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Characteristics of COVID-19 Vaccine-Hesitant UCF College Students and Potential Avenues for Increasing Vaccination Rates

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Characteristics of COVID-19 Vaccine-Hesitant UCF College Students and Potential Avenues for Increasing Vaccination Rates

By

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ABSTRACT

The COVID-19 pandemic has been an ongoing disaster that has devasted millions of lives. With the development of COVID-19 vaccines in late 2020, there was a potential for populations to gain artificial active immunity in order to prevent future outbreaks. However, despite successful clinical trials, millions of citizens have been hesitant to receive the COVID-19 vaccines (Khubchandani et al., 2021). Demographics of the most prominent US vaccine-hesitant populations consist of ethnic/racial minorities and Republicans groups (Khubchandani et al., 2021). Little information is known about COVID-19 vaccine hesitancy in colleges and universities. Colleges provide an elevated risk for infection through their communal residencies, the reemergence of campus activities, and continuous travel to home (Sharma et al., 2021).

This study explored COVID-19 vaccine hesitancy in UCF college students and explored potential pathways to achieve higher vaccination rates. Potentially believed COVID-19 misinformation was also studied. A COVID-19 opinion survey was designed and distributed to the UCF college population. Two hypotheses were made for this study: (1) There is a significant effect on vaccination status among people of different political parties, field of study, living conditions, masking frequency, and scores on the knowledge-based questions portion. (2) There will be a significant effect on knowledge-based scores with political party and field of study. The results were analyzed using Chi-square, one-way ANOVA, or two-way ANOVA on SPSS. The results showed a significant effect on vaccination status in political parties, masking frequency in class, and scores on the knowledge-based survey questions. There was no significance with race/ethnicity and field of study. There was a significant effect on the knowledge-based survey questions with political party and field of study. Potential side effects and the vaccines being seen as ineffective were the top two reasons that students choose not to vaccinate.

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INTRODUCTION

COVID-19 Vaccine Hesitancy in the United States

With the emergence of the Pfizer-BioNTech, Moderna, and Johnson & Johnson vaccines, millions of people in America have questioned whether or not to be vaccinated for COVID-19. Modern vaccine hesitancy has further polarized the division among pro-vaccine and anti-vaccine groups. In 2019, the World Health Organization declared vaccine hesitancy a global threat. They predicted three reasons for why people might be hesitant to receive vaccinations: "(i) individuals may lack confidence in and be fearful towards vaccines, especially with the misunderstanding that vaccines pose a risk of infection; (ii) individuals do not perceive a need for a vaccine (e.g., due to underestimation of disease severity) or do not value the vaccine; and (iii) individuals or community may have difficulties accessing the vaccine" (Kwok et al., 2021). Surveys revealed that the highest population of vaccination hesitancy was among African Americans, Hispanic Americans, stay-at-home parents, people in rural areas, and Republicans (Khubchandani et al., 2021). Despite the vaccine clinical trials lasting months, the widespread "anti-vax" movement was motivated by rumors and distrust in the government and physicians (Khubchandani et al., 2021). The large groups of vaccine-hesitant racial and ethnic minorities are attributed to lower access and less interaction with medical workers, a historical mistrust due to previous vaccination trials, lower participation in current vaccination trials, education disparities, lack of financial resources, and lack of awareness due to a lack of access to television and the internet (Khubchandani et al., 2021).

Family and media play a role in vaccination status (Puri et al., 2020). Women are 34% more likely to be unvaccinated if they do not have any children in their house (Men 44%). An interesting statistic showed that unemployed people are less likely to receive the vaccine than employed people (Khubchandani et al., 2021). Lastly, political parties and media have influenced the public on whether or not to receive vaccinations. Social media provides many links to websites that are either critical of the vaccine or support it (Puri et al., 2020). The most effective vaccine propaganda that persuades Americans is videos that issue an emotional appeal to the public (Puri et al., 2020). Studies have shown that people with cognitive impairment, older age, lower literacy level, and less digital literacy are more vulnerable to emotional narrative appeals about the vaccine (Puri et al., 2020). To combat misinformation, social media platforms like Twitter partnered with the Department of Human and Health Services to link any keywords associated with vaccines to the link, Vaccines.gov (Puri et al., 2020). Children are also easily influenced by social media. 59% of students active on social media could not differentiate most misinformation about the vaccine from the truth (Puri et al., 2020). However, 50% of these students reported some incorrect statements about the vaccines, such as learning about how one can get exposed to COVID-19 (Puri et al., 2020). However, the most influential role in the child's vaccination status would be the parents (Puri et al., 2020). Teens are more likely to receive the influenza vaccine after being permitted by their parents (Puri et al., 2020).

