student completion of the survey, such that one randomly selected participant received compensation in the form of a \$25 gift card from a business or charity donation of their choice.

The survey was pretested by 5 students to ensure clarity and understanding of questions. No survey modifications were necessary following the pretest. The incentive provided was given to a random participant regardless of their survey responses as long as the survey was fully completed. Incomplete responses were not included within the data analysis. The survey was emailed through the academic institution's research organization in order to prevent inauthentic participants. The survey was also limited to 22 items in order to prevent participant fatigue and disinterest in responses.

2.5. Data analysis

The survey questions were statements with the participants answering their level of agreement. The responses were coded as follows: strongly agree (5), somewhat agree (4), neither agree nor disagree (3), somewhat disagree (2), and strongly disagree (1). For yes/no questions, yes was coded as 1 and no as 0. Lastly, questions asking the likelihood of a scenario were coded as follows; extremely likely (5), somewhat likely (4), neither (3), somewhat unlikely (2), extremely unlikely (1). Data analysis was conducted using StataSE Version 16 (StataCorp, College Station, Texas). Frequencies, correlations, chi-square analyses, and logistic regression were conducted. Chi-square analyses were conducted comparing gender, health status, perceptions of adverse effects, perceptions that the vaccine trials were rushed, and perceived risk. Given that we were intending to complete a number of these chi-square tests, there was concern that Type I error would be inflated. As such, we used a *p*-value cutoff of 1%, instead of 5%, to determine statistical significance for the chi-square tests.

A multiple logistic regression analysis was conducted to examine the unique association of the following indicator variables: belief in adverse effects of vaccination, belief in clinical trials being rushed, perceived norms, perceived risk, belief that vaccination will help complete tasks required for

medical school, perceived effectiveness of vaccinations in controlling the spread of the virus, and belief the vaccine aids in developing herd immunity. Our outcome variable was on intention to get vaccinated within 6 months (yes or no).

3. Results

The survey response rate was 21.3% (370/1735). Student demographics are presented in Table 1. Of the 370 students, 229 (61%) were not vaccinated for COVID-19. Of those students that did not yet receive the vaccine, 45 (19.65%) were unsure or did not intend to accept the vaccine, while 184 (80.35%) intended to be vaccinated within 6 months. Clinical science students were significantly more likely to be vaccinated than basic medical science students for COVID-19, $X^2(1) = 110.1$, $p < .001$.

We examined Cronbach's alpha, which is a measure of how well each individual item in a scale correlates with the sum of the remaining items, to describe scale reliability of the 13 items measuring vaccine intention. The results indicated an alpha of 0.79. Generally accepted cutoffs of Cronbach's alpha are 0.7,²¹ and as such it was determined that the items assessing vaccine intention were reliable.

There was a non-significant correlation between receiving the influenza 2020–2021 vaccine and intention to be vaccinated for COVID-19 within 6 months, $X^2(1) = 4.4$, $p < .05$. Additionally, significant positive associations were found between intent to be vaccinated within six months and practicing COVID-19 preventative measures ($r = 0.4276$, $p < .001$),

belief of greater risk for contracting COVID-19 without receiving the COVID-19 vaccine, $X^2(4) = 53.0$, $p < .001$, and female gender, $X^2(1) = 21.4$, $p < .001$. Additionally, there was a significant positive correlation between the belief that the COVID-19 vaccine trials were rushed and the belief that the COVID-19 has adverse effects ($r = 0.62$, $p < .001$).

