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International migrants and coronavirus disease 2019 vaccinations: Social Media, motivated information management, and vaccination willingness

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Abstract

Objective: This study examines how those who were born outside the United States and migrated to the country in the past decade used social media and other online sites to deal with uncertainties around the coronavirus disease 2019 pandemic. In particular, we examine how they used digital communication technologies to tap into online resources and social connections both in the United States and their origin country and how various aspects of online information management were associated with their willingness to get vaccinated against the virus.

Method: We conducted an online survey and in-depth interviews with international migrants aged 18–64 years who moved to the United States in 2011 or later and were living in two neighboring states in the US Midwest as of spring 2021. Since this research involves understanding how these international migrants dealt with uncertainties related to coronavirus disease 2019 vaccinations, we collected the survey and interview data when each state had a vaccination rate of less than 10% and very limited vaccination eligibility for those aged 64 years and below.

Results: Our results show that international migrants" perceived uncertainty, positive and negative emotions, efficacy, and outcome expectancy affect their information seeking related to the coronavirus disease 2019 vaccination. In addition, issue salience moderates the effect between information seeking and vaccine willingness.

Conclusion: This research provides relevant and timely scholarly and policy implications that help advance research in this area and better support international migrant communities during public health crises such as the coronavirus disease 2019 pandemic.

Keywords

Coronavirus disease 2019 vaccination, digital health, online health literacy, international migrants, social media, mixed-methods

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Introduction

Throughout the coronavirus disease 2019 (COVID-19) pandemic in 2020 and 2021, people have dealt with uncertainties in various contexts—for example, how the virus is spread, when international sanctions on travel will be lifted, when vaccines will become available, and if, once available, vaccines will be safe and effective. As of spring 2021, uncertainties related to efficacy and availabilities of

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COVID-19 vaccines were of particular relevance to many people living in the United States.[1,2] These uncertainties were often amplified among international migrants[1] who have recently settled in a different country, as they have to deal with unfamiliarity with the health care system in the new country as well as cultural differences and language barriers. In the United States, the pandemic and responses from the federal government in 2020 severely disrupted the US immigration system causing added stress and concerns among international migrants in the country.[3]

This study examines how those who were born outside the United States and migrated to the country in the past decade used social media and other online sites to deal with uncertainties around the COVID-19 pandemic. As the world's number one in terms of number of international migrants, the United States has a diverse population, both culturally and ethnically.[4–6] As the US population becomes increasingly diverse, the systemic and income inequality among different international migrant populations has risen accordingly.[6,7] In particular, economic challenges, changing governmental policies, and language barriers, as well as limited experience with the US medical system, have made it difficult for international migrant communities to interact with health care providers and institutions in the United States.[8,9] This has left many international migrants particularly vulnerable to the COVID-19 pandemic. Some studies pointed out that international migrants who have resided in the United States for less than 5 years are at higher risk, compared with those who have lived in the United States for a longer period of time.[10]

In particular, we examine how international migrants used digital communication technologies—digital tools enabling people to communicate with one another (e.g., social media, email, and text messaging)—to tap into online resources and social connections both in the United States and their origin country and how various aspects of online information management were associated with their willingness to get vaccinated against the virus. Specifically, based on the Theory of Motivated Information Management (TMIM),[11–13] we analyze how international migrants" demographic characteristics affect their perceived uncertainty surrounding the COVID-19 vaccination, and how perceived uncertainty, positive and negative emotions, efficacy, and outcome expectancy influence their information seeking related to vaccination. Outcome expectancy refers to anticipated consequences as a result of making a particular decision,[14–16] whereas efficacy means the ability to perform a task as desired.[13,17]

For decades, uncertainty theories have served as useful frameworks to understand individuals" decision-making processes in relation to uncertainty surrounding challenging issues such as the pandemic.[18,19] In particular, the TMIM provides helpful guidance in examining individuals" information management related to the COVID-19 pandemic. Based on multiple theoretical perspectives from different disciplines, the TMIM is a relatively new theoretical framework that explains active information management efforts in response to uncertainty through a three-phase process: interpretation, evaluation, and decision-making.[11,13,17] In addition, we examine how to issue salience—how important the issue (in this case, COVID-19 vaccination) is to the participant—and exposure to online misinformation might moderate the effect between information seeking and vaccine willingness.

Research question and hypotheses

Below are our research questions and hypotheses derived from our review of previous studies. Figure 1 shows our hypothesis model.

RQ1: How are demographic characteristics associated with perceived uncertainty related to COVID-19 vaccinations and exposure to online misinformation about the topic?

H1: Perceived uncertainty related to COVID-19 vaccinations would influence positive (H1a) and negative (H1b) emotions concerning such information.
H2: Positive (H2a) and negative (H2b) emotions concerning COVID-19 vaccination information would affect outcome expectancy and efficacy related to such information.
H3: Outcome expectancy (H3a) and efficacy (H3b) related to COVID-19 vaccination information would influence information seeking regarding COVID-19 vaccinations.
H4: Information seeking would influence vaccine willingness with issue salience and online misinformation exposure moderating the main effect.

Methods

To examine online information behaviors and perspectives on COVID-19 vaccinations among international migrants in the United States, we conducted an online survey and in-depth interviews with international migrants aged 18–64 years who moved to the United States in 2011 or later and were living in two neighboring states in the US Midwest as of spring 2021. We used a mixed-method approach of combining qualitative interviews and a quantitative survey to provide a more comprehensive analysis of the research topic. Studies in health communication and other fields have used mixed-methods approaches to understand social phenomena in a more holistic manner with the number of published academic journal articles using mixed-methods growing significantly in the past decades.[20,21] All research processes described below followed protocols reviewed and approved by the Institutional Review Board (IRB) of the lead author's university.