The most studied minority group in America that is hesitant about receiving the COVID-19 vaccine is African Americans. Black Americans were 2-3 times more likely to die from COVID-19 than White Americans (Bogart, 2021). These Black individuals represent 13.4% of the American population but 24% of the COVID-19 deaths. These inequalities can be attributed to a lower socioeconomic status, lower wages, higher levels of unemployment, and poverty (Bogart, 2021). Genetic risk factors also play a role in the death rate. Black Americans are more likely to be genetically predisposed to hypertension, diabetes, and obesity, which increase the chances of not surviving a COVID-19 infection. Despite the underlying health conditions Black Americans are prone to have, they are America's most mistrustful ethnic group (Bogart, 2021). The 2016 National Survey on HIV recorded that 18% of Black Americans feel that the government is telling the truth about major health issues that are currently happening in the regions (Bogart, 2021). Black Americans resisted medical assistance by not taking medicine, not engaging with health care officials, having a lower quality of life, unwillingness to participate in screening, and vaccine hesitancy (Bogart, 2021).

For older Black Americans, there has been a history of mistrust in medical officials due to the Tuskegee Study of Untreated Syphilis in the Negro Male between 1932 and 1972. The US Public Health Service followed hundreds of Black men in poverty, where most of the participants were infected with syphilis (Alsan, 2018). They were denied penicillin, an antibiotic that would be able to treat the Syphilis bacterium and were discouraged from reaching out to medical officials about their condition outside of the study (Alsan, 2018). They were required to have their blood drawn, receive spinal taps, and have autopsies done on their bodies for their cause of death. Many individuals did not know that they were infected with syphilis and were told that they were diagnosed with having "Bad Blood" (Alsan, 2018). They were compensated for their participation with hot meals, burial payments, and what they thought were treatments. Most of the participants passed away from their easily treatable syphilis conditions. This experimentation continued until 1972, when news of the Tuskegee Study was reported in an exposé by Jean Heller (Alsan, 2018). Due to similar instances, the Black population has been reluctant, especially Black males, to participate in medical research, listen to medical campaigns, and participate in clinical trials (Alsan, 2018).

Like Black Americans, Hispanic Americans are more likely to suffer from pre-existing conditions, such as obesity, coronary artery disease, and diabetes, compared to White Americans (Kricorian, K., & Turner, K. 2021). They also received a greater degree of layoffs due to the pandemic (Kricorian, K., & Turner, K. 2021). However, studies show that Hispanic Americans are more likely to postpone routine visits to health services, which affects their overall health (Kricorian, K., & Turner, K. 2021). This lack of routine is attributed to a lack of trust in medical professionals due to a potential language barrier between physician and patient (Kricorian, K., & Turner, K. 2021). For native Spanish speakers, US websites that talk about COVID-19 vaccines could have erroneous Spanish translations that would be viewed as confusing for Hispanic Americans (Kricorian, K., & Turner, K. 2021). Medical centers might not have access to translators to help Hispanics/Latino Americans understand the importance of the COVID-19 vaccine (Kricorian, K., & Turner, K. 2021). This poor translation will make non-English speakers feel vulnerable to medical malpractice and skeptical to trust medical professionals who advise the COVID vaccine (Kricorian, K., & Turner, K. 2021). This leads the ethnic groups to feel very skeptical towards COVID in general.