Chi-square analysis showed that increased vaccination intention was significantly associated with beliefs that the COVID-19 vaccine is effective, $X^2(4) = 104.4$, $p < .01$, absolute risk of contracting COVID-19, $X^2(4) = 53.0$, $p < .01$, acceptance is part of a physician's responsibility, $X^2(4) = 120.4$, $p < .01$ and the vaccine will benefit completion tasks in medical school (clinical rotations, traveling, attending in-person education), $X^2(4) = 109.9$, $p < .01$. Additionally, decreased vaccination intention was significantly associated with the belief that the vaccine is associated with adverse effects, $X^2(4) = 40.1$, $p < .01$ and that the clinical trials were rushed, $X^2(4) = 81.3$, $p < .01$. Lastly, no significant associations were observed between vaccine intention vaccine price, $X^2(4) = 2.2$, $p = .701$, convenience (transportation, distance to vaccination clinic, etc.), $X^2(4) = 8.4$, $p = .077$, health status, $X^2(4) = 6.3$, $p = .179$ and comparative risk of contracting COVID-19, $X^2(4) = 7.9$, 9 (Table 2).

We examined multicollinearity among all variables that were included in the logistic regression analysis using variance inflation factor (VIF). The VIF is a measure of the inflation in the variances of the parameter estimates due to multicollinearity, potentially caused by the correlated predictors. It is generally accepted that VIF cutoffs greater than 10, and more conservatively 5, indicate the potential for multicollinearity,²² although it should be noted that there is no universal agreement as what the cutoff based on values of VIF should be used to detect multicollinearity.

Logistic regression analysis indicated that students with the belief that the COVID-19 vaccine trials were rushed were 60% less likely to receive the COVID-19 vaccine within 6 months ($OR = 0.4$, 95% CI: [0.2, 0.8]). Student belief that the vaccine would allow them to complete their tasks in medical school was uniquely significantly associated with an increased likelihood of intending to be vaccinated for COVID-19 within 6 months ($OR = 2.6$, 95% CI [1.7, 4.0]). Additionally, the odds of student intention to receive the COVID-19 vaccine within 6 months was two and a half times higher for those that believe the

Table 1. Description of medical student sample characteristics.

| | Number (N = 370) | % |
|--|------------------|-------|
| Year in medical school | | |
| Basic sciences | 232 | 62.70 |
| Clinical sciences | 138 | 37.30 |
| Majority of time spent within last 12 months | | |
| Sint Maarten | 53 | 14.32 |
| United Kingdom | 13 | 3.51 |
| United States | 282 | 76.22 |
| Canada | 17 | 4.60 |
| Other | 5 | 1.35 |
| Gender | | |
| Female | 231 | 62.43 |
| Male | 134 | 36.22 |
| Non-binary/third gender | 0 | 0 |
| Prefer not to say | 5 | 1.35 |
| Age (y) | | |
| 18–25 | 126 | 34.05 |
| 26–33 | 204 | 55.14 |
| 34–41 | 26 | 7.03 |
| 42+ | 14 | 3.78 |
| Race/Ethnicity | | |
| Caucasian | 162 | 43.78 |
| African-American/Black | 32 | 8.65 |
| Hispanic | 43 | 11.62 |
| American Indian | 1 | 0.27 |
| Asian | 81 | 21.89 |
| Other | 51 | 13.78 |
| Country of permanent residence | | |
| US | 330 | 89.19 |
| United Kingdom | 2 | 0.54 |
| Canada | 30 | 8.11 |
| Other | 9 | 2.43 |
| Population of permanent residence | | |
| Rural | 76 | 20.54 |
| Urban | 294 | 79.46 |

Table 2. Chi-square analysis of factors impacting COVID-19 vaccination intention.