Sampling

To recruit participants for our survey and interviews, we reached out to nonprofit organizations in the two states that support those who relocated to the United States from

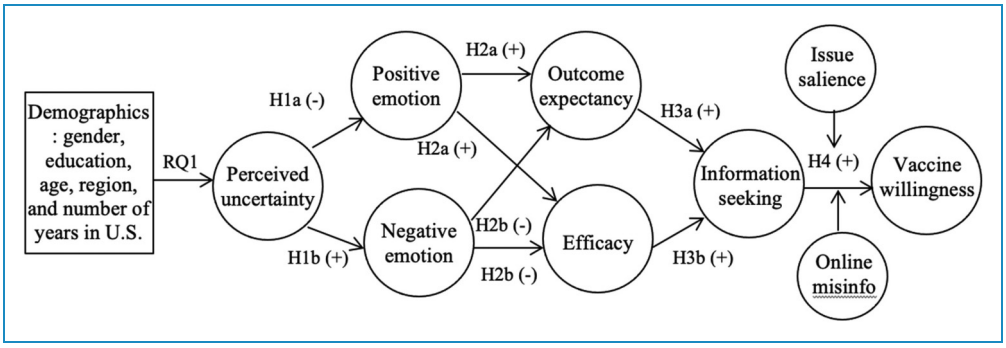

Figure 1. Hypothesized model.

other countries. These organizations were identified through each state's webpage on refugee and immigrant services. These organizations distributed the participant recruitment information for the research and the online survey link to their clients through their email listserv and social media platforms. We included several screening questions in our online survey to ensure only those who are qualified for the research are included in the study. Interview participants were recruited through recommendations from these organizations as well as personal contacts of research team members.

According to the 2018 US Census data, each Midwestern state under study had more than 200,000 international migrants.[22] International migrants in the states worked in the areas of educational services, manufacturing, accommodation and food services, health care and social assistance, and construction, among others. Top countries of origin for international migrants in each state included Mexico, China, and India, which is in line with the characteristics of US international migrants overall.[5,22]

Online survey

We conducted an online survey of international migrants in the two neighboring Midwestern states in March 2021. All survey questions were in English. The review of previous studies discussed in the Literature Review section informed the construction of our survey questionnaire. After developing our initial set of questions, we conducted a pretest of the survey questionnaire with a sample of 15 international migrants in the states. Based on the feedback from the pretest, we finalized the survey questionnaire and created it on Qualtrics, an online survey platform. The final survey questionnaire included a total of 37 multiple-choice questions some of which were branching questions. We used regression to analyze relationships between demographic characteristics (i.e., age, the highest level of education completed, region of origin, and a number of years living in the United States) and perceived uncertainty and level of trust in social media information. Specific question items used to measure concepts and topics in this study are described below.

Measurement items. ***Demographics.*** The demographics portion of the survey questionnaire asked questions on the participant's self-identify country of origin, race/ethnicity, gender, age, highest level of education completed, and marital status. In addition, we asked the participant how long the United States has been their primary residence and whether they live with or have family members in the United States. Finally, we included questions asking the participant how they would rate their overall physical and mental health (1: *Poor* to 5: *Excellent*).

Social media use and online misinformation exposure. We asked multiple questions to understand international migrants" social media use. The first set of questions were about how frequently they use social media including Instagram, Facebook, TikTok, Twitter, Snapchat, WhatsApp, LinkedIn, and YouTube. In addition, we asked participants to indicate the level of importance to them of different reasons for using social media. These reasons included: (a) *To build and/or maintain relationships with people in my country of origin*; (b) *To build and/or maintain relationships with people in the United States*; (c) *To get news and information about my country of origin*; (d) *To get news and information about the United States*; (e) *To seek medical information*; (6) *For fun;* and (7) *For professional development*. In addition, we asked how frequently participants encounter misinformation about COVID-19 on various online sources. These sources include Google or other search engines and popular social media platforms such as Facebook, YouTube, Twitter, Instagram, WhatsApp, and TikTok. According to Cronbach's alpha test, the online misinformation exposure variable was reliable ($\alpha = 0.89$).

Perceived uncertainty. Perceived uncertainty was measured by asking each participant how uncertain they are on each of the three following issues: (a) *Getting vaccinated for COVDI-19 is a beneficial decision*; (b) *Vaccines rarely cause serious side effects*; and (c) *COVID-19 vaccination is important and saves lives*. The items were adapted from previous research on uncertainties around vaccination.[14] Cronbach's alpha test showed that the item was reliable ($\alpha = 0.90$).

Emotions. To measure emotions resulting from uncertainty, we asked each participant to indicate to what

extent they experience eight different emotional responses when thinking about how much/little they know about COVID-19 vaccination. *Excited*, *interested*, *alert*, and *attentive* were used to measure positive emotions, whereas *scared*, *afraid*, *worried*, and *anxious* were utilized for negative emotions. These items are selected from the Positive and Negative Affect Schedule which consists of 10 positive and 10 negative emotions.[23,24] An index of each positive and negative emotion variable was created based on the scores assigned to the items, and it was reliable based on Cronbach's alpha test ($\alpha = 0.82$ for positive emotion; $\alpha = 0.91$ for negative emotion).

Outcome expectancy. To measure outcome expectancy, we used three items adapted from previous studies.[14–16] They are (a) *Searching for more information online about COVID-19 will have positive outcomes*, (b) *There are a lot more benefits than there are problems associated with information online about COVID-19 vaccination*, and (c) *The benefits associated with searching for more information online about COVID-19 vaccination are important*. Cronbach's alpha test indicated that an index based on these multiple items was reliable ($\alpha = 0.83$).