Immigration plays a significant factor, too, as Hispanics/Latinos were infected with coronavirus at a disproportionate rate (Kricorian, K., & Turner, K. 2021). Due to strict immigration laws in place during the first year of the pandemic, many Hispanic/Latino immigrants without legal documentation felt discouraged to access COVID-19 testing and other medical resources (Kricorian, K., & Turner, K. 2021). Due to the strict immigration laws, Hispanic Americans disproportionally served as frontline workers: construction, food production and delivery, farming, and waste management (Kricorian, K., & Turner, K. 2021). These occupations increased chances of coronavirus exposure compared to White Americans. The

Centers for Disease Control and Prevention (CDC) estimated that only 38% of Hispanic Americans had received the influenza vaccine, compared to 41% of African Americans and over half of White Americans (Kricorian, K., & Turner, K. 2021). One of the most significant factors in vaccine hesitancy for Hispanic Americans is that they feel that they are not eligible to obtain a vaccine within their state. For undocumented immigrants, this could be due to a fear of deportation (Kricorian, K., & Turner, K. 2021). For citizens, this could be due to their geographic areas having scarce access to pharmacy services that make it a challenge to visit (Kricorian, K., & Turner, K. 2021). There could be a lack of a centralized system for the residents to schedule a vaccine appointment (Kricorian, K., & Turner, K. 2021).

There is significant political polarization in the US about vaccinations (Bruine de Bruin et al., 2020). Even before the emergence of the Pfizer-BioNTech, Moderna, and the Johnson and Johnson vaccines, there was distrust in the government's role in the creation of the vaccinations (Sultana et al., 2020). A poll developed by the Kaiser Family Foundation (KFF) completed during the last week of August 2020 found that only 42% of the participants would be willing to receive the COVID-19 vaccine if it were to be approved before the 2020 election in November. The reasoning behind the hesitancy was clarified in a later response by the participants. In the KFF poll, 62% of the respondents believed that sociopolitical factors and pressures could potentially lead to the clinical trials and approval being rushed to meet America's initial deadline of the November election (Sultana et al., 2020). The concerns remained after the first clinical trial results for potential vaccine candidates were announced in November (Sultana et al., 2020). The lowest COVID-19 vaccination rates are located in Republican-leaning states (Bruine de Bruin, Saw, & Goldman, 2020). Unvaccinated Republicans have also opposed social distancing and mask-wearing. These are both important methods for preventing the spread of coronavirus.

Until the emergence of the COVID-19 vaccines, the anti-vaccine rhetoric had little to no involvement in bipartisan political leadership (Bruine de Bruin et al., 2020). The use of news media also fueled rhetoric as to whether or not COVID-19 should be taken seriously. Self-identifying Democrats preferred to watch CNN, while self-identifying Republicans preferred to watch Fox News (Bruine de Bruin et al., 2020). Polls showed that watchers of Fox News were not as worried about the effects of COVID-19 compared to people that watched CNN (Bruine de Bruin et al., 2020). The differences in beliefs surfaced during the start of the pandemic. Democrats were 1.76 times more likely to wear a face mask than Republicans and 1.45 times more likely to avoid large crowds and public spaces (Bruine de Bruin et al., 2020). Independents were 1.23 times more likely to avoid large crowds than Republicans (Bruine de Bruin et al., 2020).

Ali (2020) proposed that the best overall route to combat vaccination hesitancy was to rebuild trust between the citizens and healthcare professionals. Patients will typically seek a physician and form a bond of trust with a physician who shares similar values and beliefs (Verger & Dubé, 2020). The government has played a role in mistrust, too. Although initially considered helpful, vaccination mandates cannot stop vaccine hesitancy but are more likely to ignite it when citizens feel their freedom is being restricted (Verger & Dubé, 2020). Often the patient will feel more secure with a physician of a similar ethnicity (Verger & Dubé, 2020). This can also contribute to less disengagement between the physician and their patient (Verger & Dubé, 2020). A patient-centered approach is one of the most beneficial methods of patient engagement, especially if it involves face-to-face motivational interviews (Verger & Dubé, 2020). This patient-centered approach will alter their vacillation, avoid rebuttals that provide erroneous opinions, follow an empathic route, explore the patient's source of motivation, and encourage self-autonomy (Verger & Dubé, 2020).