| | Chi-Square (X^2) | p-Value |
|---|----------------------|---------|
| Clinical sciences > Basic sciences (COVID-19) | $X^2(1) = 110.1$ | <.001 |
| Clinical sciences > Basic sciences (Influenza) | $X^2(1) = 33.2$ | <.001 |
| Receiving influenza 2020–2021 vaccine | $X^2(1) = 4.4$ | <.05 |
| Greater risk for COVID-19 without vaccine | $X^2(4) = 53.0$ | <.001 |
| Female gender | $X^2(1) = 21.4$ | <.001 |
| Belief that COVID-19 vaccine effective | $X^2(4) = 104.4$ | <.01 |
| Absolute risk of contracting COVID-19 | $X^2(4) = 53.0$ | <.01 |
| Taking vaccine part of physician responsibility | $X^2(4) = 120.4$ | <.01 |
| Aide in completing medical school | $X^2(4) = 109.9$ | <.01 |
| Belief in adverse effects of vaccine | $X^2(4) = 40.1$ | <.01 |
| Belief in rushed clinical trials | $X^2(4) = 81.3$ | <.01 |
| Vaccine price | $X^2(4) = 2.2$ | .701 |
| Convenience for vaccination | $X^2(4) = 8.4$ | .077 |
| Health status of respondent | $X^2(4) = 6.3$ | .179 |
| Comparative risk of contracting COVID-19 | $X^2(4) = 7.9$ | .095 |

Table 3. Logistic regression analysis of factors influencing medical students' intention to vaccinate versus not vaccinate.

| Predictor | Coefficient | OR | 95% CI |
|--|-------------|------|----------|
| Belief in adverse effects of vaccine | 0.347 | 1.4 | 0.7–2.9 |
| Belief in rushed clinical trials | −0.801 | 0.4* | 0.2–0.8 |
| Female gender | −0.261 | 0.8 | 0.3–2.3 |
| Year in medical school | 0.841 | 2.3 | 0.4–12.5 |
| Descriptive norms | 0.014 | 1.0 | 1.0–1.0 |
| Injunctive norms | −0.009 | 1.0 | 1.0–1.0 |
| Aide in completing medical school | 0.996 | 2.7* | 1.6–4.6 |
| Control pandemic spread | −0.372 | 0.7 | 0.4–1.1 |
| Belief in herd immunity | −0.389 | 0.7 | 0.4–1.1 |
| Comparative risk of contracting COVID-19 | 0.390 | 1.5 | 0.8–2.6 |
| Absolute risk of contracting COVID-19 | 0.622 | 1.9* | 1.2–3.0 |

95% CI = 95% confidence interval, OR = odds ratio. * Indicates significant outcome on regression analysis at $p < .5$.

vaccine will allow them to complete their tasks in medical school (OR = 2.5, 95% CI [1.5, 4.0]), and nearly twice as high for those who believed they were at greater risk for contracting COVID-19 if they did not get vaccinated (OR = 1.9, 95% CI [1.2, 3.0]) (Table 3).

4. Discussion

In this study, we aimed to identify factors that were associated with the intention of medical students to be vaccinated for COVID-19. At the time of evaluation, approximately 80% of surveyed participants were not vaccinated, and nearly 20% of these students reported no intention of being vaccinated within 6 months. The following factors were significantly associated with the intention to be vaccinated within 6 months: gender of student (female), clinical science students, engagement in COVID-19 preventative behaviors, perceived risk, and the belief that being vaccinated would help complete their medical education. Beliefs such as the COVID-19 vaccination trials were rushed, or that the COVID-19 vaccine was associated with adverse side effects were significantly associated with no intention to receive the vaccine within 6 months.

Since a significant majority of female participants intended to become vaccinated, this would suggest a gender bias toward vaccination among medical students. Past research yields mixed results in the association of gender and intention to become vaccinated, with three studies that reported the association of male gender with increased COVID-19 vaccine acceptance within Jordanian university students,²³ and American¹⁵ and Chinese adults.¹⁷ However, another study found no significant differences in vaccination acceptance rates between genders in a survey analysis involving participants from 19 different countries.¹⁴ We assume that gender may be associated with vaccine intention differentially across populations and warrants further investigation.