Efficacy. In understanding the participant's efficacy, we examined communication efficacy, coping efficacy, and target efficacy.[13,17] Theoretical definitions of these concepts were discussed in the Literature Review section. The following three items were used to measure communication efficacy: (a) *I am able to search for more information online about COVID-19 vaccination*, (b) *I feel like I have the ability to evaluate the quality of information online about COVID-19 vaccination*, and (c) *I know what I need to search for more information online about COVID-19 vaccination*. The three measurement items utilized for the coping efficacy dimension are (a) *I feel confident that I can handle whatever information I find online regarding COVID-19 vaccination*, (b) *I feel confident that I can cope with whatever I discover online about COVID-19*, and (c) *I have a strong support system that would help me to manage the information I discover online about COVID-19 vaccination*. Target efficacy was measured by the following items: (a) *In my opinion, online sources provide me with relevant information concerning COVID-19*; (b) *In my opinion, information online about COVID-19 vaccination is generally accurate*; (c) *In my opinion, information online about COVID-19 vaccination is generally comprehensive*; and (d) *In my opinion, information online about COVID-19 vaccination is generally helpful*. Cronbach's alpha test indicated that an index based on these multiple items was reliable ($\alpha = 0.84$).

Online information seeking. Three items were used to measure information-seeking behavior. They are (a) *I look for information online about COVID-19 vaccination*, (b) *I actively search for information online about COVID-19 vaccination*, and (c) *If I see something on news or online about COVID-19 vaccination, I am likely to watch/listen to/read the story*. These items are adapted from previous studies examining individuals" information-seeking behavior in uncertain times and related topics.[14,16,25] Cronbach's alpha test indicated that an index based on these multiple items was reliable ($\alpha = 0.90$).

Issue salience. Issue salience was measured by two items (a) *To what extent do you think COVID-19 vaccination is an important topic in your life?* and (b) *To what extent do you think it is important to stay up-to-date on COVID-19 vaccination situations?* The index variable was reliable according to Cronbach's alpha test ($\alpha = 0.86$).

Vaccine willingness. Vaccine willingness was measured by the following two items: (a) *If a Food and Drug administration (FDA)-approved vaccine to prevent COVID-19 was available right now at no cost, how likely are you to agree to be vaccinated?* and (b) *How confident are you that you will be protected from being infected by COVID-19 if you get an FDA-approved vaccine?* The index variable was reliable according to Cronbach's alpha test ($\alpha = 0.91$). We used the terminology "FDA-approved vaccine" to be consistent with national surveys on the topic conducted by Gallup.[26]

Interview research

As discussed above, the interview portion of this research study is aimed at providing more contextual understanding of the research topic. We conducted a total of 39 interviews in spring 2021 using a semi-structured interview method. Each interview was conducted and transcribed by a research team member who received the university's IRB human subject research certificate. Interviews were conducted in English or the participant's native language depending on participant preference (34 out of the 39 interviews were conducted in English). Our open-ended interview questionnaire covered their immigration experiences in the United States, social media use, health information seeking in general, use of online information sources for COVID-19 information, and vaccine willingness. We conducted interviews until we reached the theoretical saturation of themes.

In analyzing the interview transcripts, we utilized Dedoose 8.0.35, an analytics platform for qualitative or mixed-methods research. Specifically, we developed codes using a constant comparison technique based on grounded theory.[27–30] This inductive approach allowed us to identify patterns in transcripts related to themes of health information seeking online and misinformation related to COVID-19 as well as new and emergent themes.

Results

A total of 200 international migrants responded to the survey. Of these, 13 respondents, who indicated that they received COVID-19 vaccination at the time of data collection in spring 2021, were removed from the final analysis. Only

those who were not vaccinated at the time of research were included in the final data analysis, as this study focuses on how international immigrants dealt with uncertainties surrounding whether to get vaccinated or not. When we collected the survey and interview data, each state had a COVID-19 vaccination rate of less than 10% and very limited vaccination eligibility for those aged 64 years and younger. At that time, those who are 65 years or older, live and work in congregate settings, or were considered "essential" workers were eligible to be vaccinated.[31]

The following results are based on survey responses from 187 international migrants and interviews with 39 international migrants living in two bordering Midwestern states at the time of the data collection in spring 2021. Participants, aged 18–64 years, were not vaccinated against COVID-19 at the time of data collection.

Demographics of study participants

Survey participants. Table 1 shows key demographic characteristics of the survey participants. About 31% of the respondents were from East Asia including China, South Korea, and Japan, with about 19.8% from South or Southeast Asia including India and Pakistan. A total of 15.5% of the respondents reported coming from the Middle East and North Africa (MENA) region including Saudi Arabia and Iran, and another 15.5% of participants were from Sub-Saharan Africa including Kenya and

Table 1. Demographic characteristics of survey participants.

Variable	Value	Count	Percent
Age	18–29	81	43.3
	30–39	67	35.8
	40–49	26	13.9
	50–64	13	7.0
	Total	187	100
Region	East Asia	58	31
	South or Southeast Asia	37	19.8
	Middle East and North Africa	29	15.5
	Sub-Saharan Africa	29	15.5
	South or Central America	18	9.6
	Europe	16	8.6
	Total	187	100
Gender	Male	103	55.1
	Female	84	44.9
	Total	187	100
Education	High school completed	31	16.6
	Bachelor's degree	71	37.9
	Master's degree	70	37.5
	PhD	15	8
	Total	187	100

Table 2. Demographic characteristics of interview participants.