College attendance places students at a high risk of infection through their communal residencies both on- and off-campus, the reemergence of campus activities, and travel between campus and home (Sharma et al., 2021). A study conducted on Italian college students showed that students that were willing to receive the vaccine were either on a medical track, had prior knowledge of COVID-19, had the previous inoculation of the influenza vaccine, or were immunocompromised (Sharma et al., 2021). Very little research has been conducted to understand college student vaccination intentions in the United States. However, one study of a college population found that 47.5% of students were hesitant to receive the vaccine (Sharma et al., 2021). Multi-theory model (MTM) construct of behavioral confidence showed to be significant in the population that identified as Republican ($b = 0.022$, $p < 0.001$) (Sharma et al., 2021). The Republican students' beliefs were negatively associated with the acceptance of COVID vaccinations (Sharma et al., 2021).

To encourage vaccinations, the University of Central Florida (UCF) provides educational resources about COVID-19 infection and prevention. The information is distributed through frequent emails which also focuses on the efficacy of COVID-19 vaccinations. UCF also encourages vaccination by having a pharmacy on campus that administers free COVID-19 vaccines (Florida, 2021). In addition, UCF publicly supports the Centers for Disease Control and Prevention's message on vaccinations as a method to prevent the emergence of more variants (CDC, 2021). However, there is still a population of students that are hesitant to receive the COVID vaccine.

Vaccine Efficacy

Throughout history, the best-known way to combat a pandemic is through inoculations (vaccines), which are known to prevent over 103,000,000 cases of diseases in children between 1924 and 2010 (Iwasaki & Omer, 2020). The most significant known victory of vaccines was eradicating the smallpox virus (Iwasaki & Omer, 2020). Smallpox was active in humanity for 3,000 years, taking over 300,000,000 lives during the twentieth century (Iwasaki & Omer, 2020).

The earliest record of inoculations was in 1796, when Edward Jenner became the first known scientist to provide a scientific experiment and a description of vaccinations (Sultana et al., 2020). His work was seen as the "foundation of immunology" (Riedel, 2005). After hearing stories about how dairymaids seemed be protected from getting smallpox after being infected with cowpox, a tamer disease compared to smallpox, he deduced that the cowpox disease protected against the more lethal smallpox disease. Cowpox genetic material could be transmitted from one individual to another as a method to cause immunity to smallpox (Riedel, 2005). In May 1796, Edward Jenner collected cowpox lesions from a dairymaid and inoculated an 8-year-old boy with the lesion (Riedel, 2005). The boy underwent a mild fever, discomfort, and loss of appetite following the procedure but quickly recovered (Riedel, 2005). In July 1796, Jenner then inoculated the boy with a smallpox lesion. The boy never developed smallpox-related symptoms (Riedel, 2005). The experiment was a complete success. After several similar experiments were conducted with the same results, Jenner published his booklet about his discoveries, "An Inquiry into the Causes and Effects of the Variolae Vaccinae, a disease discovered in some of the western counties of England, particularly Gloucestershire and Known by the Name of Cow Pox" (Riedel, 2005). He came up with the term vaccination from the Latin word for cow (vacca) and the Latin word for cowpox (vaccinia) (Riedel, 2005). Jenner also received credit for the first scientific description of vaccinations (Iwasaki & Omer, 2020).

In 1843, Robert Koch, a Prussian physician, discovered the bacillary etiology of the Tuberculosis bacteria. Koch noted that it is microbes like Mycobacterium tuberculosis that cause diseases. He studied other microorganisms like anthrax bacillus and Yersinia Pestis (Lakhtakia, 2014). That is when he created the Koch Postulate stating that an organism is the reason behind an infection: the same pathogen was found after every infection of the same disease, it does not exist in other known disease conditions, and it produces the same disease symptoms in a healthy individual after it is isolated and given time to multiply (Riedel, 2005). Studying Koch's work, Louis Pastier, a French chemist, developed modern vaccines for chicken cholera and then anthrax by attenuating the virus by weakening it with heat. (Smith, 2012). Originally given to sheep and humans, the anthrax vaccine provided lasting immunity to individuals affected by anthrax bacteria. The sheep given the vaccination remained alive and well compared to the control group that was gravely ill (Smith, 2012). One of Pasteur's most significant accomplishments was his creation of the vaccine for rabies. To do this, Pasteur and his colleague, Emile Roux, attenuated the virus using spinal tissue from rabbits that passed away from rabies and suspending them in flasks exposed to potassium hydroxide as a desiccant to prevent the cords from purifying (Smith, 2012). The first person to receive the vaccine was eight-year-old Joseph Meister, who was bitten by a dog that supposedly had rabies (Smith, 2012). The vaccine was injected subcutaneously, and he did not develop rabies after the inoculation. It was the contributions of scientists like Pasteur and Jenner that opened the doors for opportunities to engineer medical tools to fight off virulent microorganisms that invade the human body (Smith, 2012). American scientists, Daniel Elmer Salmon and Theobald Smith, created vaccines with dead pathogens. Over time, Salmon and Smith created vaccines for polio, rotavirus, and the well-known influenza virus (Plotkin, 2014). The vaccines originally started off either with the attenuated form of the pathogen or its dead form. It was not until 1986 when a surface antigen recombinant vaccine of the Hepatitis B virus was genetically engineered for humans (Plotkin, 2014).