Medical students in their clinical science years (third and fourth year) were significantly more likely to be vaccinated for COVID-19 compared to basic science students (first and second year). We infer that past vaccination practices are a predictor of COVID-19 vaccination intention and acceptance. Students that believed that the vaccine would allow them to complete their tasks in medical school were two and a half times more likely to intend on being vaccinated for COVID-19 within 6 months than those that did not. Clinical

science students are enrolled mostly in US and UK hospitals and may be mandated, or strongly encouraged by clinical sites to get vaccinated, or have convenient access to vaccination compared to basic science students that mainly focus on foundational medical knowledge in a classroom or virtual setting. A recent questionnaire study on 687 Polish medical students found that higher year of medical school was significantly associated with increased willingness to be vaccinated as soon as possible.²⁴ Three prior studies found significantly increased willingness of COVID-19 vaccination in those who previously had an influenza vaccination among European undergraduate students,²⁵ American¹³ and Chinese adults.¹⁷ Additionally, a strong drive to advance through academia as studies progress and clinical experience are possible factors associated with intent to be vaccinated.

We found that student practice of COVID-19 preventative measures such as hand washing, hand sanitizing, face coverings, and social distancing were associated with intention of COVID-19 vaccination, thereby demonstrating a positive relationship between social behavior of preventative practices and COVID-19 vaccine intention. Accordingly, past research found positive beliefs of vaccination effectiveness in prevention and control of the COVID-19 pandemic significantly associated with higher odds of COVID-19 vaccination.¹⁷ We speculate that practice of pandemic preventative measures are associated with increased COVID-19 vaccine willingness.

Greater beliefs that one would be at higher risk for contracting COVID-19 without receiving the COVID-19 vaccine were associated with intentions to be vaccinated. One study found that medical students significantly reported increased fear of contracting COVID-19, and concern of transmitting COVID-19 to relatives compared to non-medical students.²⁴ Other studies found significantly higher willingness of COVID-19 vaccination in students with greater fear of COVID-19 related deaths, increased positive cases than those without such fear and increased cases,²⁵ and higher perceived severity and fear of the COVID-19 virus.²⁶ Our findings support past research that indicates a strong association between increased perception of risk of COVID-19 contraction and vaccine intention or acceptance.

Greater beliefs that the COVID-19 vaccine trials were rushed was significantly associated with a lessened likelihood of intention to be vaccinated for COVID-19 within 6 months. A recent US study found overwhelming belief among health-care workers for the COVID-19 vaccine's effectiveness; however, most were unlikely to receive the vaccine as soon as it is available due to the science behind the vaccine, current political climate in the US and fast-track timeline.²⁷ However, our study found that increased vaccination intention was significantly associated with stronger belief in vaccine effectiveness. We suggest that the perception that the COVID-19 vaccination development was rushed may present a barrier to intention to vaccination. Increasing student belief that the COVID-19 vaccine is effective should increase student vaccination intention.

The greater the student's belief that the COVID-19 vaccine is associated with adverse effects, the less likely the student was to intend to receive the vaccine within 6 months. Medical students fear of vaccine side effects significantly associated with decreased vaccine readiness.²⁴ We speculate that recent

government recalls of specific COVID-19 vaccines related to hemorrhage, blood clots and thrombocytopenia²⁸ may negatively impact vaccine intention.

Potential limitations of our study include higher female response rate than males, relatively small sample size and overall response rate. Another limitation is the cross-sectional nature of this study. Thus, the dynamic nature of student opinions regarding COVID-19 vaccine as additional information and availability of vaccines change may impact future findings. Additionally, our survey was distributed mainly to North American international medical students with approximately 20% of respondents originating from non-Western countries. This heterogeneous sample potentially raises concern for confounding and extraneous variables. Our survey was originally developed for this research based on prior literature.^{7,11–17} Scales used in other studies include Drivers of COVID-19 Vaccination Acceptance Scale and Motors of Influenza Vaccination Acceptance Scale.^{29,30} The Motors of COVID-19 Vaccination Acceptance Scale and Drivers of COVID-19 Vaccination Acceptance Scale are amended Motors of Influenza Vaccination Acceptance Scales developed and translated months after our survey was distributed.