Variable	Value	Count	Percent
Age	18–29	13	33.3
	30–39	12	30.8
	40–49	8	20.5
	50–59	5	12.8
	60–64	1	2.6
	Total	39	100
Region	East Asia	9	23.1
	South or Southeast Asia	9	23.1
	Middle East and North Africa	7	17.9
	Sub-Saharan Africa	7	17.9
	South or Central America	7	17.9
	Total	39	100
Gender	Female	20	51.3
	Male	19	48.7
	Total	39	100
Education	High school completed	12	30.8
	Bachelor's degree	13	33.3
	Master's degree	13	33.3
	PhD	1	2.6
	Total	39	100

South Africa. About 9.6% of the respondents were from South or Central America such as Brazil and Mexico, and 8.6% were from Europe. When asked how long the United States has been their primary residence, 28% said less than 2 years, 30.7% between 2 years and less than 5 years, 33.3% between 5 years and less than 8 years, and 7.9% between 8 years and less than 10 years.

In terms of gender, about 55.1% identified themselves as male and 44.9% as female. About 43.3% of the participants were aged 18–29 years, 35.8% were in their 30s, 13.9% were in their 40s, and 7% were 50–64 years of age. In terms of the highest level of education completed, 16.6% said high school degree, 37.9% bachelor's degree, 37.5% master's degree, and 8% PhD About 57.3% said they were single or never married, 34.7% married or domestic partnership, 6.6% divorced or widowed, and 1.3% preferred not to answer the marital status question.

Interview participants. Table 2 summarizes the demographic characteristics of interview research participants. Of the 39 participants, nine were from East Asia, nine from South or Southeast Asia, seven from the MENA region, seven from Sub-Saharan Africa, and seven from South or Central America. In terms of age, 13 were those ages 18–29 years, 12 were in their 30s, eight were in their 40s, and six were 50–64 years of age. Twenty participants identified themselves as women and 19 men. In terms of the education level, 12 had completed high school, 13 bachelor's degree, 13 master's degree, and 1 PhD

COVID-19 uncertainty and social Media misinformation (RQ1)

Our first research question asked how international migrants" demographic characteristics are associated with their perceived uncertainty related to COVID-19 information and perceived level of exposure to pandemic-related misinformation on social media. With regard to perceived uncertainty related to COVID-19 information, education was the only variable that was significantly associated with perceived uncertainty ($\beta = -0.37$, $t = -2.91$, $p < 0.01$). Specifically, the more educated the survey respondent was, the less uncertain the respondent felt about the COVID-19 situation. However, there was no significant relationship between any of the demographic variables and with perceived level of exposure to misinformation related to COVID-19.

When asked to indicate on a scale of 1 (*Not at all*) to 5 (*Very much*) how much they were exposed to misinformation related to COVID-19, international migrants who participated in the survey reported a relatively high level of exposure to misinformation online ($M = 3.41$, $SD = 0.96$). In terms of misinformation exposure on specific social media platforms, WhatsApp ($M = 3.48$, $SD = 1.19$) was considered the most significant source of misinformation about the pandemic, followed by Facebook ($M = 3.30$, $SD = 1.22$), TikTok ($M = 3.24$, $SD = 1.53$), and YouTube ($M = 3.11$, $SD = 1.12$). In comparison, their perceived exposure to pandemic-related misinformation on national ($M = 2.60$, $SD = 1.16$) and local ($M = 2.51$, $SD = 1.15$) news sites was lower than those on social media platforms.

Our interview data provide additional insights into uncertainties international migrants faced during the pandemic as well as exposure to online misinformation, as many of them had to deal with unfamiliarity with the US health care system and lack of related resources. They relied on online resources and family and friends in the United States and their origin country to deal with the situation. For example, a 26-year-old woman from Bangladesh, said "I don't have any insurance here. If I get sick or if I have a problem, I try to solve it with Google. Also, I try to find home remedy that is easy for me here because I don't have any insurance and it is very expensive for me to get medical care here." She added that she follows Facebook pages focusing on health issues and "try to consult with doctors who are the admins of those Facebook pages." Also, many interviewees expressed concerns about uncertainties around visiting their origin country, with the desire to get vaccinated for COVID-19 often associated with this concern. A 19-year-old woman working in a large Midwestern city said she looked for COVID-19 vaccination information online in hopes of visiting Mexico where she is from. She said, "I'm looking online to look for information to check if I'm eligible to get the vaccine. To be honest, I think I'm going to need the vaccine to fly and go to Mexico to [see] my family and I'll need it."

In terms of misinformation online related to COVID-19, international migrants were exposed to misinformation widely spread both in the United States and their origin country and demonstrated different strategies for assessing the quality of information online. A 52-year-old woman from Brazil said she "panicked" reading on Facebook about people dying of getting vaccinated for COVID-19, which she later learned was false. A 32-year-old woman from South Korea said that she saw misinformation on Facebook and KakaoTalk (a popular messaging app in South Korea) intended to discourage people from getting a COVID-19 vaccine. "They were saying it is not effective or it will alter human DNA. When I see information like that, I try to look it up on news sites or health information sites like WebMD. I have recently found that WebMD and other organizations are doing something like VaxFacts to fight misinformation around COVID vaccinations." Other interviewees also mentioned that they look up online resources popular in the United States or their origin country or talk with family or friends if they are unsure of the validity of information online.