Vaccines work because they contain two critical components that induce immunity: antigens and natural adjuvants (Iwasaki & Omer, 2020). The antigens alert the adaptive immune system of the body to be prepared for the pathogen that the antigen came from (Iwasaki & Omer, 2020). The adjuvants stimulate the innate immune system's pattern recognition receptors (PRRs) (Iwasaki & Omer, 2020). The antigens and adjuvants contain pathogen-associated molecular patterns (PAMPs) that will trigger the PRRs of the immune cells (Iwasaki & Omer, 2020). This activation is necessary so that the PAMPs on the antigens will alert the PRRs in antigen-presenting cells like dendritic cells, macrophages, and B cells (Iwasaki & Omer, 2020). Routine vaccines are molecular vaccines that consist of fragmented peptides, whole proteins, or non-virulent forms (attenuated) of the pathogen containing the genetic code for the variant introduced (Chung et al., 2021).

The human major histocompatibility complex (MHC) is the key to activating the immune system against the pathogen. The MHC is a group of genes that code for proteins located on the surface of the cell that presents the antigen necessary for T cell activation (Klein & Sato, 2000). Dendritic cells will fragment the antigens into tiny peptides and present the peptides on their MHC II to naive T cells to initiate humoral and cellular immunity to help protect against the pathogen. In humans, MHC I and II are called the human leukocyte antigens (HLA) I and II genes (Klein & Sato, 2000). The HLA I genes are expressed in almost all somatic cells. HLA II genes are expressed in B cells, dendritic cells, macrophages, activated T cells, and epithelial cells of the thymus. The thymus, in particular, is used to mature T cells before they are activated (Klein & Sato, 2000). If an antigen is presented by HLA I and co-stimulatory surface ligands, CD80 and CD86, this will lead to the activation of CD8+ T cells (cytotoxic T cells) (Klein & Sato, 2000). These lymphocytes will target and program cells with similar presented antigens to go through apoptosis, where cytosolic proteins of the cell surface are degraded to prevent further infection (Chung et al., 2021). When HLA II presents the antigen, it activates CD4+ T cells (helper T cells). The CD4+ T cells will activate naïve B cells using IL-2, IL-4, and IL-5 cytokines (Mascellino, Di Timoteo, De Angelis, & Oliva, 2021). The naïve B cells will mature into plasma cells and start producing antibodies that neutralize pathogens and prevent further infection (Chung et al., 2021).

After activation and secretion of antibodies specific to the pathogen, B cells will remember the genetic code of the pathogen that "invaded" through inoculation and produce antibodies for the pathogen (Iwasaki & Omer, 2020). The antibodies will bind to the receptors of the pathogen and serve as markers for cells that perform endocytosis. These cells include neutrophils, monocytes, and phagocytes. T cells not only activate naïve B cells to produce antibodies, but they also activate somatic hypermutation and class-switch recombination. These two processes happen in which B cells alter their genetic code to produce antibodies with a stronger affinity to the epitopes of the pathogens to which it is programmed to bind (Crotty, 2015).