Although other studies have surveyed graduate level or medical students on their beliefs about COVID-19 vaccination, our study is unique from those studies in a number of ways. Specifically, Qiao et al.²⁶ assessed general participant demographics, COVID-19 exposure, attitude toward general vaccination, and perceived risk such as perceived susceptibility, perceived severity of COVID-19 and fear of COVID-19 of college students. Lucia et al.⁷ surveyed 168 medical students to assess previous immunization behavior, attitudes and perception of vaccination, current knowledge and interest regarding the COVID-19 vaccine, perceived risk of COVID-19 infection, and personal experience with COVID-19. Our research presented a more comprehensive survey than the past two studies as we included the impact of social norms, comparative risk, perception that vaccine trials were rushed, perception of vaccine adverse effects, and impact on completion of medical school tasks. Additionally, our study had double the sample size of Lucia et al.⁷. This study went beyond previous studies in examining medical student attitudes toward COVID-19 vaccination trials, vaccine effectiveness, vaccine price, vaccination convenience, herd immunity, comparative risk, and possible aid of vaccination in completion of medical school.

As a result of this study, we have identified several strategies that could increase the vaccination intention among international medical students. For example, recognition of beliefs regarding adverse effects and rushed vaccination trials within vaccine campaigns may better address the concerns of medical students and target immunization strategies to increase intention to vaccinate among future medical health professionals. Furthermore, increasing male participation in vaccine uptake by a targeted communication campaign, or social media marketing campaign,^{31,32} encouraging practice of COVID-19 preventative behaviors, and encouraging vaccination for influenza may lead to increased COVID-19 vaccination intention among medical students. Specifically, these targeted social media marketing campaigns could incorporate messages to heighten risk appraisal, such as

risk perceptions and perceived severity, and have been found to increase behavioral intention and activation.³³ Moreover, mandates or strong institutional encouragement may increase the belief that being vaccinated would aid in completion of tasks during their international medical education and increase intent to vaccinate. Additionally, increased education and curriculum development regarding COVID-19 vaccination trials, mRNA vaccine science and adverse effects may alter perception that the trials were rushed, or that adverse effect rates are high. Finally, educational and marketing strategies that impress upon international medical students the increased risk for contracting COVID-19 may increase intention. Lastly, medical students possess the knowledge and expertise to learn and disseminate such knowledge to their peers, families, patients and the general public that may increase overall COVID-19 vaccination.

5. Conclusions

The current study provided much insight into the willingness or reluctance of medical students in receiving the COVID-19 vaccination, which should allow for the generation of better strategies to increase vaccination rates among this selected population. Vaccination mandates or institutional encouragement by school or clinical sites, increased education regarding mRNA vaccine science, clinical trials and adverse effects should increase medical student vaccination intention and acceptance. Medical students represent future front-line health-care personnel who should be equipped with the knowledge and desire to vaccinate themselves and promote vaccination.

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Author contributions

DG, AP and DVR contributed to study conceptualization and design, data acquisition, data analysis, and drafting the manuscript. KP, IR, GN, RZ, AZ, JJ, RH, GS and RC contributed to survey development and drafting the manuscript. All authors approved the final version of the manuscript.

Institutional review board statement

Ethical approval was granted by the American University of the Caribbean School of Medicine Institutional Review Board (IRB) before the survey was administered (IRB approval: IRB study #: 2021-2).