Perceived uncertainty and emotions (H1)

Figure 2 shows the results of our hypothesis testing based on path analyses. Our first hypothesis posited that perceived

uncertainty related to COVID-19 information influences positive (H1a) and negative (H1b) emotions concerning such pandemic information. The positive emotion and negative emotion variables were measured by how much the respondent felt excited, interested, alert, and attentive (positive emotion) and worried, anxious, scared, and afraid (negative emotion) in thinking about how much/little they knew about COVID-19 vaccinations. Participants expressed higher levels of positive emotions related to COVID-19 vaccinations compared with their responses to negative emotions. Specifically, when asked on a scale of 1–5 (1: *Strongly disagree*; 5: *Strongly agree*), the means for positive emotion items were higher than those for negative emotion items: alert ($M = 3.88$, SD = 0.92), interested ($M = 3.82$, SD = 0.98), attentive ($M = 3.73$, SD = 0.88), and excited ($M = 3.45$, SD = 1.09); worried ($M = 2.53$, SD = 1.18), anxious ($M = 2.32$, SD = 1.18), scared ($M = 2.18$, SD = 1.26), and afraid ($M = 2.03$, SD = 1.25). In addition, our results show that perceived certainty is negatively associated with positive emotions ($\beta = -0.43$, $t = -4.59$, $p < 0.001$). Therefore, H1a is supported. In contrast, there was no significant relationship between perceived uncertainty and negative emotions measured ($\beta = 0.13$, $t = -1.27$, $p = 0.21$).

Effects of emotions on outcome expectancy and efficacy (H2)

Our second hypothesis proposed that positive (H2a) and negative (H2b) emotions concerning COVID-19 information influence outcome expectancy and efficacy related to such information. Overall, survey participants demonstrated high levels of outcome expectancy. The means and standard deviations for the three measurement items are: *Searching for more information online about COVID-19 will have positive outcomes* ($M = 3.52$, SD = 0.99); *There are a lot more benefits than there are problems associated with information online about COVID-19 vaccination* ($M = 3.55$, SD = 0.93); and (3) *The benefits associated with searching for more information online about COVID-19 vaccination are important* ($M = 3.67$, SD = 0.86). In terms of efficacy, communication efficacy was highest ($M = 3.96$, SD = 1.13), followed by coping efficacy ($M = 3.82$, SD = 1.22) and target efficacy ($M = 3.45$, SD = 1.19). Results show that positive emotions affect outcome expectancy ($\beta = 0.30$, $t = 2.98$, $p < 0.01$) with negative emotions not significantly related to outcome expectancy ($\beta = -0.17$, $t = -1.26$, $p = 0.21$). Similarly, efficacy was significantly associated with positive emotions ($\beta = 0.28$, $t = 2.79$, $p < 0.01$), whereas it had no significant association with negative emotions ($\beta = -0.06$, $t = -0.67$, $p = 0.51$). Therefore, only H2a is supported.

Roles of outcome expectancy and efficacy in COVID-19 information seeking (H3)

Our third hypothesis posited that outcome expectancy (H3a) and efficacy (H3b) would influence information seeking related to COVID-19. Participants indicated that they are likely to seek online resources for COVID-19 vaccination information. Specifically, they reported looking for information online about COVID-19 vaccinations ($M = 4.04$, SD = 1.48), being likely to watch/listen to/read a story about vaccinations if they see something on the news online ($M = 3.84$, SD = 1.35), and actively searching for information about the topic ($M = 3.41$, SD = 1.51). We found that both outcome expectancy ($\beta = 0.25$, $t = 2.95$, $p < 0.05$) and efficacy ($\beta = 0.53$, $t = 5.88$, $p < 0.001$) were positively associated with information seeking. Thus, both H3a and H3b are supported.

Information seeking, vaccine willingness, issue salience and misinformation exposure (H4)

Finally, our fourth hypothesis posited that international migrants" information seeking would influence their vaccine willingness with issue salience and exposure to online misinformation moderating the effect. The participants demonstrated a high level of vaccine willingness: likely to agree to be vaccinated if an FDA-approved vaccine is available right now ($M = 4.32$, SD = 1.08) and confident that they will be protected from being infected from COVID-19 ($M = 3.93$, SD = 1.09). While there was no direct effect of information seeking on vaccine willingness ($\beta = -0.02$, $t = -0.25$, $p = 0.80$), our moderation analysis (Aiken & West, 1991) shows that issue salience moderated the effect of information seeking on vaccine willingness. Specifically, among the low issue salience group (COVID-19 vaccination is not an important topic for them), the more they seek online information on COVID-19, the less likely they are to get a COVID-19 vaccine. In contrast, the relationship between information seeking and vaccine willingness was positive among the high issue salience group. There was no moderating effect of online misinformation exposure on the relationship between information seeking and vaccine willingness.

It should be noted that 76.4% of our survey participants indicated that they were willing or very willing to get a COVID-19 vaccine. However, about 8.3% of the survey participants indicated that it is unlikely that they will get vaccinated with 15.3% indicating they were undecided. This is in line with our interview findings that about 20% of our participants either opposed or were hesitant to get vaccinated against COVID-19. Comments from our interviewees shed some light on their thinking. Concerns about genetic modification and "insufficient" data on vaccine efficacy were some of the primary reasons cited by those not wanting to get vaccinated. With regard to a lack of sufficient data on vaccine efficacy and side effects, a 19-year-old woman from South Africa said, "I don't want to put anything into my body at this point if I haven't seen enough information on the vaccine." She added that she thinks "the pharmaceutical industry

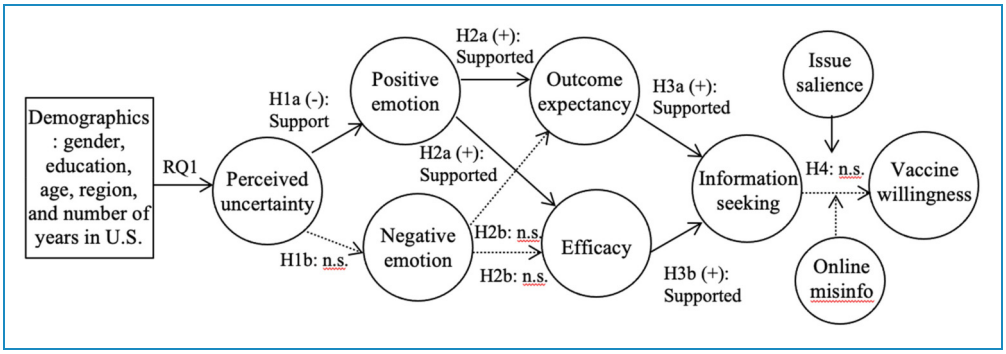

Figure 2. Path analysis results.

developed the vaccine too quickly and there's not enough information about what happens about the symptoms and side effects of the vaccine." Several women expressed their concerns about COVID-19 vaccines potentially affecting their fertility. Some participants opposed the idea of vaccination itself. When asked about his willingness to get a COVID-19 vaccine, a 21-year-old man from Uganda said: "Ok for me personally, if it is by law … is compulsory, then I will take it. But if it is not by law and it is personal willing, I'm not taking it because I don't believe I will get this virus and it is not something that I am scared of … I don't believe in taking any vaccine."

Discussion

Based on a survey and in-depth interviews with international migrants living in the US Midwest in spring 2021, our study analyzed how the group utilized online resources popular both in the United States and their origin country as they dealt with uncertainties surrounding the COVID-19 pandemic. Our results show that international migrants" perceived uncertainty, positive and negative emotions, efficacy, and outcome expectancy affect their information seeking related to COVID-19 vaccinations. In addition, issue salience moderates the effect between information seeking and vaccine willingness. This research provides relevant and timely scholarly and policy implications that help advance research in this area and better support international migrant communities during public health crises such as the COVID-19 pandemic.

Scholarly/policy implications

Our research shows that international migrants face challenges when it comes to online misinformation during public health crises such as COVID-19, especially as they are exposed to such information widespread not only in their host country but also in their country of origin. Our findings indicated that misinformation related to COVID-19 was shared with international migrants in the United States through social media platforms popular in the United States (e.g., Facebook or Instagram) or those more specific to their origin country (e.g., KakaoTalk, Telegram, or WeChat). Indeed, both our survey and interview research participants indicated a relatively high level of exposure to misinformation online. For example, a 25-year-old interviewee from Mexico said that people living in Mexico "were saying on Facebook that health workers are killing people and COVID didn't exist … I think there is a lot of fake news online and I think it's hard to tell what's actually being genuine and what is being used for political use or fake news just to get people talking." A 35-year-old woman from Vietnam said she read articles published in Vietnam about eating hard-boiled eggs to kill the virus, whereas a 31-year-old man from China said he read posts on WeChat about 5G spreading COVID-19. A 30-year-old man from Iran reported seeing "so much false information" about the pandemic on Telegram. Some interviewees reported getting "anxious" or "stressed" after being exposed to such misinformation and deciding to stay away from social media for a while. The findings are in line with previous studies that showed that many international migrants see social media as a hotbed of misinformation and conspiracy theories, and ultimately sources of anxiety and stress.[32] In recent years, anti-vaccine movements have been amplified through misinformation and conspiracy theories shared via social media globally.[33,34] The findings from our research highlight the importance of understanding cross-country/cultural flows of misinformation to develop a more holistic approach to fighting against misinformation, especially on topics as significant as vaccination.[35]

The results of this study show the significant effect of issue salience on vaccine willingness, indicating the importance of raising public awareness of the issue to encourage more people to get vaccinated against COVID-19. Vaccination is one of the most effective and successful public health interventions and a cornerstone for the prevention and treatment of communicable infectious diseases in human history.[36] In particular, vaccine acceptance among the public is required to maintain herd immunity, prevent disease outbreaks, and treat illnesses.[37]

Our study found no evidence for a moderating effect of online misinformation exposure on the relationship between information seeking and vaccine willingness. While widespread misinformation about COVID-19 may potentially decrease the perceived relevance and salience of the topic among some individuals, this study suggests that perceived exposure to COVID-19 misinformation itself did not deter this study sample's intention to look for COVID-19 information and did not influence how their information seeking is related to vaccine willingness. This finding suggests this study sample feels relatively well equipped to assess misinformation and thus their perceived exposure to misinformation did not influence how they approached COVID-19 information seeking or their vaccine willingness. As previous studies have shown, strengthening citizens" abilities to assess the quality of information online and nurture civil dialog on related topics is one of the most important ways to fight against online misinformation.[38–41] It is also important for social media platforms and other relevant entities to work together to develop comprehensive measures that more effectively handle misleading information about COVID-19 vaccination.[41]

About 76.4% of our survey participants in spring 2021 indicated that they were willing or very willing to get a COVID-19 vaccine. This figure is similar to that of the US national sample: According to a Gallup survey in May 2021, 74% of people in the United States said they would be willing to get a COVID-19 vaccine.[42] Another important similarity between our findings and those from the US national random sampling surveys is that trust in the vaccine research and development process was significantly associated with willingness to get vaccinated.[43] While there are no national data to compare with regard to our findings on international immigrants" misinformation exposure, various reports suggested that the US general population was also concerned about the widespread misinformation about COVID-19.[38,44] For example, the claim that COVID-19 vaccines using new mRNA technology can potentially affect genetic makeup was a widely circulated false assertion.[29,45]

As there is insufficient research in this area, this study fills an important gap. In particular, theoretical and methodological approaches used in this research should be helpful for future research examining international migrants" use of digital communication technologies during a pandemic or other public health crisis situations. Practically, findings from this study can help policymakers and practitioners in the areas of international communication and health communication develop more tailored and holistic strategies to support international migrants.