References

- Sohrabi C, Alsafi Z, O'Neill N, Khan M, Kerwan A, Al-Jabir A, Iosifidis C, Agha R. Corrigendum to "World Health Organization declares global emergency: a review of the 2019 novel coronavirus (COVID-19)" [Int. J. Surg. 76 (2020) 71-76]. *Int J Surg.* 2020;77:217. doi:10.1016/j.ijsu.2020.03.036.
- Pfizer-BioNTech COVID-19 Vaccine. US food and drug administration. 2020.
- COVID-19 Vaccinations in the United States. Center for disease control and prevention. 2021.
- Saxena SK, Kumar S, Ansari S, Paweska JT, Maurya VK, Tripathi AK, Abdel-Moneim AS. Characterization of the novel SARS-CoV-2 Omicron (B.1.1.529) Variant of Concern and its global perspective. *J Med Virol.* 2021. doi:10.1002/jmv.27524.
- Wang X, Powell CA. How to translate the knowledge of COVID-19 into the prevention of Omicron variants. *Clin Transl Med.* 2021;11:e680. doi:10.1002/ctm2.680.
- Centers for Disease Control and Prevention. Omicron variant: what you need to know. [online]; 2021 [accessed 2021 Dec 19]. <https://www.cdc.gov/coronavirus/2019-ncov/variants/omicron-variant.html>.
- Lucia VC, Kelekar A, Afonso NM. COVID-19 vaccine hesitancy among medical students. *J Public Health (Oxf)* 43 3 445-449. 2020.
- Yahaghi R, Ahmadzade S, Fotuhi R, Taherkhani E, Ranjbaran M, Buchali Z, Jafari R, Zamani N, Shahbazkhania A, Simiari H, et al. Fear of COVID-19 and perceived COVID-19 infectability supplement theory of planned behavior to explain Iranians' intention to get COVID-19 vaccinated. *Vaccines (Basel).* 2021;9. doi:10.3390/vaccines9070684.
- Wang PW, Ahorsu DK, Lin CY, Chen, IH, Yen, CF, Kuo, YJ, Griffiths, MD, Pakpour, AH, al. Motivation to have COVID-19 vaccination explained using an extended protection motivation theory among university students in China: the role of information sources. *Vaccines (Basel).* 2021;9 4 380.
- Fan CW, Chen IH, Ko NY, Yen C-F, Lin C-Y, Griffiths MD, Pakpour AH. Extended theory of planned behavior in explaining the intention to COVID-19 vaccination uptake among mainland Chinese university students: an online survey study. *Hum Vaccin Immunother.* 2021;17:3413-20. doi:10.1080/21645515.2021.1933687.
- Sarathchandra D, Navin MC, Largent MA, McCright AM. A survey instrument for measuring vaccine acceptance. *Prev Med.* 2018;109:1-7. doi:10.1016/j.yjpm.2018.01.006.
- Dror AA, Eisenbach N, Taiber S, Morozov NG, Mizrahi M, Zigron A, Srouji S, Sela E. Vaccine hesitancy: the next challenge in the fight against COVID-19. *Eur J Epidemiol.* 2020;35:775-79. doi:10.1007/s10654-020-00671-y.
- Fisher KA, Bloomstone SJ, Walder J, Crawford S, Fouayzi H, Mazor KM. Attitudes toward a potential SARS-CoV-2 vaccine: a survey of U.S. adults. *Ann Intern Med.* 2020;173:964-73. doi:10.7326/M20-3569.
- Lazarus JV, Ratzan SC, Palayew A, Gostin LO, Larson HJ, Rabin K, Kimball S, El-Mohandes A. A global survey of potential acceptance of a COVID-19 vaccine. *Nat Med.* 2021;27:225-28. doi:10.1038/s41591-020-1124-9.
- Malik AA, McFadden SM, Elharake J, Omer SB. Determinants of COVID-19 vaccine acceptance in the US. *EClinicalMedicine.* 2020;26:100495. doi:10.1016/j.eclinm.2020.100495.
- Reiter PL, Pennell ML, Katz ML. Acceptability of a COVID-19 vaccine among adults in the United States: how many people would get vaccinated? *Vaccine.* 2020;38:6500-07. doi:10.1016/j.vaccine.2020.08.043.