Limitations and future research

As with any social science research, this study has several limitations. We decided to study international migrants in two neighboring states with similar COVID-19 developments to control for extraneous variables such as vaccination rates. Therefore, the results of this research cannot be generalized to a larger international migrant population in the United States. Future research with a larger and nationally representative sample will be able to produce more generalizable findings. While our interviews were conducted in the language choice of our participants (English or their native language), our survey was conducted in English only. Future research in this area should consider implementing survey research in multiple languages to include a broader group of international migrants. In addition, about 75% of participants in our study had a bachelor's degree. This relatively high education level may be associated with the fact that our survey was conducted only in English. Moreover, international migrants with lower formal education levels may demonstrate different perspectives or behaviors related to online health information seeking.

Finally, we included only unvaccinated international migrants in the final analysis, and this may have influenced the relationships between the variables analyzed. As mentioned earlier, only 13 out of 200 respondents to our survey indicated they were vaccinated as of spring 2021, and our examination of demographic characteristics of vaccinated (13) and unvaccinated (187) individuals did not suggest meaningful differences between the two groups. Moreover, given a significantly smaller proportion of vaccinated international migrants in the survey respondents, inferential statical analysis for comparing the two groups would not yield any meaningful findings. A future study conducted in the later stages of the COVID-19 pandemic may benefit from comparing vaccinated and unvaccinated international immigrants with regard to their online health information use and vaccination willingness.

Conclusion

While the number of international migrants in the United States is increasing, there is still insufficient research about this international population's information-seeking processes regarding health-related issues. The COVID-19 pandemic provides an important opportunity to analyze international migrants" perspectives on uncertainties, online information use, and willingness to take necessary health actions during a public health crisis. By applying the Theory of Motivated Information Management and a mixed-methods approach to the COVID-19 pandemic situation, this research helps both scholarly and policy communities better understand how to evaluate international migrants" challenges and needs in online information seeking and developed tailored communication strategies to support them.

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Note

1. According to the United Nations, "there is no legal definition" of an international migrant.[71] Following conventions of the United Nations and other international organizations, this paper defines an international migrant as someone who changes their "country of usual residence, irrespective of the reason for migration or legal status."[71,72]

References

1. Huang P. Unpacking the variations in vaccine efficacy data, *NPR*, https://www.npr.org/2021/01/31/962638211/unpacking-the-variations-in-vaccine-efficacy-data (2021, accessed 31 January 2021).
2. Roberts M. Study reveals extent of COVID vaccine side-effects, *BBC*, https://www.bbc.com/news/health-55932832 (2021, accessed 4 February 2021).
3. Loweree J, Reichlin-Melnick A and Ewing W. *The impact of COVID-19 on noncitizens and across the U.S. immigration system*. Washington, DC: American Immigration Council, 2020. https://www.americanimmigrationcouncil.org/research/impact-covid-19-us-immigration-system (2021, accessed 14 January 2021).
4. International Organization for Migration. World Migration Report 2020, https://www.un.org/sites/un2.un.org/files/wmr_2020.pdf (2020, accessed 17 April 2021).
5. Pew Research Center. Key findings about U.S. immigrants, https://www.pewresearch.org/fact-tank/2020/08/20/key-findings-about-u-s-immigrants/ (2020, Accessed 17 February 2021).
6. Katz VS, Gonzalez C and Clark K. Digital inequality and developmental trajectories of low-income, immigrant, and minority children. *Pediatrics* 2017; 140: S132–S136.
7. Wilson FA and Stimpson JP. US policies increase vulnerability of immigrant communities to the COVID-19 pandemic. *Ann Glob Health* 2020; 86: 57.
8. Banas JR, Ball JW, Wallis LC, et al. The adolescent health care broker—adolescents interpreting for family members and themselves in health care. *J Community Health* 2017; 42: 739–747.
9. Chen CJ, Kendall J and Shyu YIL. Grabbing the rice straw: health information seeking in Chinese immigrants in the United States. *Clin Nurs Res* 2010; 19: 335–353.
10. Chilton M, Black MM, Berkowitz C, et al. Food insecurity and risk of poor health among US-born children of immigrants. *Am J Public Health* 2009; 99: 556–562.
11. Afifi T and Afifi W. *Uncertainty, information management, and disclosure decisions: Theories and applications*. New York, NY: Routledge, 2015.
12. Afifi WA and Morse CR. Expanding the role of emotion in the theory of motivated information management. In: Afifi TD and Afifi WA (eds) *Uncertainty, information management, and disclosure decisions: theories and applications*. New York, NY: Routledge/Taylor & Francis Group, 2009, pp. 87–105.
13. Afifi WA and Weiner JL. Toward a theory of motivated information management. *Commun Theory* 2004; 14: 167–190.
14. Crowley JL and High AC. Parents' information seeking during adolescent career development: a test of the theory of motivated information management. *J Appl Commun Res* 2018; 46: 348–367.
15. Center for Disease Control and Prevention. *Interim list of categories of essential workers mapped to standardized industry codes and titles*, https://www.cdc.gov/vaccines/covid-19/categories-essential-workers.html (2020, accessed 1 March 2021).
16. Creswell JW and Plano Clark VL. *Designing and conducting mixed methods research*. 3rd ed. London, UK: Sage, 2018.
17. Kanter E, Bevan JL and Dorros SM. The use of online support groups to seek information about chronic illness: applying the theory of motivated information management. *Commun Q* 2019; 67: 100–121.
18. Li J, Wen J, Kim J, et al. Applying the theory of motivated information management to the context of conflicting online health information: implications for childhood vaccination communication with parents. *Int J Strateg Commun* 2020; 14: 330–347.
19. Afifi WA and Weiner JL. Seeking information about sexual health: applying the theory of motivated information management. *Hum Commun Res* 2006; 32: 35–57.
20. American Immigration Council. *State factsheets*, https://www.americanimmigrationcouncil.org/topics/state-by-state (2020, accessed 1 March 2021).
21. Magyar-Moe JL. *Therapist's guide to positive psychological interventions*. Cambridge, MA: Academic Press, 2009.
22. Rauscher EA and Hesse C. Investigating uncertainty and emotions in conversations about family health history: a test of the theory of motivated information management. *J Health Commun* 2014; 19: 939–954.
23. Kim JN and Grunig JE. Problem solving and communicative action: a situational theory of problem solving. *J Commun* 2011; 61: 120–149.
24. Glaser B and Strauss A. *The discovery of grounded theory strategies for qualitative research*. Mill Valley, CA: Sociology Press, 1967.
25. Hesse-Biber SN and Leavy P. *The practice of qualitative research*. Thousand Oaks, CA: Sage Publications, 2010.

26. Brenan M. *Willingness to get COVID-19 vaccine ticks up to 63% in U.S.*, https://news.gallup.com/poll/327425/willingness-covid-vaccine-ticks.aspx#:~:text=Americans'%20willingness%20to%20receive%20a,the%2050%25%20reading%20in%20September (2020, accessed 8 December 2020).
27. Rubin HJ and Rubin IS. *Qualitative interviewing: The art of hearing data*. Thousand Oaks, CA: Sage Publications, 2011.
28. Strauss A and Corbin J. Grounded theory methodology: an overview. In: Denzin NK and Lincoln YS (eds) *Handbook of qualitative research*. Sage Publications, 1994, pp.273–285.
29. Reuters Fact Check. Fact check—mRNA vaccines are distinct from gene therapy, which alters recipient's genes, https://www.reuters.com/article/factcheck-covid-mrna-gene/fact-check-mrna-vaccines-are-distinct-from-gene-therapy-which-alters-recipients-genes-idUSL1N2PH16N (2021, accessed 1 March 2021).
30. Seo H and Faris R. Comparative approaches to mis/disinformation: Introduction. *Int J Commun* 2021; 15.
31. Johnson RB, Onwuegnuzie AK and Turner LA. Toward a definition of mixed methods research. *J Mix Methods Res* 2007; 1: 112–133.
32. Gonzalez C and Katz VS. Transnational family communication as a driver of technology adoption. *Int J Commun* 2016; 10.
33. Johnson NF, Velásquez N, Restrepo NJ, et al. The online competition between pro- and anti-vaccination news. *Nature* 2020; 582: 230–233.
34. Forster V. Covid-19 vaccines can't alter your DNA, here is why. *Forbes*, https://www.forbes.com/sites/victoriaforster/2021/01/11/covid-19-vaccines-cant-alter-your-dna-heres-why/?sh=7aceadc12491 (2021, accessed 14 January 2021).
35. Callender D. Vaccine hesitancy: more than a movement. *Hum Vaccin Immunother* 2016; 12: 2464–2468.
36. Boodoosingh R, Olayemi LO and Sam FAL. COVID-19 vaccines: getting anti-vaxxers involved in the discussion. *World Dev* 2020; 136: 105177.
37. Armitage R. Online 'anti-vax' campaigns and COVID-19: censorship is not the solution. *Public Health* 2021; 190: e29.
38. Desmond A and Offit PA. The antivax movement and what allergists can do. *Ann Allergy Asthma Immunol* 2020; 125: 8–9.
39. Choukou M-A, Sanchez-Ramirez DC, Pol M, et al. COVID-19 infodemic and digital health literacy among vulnerable populations: a scoping review. *Digit Health* 2022; 8: 1–13.
40. Ittefaq M, Seo H, Abwao M, et al. Social media use for health, cultural characteristics, and demographics: a survey of Pakistani millennials. *Digit Health* 2022; 8: 1–12.
41. United Nations. *Refugees and migrants: Definitions*, https://refugeesmigrants.un.org/definitions (n.d., accessed 14 February 2021).
42. Ray J. *Over 1 billion worldwide unwilling to take COVID-19 vaccine*, https://news.gallup.com/poll/348719/billion-unwilling-covid-vaccine.aspx (2021, accessed 3 May 2021).
43. Funk C and Tyson A. *Intent to get a COVID-19 vaccine rises to 60% as confidence in research and development process increases*, https://www.pewresearch.org/science/2020/12/03/intent-to-get-a-covid-19-vaccine-rises-to-60-as-confidence-in-research-and-development-process-increases/#intention-to-be-vaccinated-for-covid-19-rises-across-the-board (2020, accessed 3 December 2020).
44. Tran L. Firehosing: The systemic strategy that anti-vaxxers are using to spread misinformation. *The Guardian*, https://www.theguardian.com/commentisfree/2019/nov/07/firehosing-the-systemic-strategy-that-anti-vaxxers-are-using-to-spread-misinformation (2019, accessed 14 January 2021).
45. Puri N, Coomes EA, Haghbayan H, et al. Social media and vaccine hesitancy: new updates for the era of COVID-19 and globalized infectious diseases. *Hum Vaccin Immunother* 2020; 16: 1–8.