- Wang J, Jing R, Lai X, Zhang, H, Lyu, Y, Knoll, MD, Fang, H, et al. Acceptance of COVID-19 vaccination during the COVID-19 pandemic in China. *Vaccines (Basel).* 2020;8 3 482.
- Ajzen I. The theory of planned behavior. *Organ Behav Hum Decis Process.* 1991;50:179-211. doi:10.1016/0749-5978(91)90020-T.
- Floyd DL, Prentice-Dunn S, Rogers RW. A meta-analysis of research on protection motivation theory. *J Appl Soc Psychol.* 2000;30:407-29. doi:10.1111/j.1559-1816.2000.tb02323.x.
- Qualtrics. Qualtrics. 2021.
- Nunnally JC, Bernstein IH. The assessment of reliability. *Psychometric Theory.* 1994;3:248-92.
- Kutner MH, Neter J, Nachtsheim CJ, Li W. Applied linear statistical models. 5th ed. Irwin (Boston): McGraw- Hill; 2004.
- Sallam M, Dababseh D, Eid H, Hasan H, Taim D, Al-Mahzoum K, Al-Haidar A, Yaseen A, Ababneh NA, Assaf A, et al. Low COVID-19 vaccine acceptance is correlated with conspiracy beliefs among university students in Jordan. *Int J Environ Res Public Health.* 2021;18:2407. doi:10.3390/ijerph18052407.
- Szmyd B, Bartoszek A, Karuga FF, Staniecka K, Blaszczyk M, Radek M. Medical students and SARS-CoV-2 vaccination: attitude and behaviors. *Vaccines (Basel).* 2021;9 128.
- Pastorino R, Villani L, Mariani M, Ricciardi W, Graffigna G, Boccia S. Impact of COVID-19 pandemic on flu and COVID-19 vaccination intentions among university students. *Vaccines (Basel).* 2021;9. doi:10.3390/vaccines9020070.
- Qiao S, Tam CC, Li X. Risk exposures, risk perceptions, negative attitudes toward general vaccination, and COVID-19 vaccine acceptance among college students in South Carolina. *medRxiv.* 2020.
- Gadoth A, Halbrook M, Martin-Blais R, Gray A, Tobin NH, Ferbas KG, Aldrovandi GM, Rimoin AW. Cross-sectional assessment of COVID-19 vaccine acceptance among health care workers in Los Angeles. *Ann Intern Med.* 2021;174:882-85. doi:10.7326/M20-7580.
- Merchant HA. CoViD vaccines and thrombotic events: EMA issued warning to patients and healthcare professionals. *J Pharm Policy Pract.* 2021;14:32. doi:10.1186/s40545-021-00315-w.
- Chen IH, Ahorsu DK, Ko NY, Yen C-F, Lin C-Y, Griffiths MD, Pakpour AH. Adapting the motors of influenza vaccination acceptance scale into the motors of COVID-19 vaccination acceptance scale: psychometric evaluation among mainland Chinese university students. *Vaccine.* 2021;39:4510-15. doi:10.1016/j.vaccine.2021.06.044.
- Yeh YC, Chen IH, Ahorsu DK, Ko N-Y, Chen K-L, Li P-C, Yen C-F, Lin C-Y, Griffiths MD, Pakpour AH, et al. Measurement invariance of the drivers of COVID-19 vaccination acceptance scale: comparison between Taiwanese and Mainland Chinese-speaking populations. *Vaccines (Basel).* 2021;9. doi:10.3390/vaccines9030297.
- Hughes CT, Kirtz S, Ramondetta LM, Lu Q, Cho D, Katzin C, Kahlor LA. Designing and implementing an educational social media campaign to increase HPV vaccine awareness among men on a large college campus. *Am J Health Educ.* 2020;51:87-97. doi:10.1080/19325037.2020.1722297.
- Limaye RJ, Holroyd TA, Blunt M, Jamison AF, Sauer M, Weeks R, Wahl B, Christenson K, Smith C, Minchin J, et al. Social media strategies to affect vaccine acceptance: a systematic literature review. *Expert Rev Vaccines.* 2021;20(8):959-73. doi:10.1080/14760584.2021.1949292.
- Sheeran P, Harris PR, Epton T. Does heightening risk appraisals change people's intentions and behavior? A meta-analysis of experimental studies. *Psychol Bull.* 2014;140:511-43. doi:10.1037/a0033065.