During vaccine development, many challenges can hinder development and slow down the process. Vaccines must be monitored constantly to ensure a long-lasting protective immunity. Adverse side effects also have to be monitored (Mascellino et al., 2021). The gap in time between using animal models and humans for vaccine research also provides a hurdle for vaccine development. However, this process can be expedited by incorporating human cells and tissue into a physiological in vivo setting, such as humanizing mice with engrafted human cells to study human-specific pathogens (Mascellino et al., 2021). Vaccines with high efficacy would be able to induce an early immune response that will help protect the host from the designated pathogen.

Currently, there are three vaccines that the Food and Drug Administration has authorized for emergency use for COVID-19 in America: Pfizer-BioNTech, Moderna, and the Johnson and Johnson vaccines. The United Kingdom AstraZeneca-Oxford vaccine is authorized for use in European countries, and the Russian Sputnik V vaccine is currently in clinical phases. While previous vaccines underwent development and clinical testing for eight to ten years, the approved anti-SARS-CoV-2 vaccines were developed and tested after eight to ten months (Mascellino et al., 2021). The shortened timeline was possible because pharmaceutical companies such as AstraZeneca, Janssen Pharmaceuticals, Pfizer-BioNTech, and Moderna invested many resources, received research funding, used advanced technology, and tested preclinical test candidates at an expeditious rate (Mascellino et al., 2021). With vaccines with an efficacy of about 95%, 63%-76% of the population must be vaccinated to reach herd immunity (Kadkhoda, 2021).

The Moderna and Pfizer-BioNTech vaccines are mRNA (messenger ribonucleic acid) vaccines that utilize lipid nanoparticles for storage (Mascellino et al., 2021). The mRNA vaccines themselves can be developed rapidly at a low cost since cell cultures or fermentation of viruses is not essential for their synthetic nature. Pfizer-BioNTech and Moderna manufactured the vaccines by isolating mRNA of the spike proteins that display three copies of the exact protein, leading to only one mRNA being produced (Mascellino et al., 2021). The host cells then translate the mRNA of the spike protein into superficial spike proteins of SARS-CoV-2 (Mascellino et al., 2021). The mRNA is stored in a lipid nanoparticle injected intramuscularly into the body, where it attaches to human cells (Mascellino et al., 2021). The nanoparticle inserts the mRNA into the cytoplasm, where it is translated by ribosomes to synthesize spike proteins (Mascellino et al., 2021). Once translated, the spike proteins will be presented to naïve T cells through the MHC I or MHC II complex, depending on the cell (Mascellino et al., 2021). When the T cells recognize the spike protein antigen bound to MHC II, they will differentiate into helper T cells and produce interleukins that will activate B-cells into plasma cells to secrete antibodies (Mascellino et al., 2021). These antibodies, primed for spike proteins, will neutralize the virus to prevent the spike proteins from binding to the ACE2 receptor and tag them for phagocytosis. There are no adjuvants included in the vaccine due to mRNA able to stimulate an immune response by itself. The mRNA is also included in a lipid particle barrier to protect it against integral damage and prevent confusion with other RNA molecules. The main drawback to the mRNA vaccines is the instability of mRNA compared to DNA. The mRNA must be translated within two days of entering the body before it is degraded, and it requires a high cold chain for preservation. -94°F (-70°C) is the known storage temperature for the Pfizer-BioNTech vaccine.

The Johnson and Johnson vaccine, produced by Janssen Pharmaceuticals, uses a nonvirulent (non-infectious) adenovirus to serve as a vector for the delivery of DNA that codes for the spike protein of SARS- CoV-2 (Mascellino et al., 2021). The adenovirus will be modified so that replication is impossible (Mascellino et al., 2021). Once injected into the body, the adenovirus will inject its viral DNA into the host cell's cytoplasm, entering the nucleus for transcription (Mascellino et al., 2021). Spike mRNA is then translated in the cytoplasm

(Mascellino et al., 2021). The newly synthesized spike proteins on the MHCs on the surface of the cells will be presented to the T cells to differentiate them and cause an immune response. The AstraZeneca vaccine is very similar in vaccination procedures. It uses a Chimpanzee adenovirus as a viral vector with DNA that codes for the SARS-CoV-2 spike protein (Mascellino et al., 2021).

Vaccines have been a well-renowned accomplishment globally, saving millions of lives by preventing viral and bacterial infections. Due to the contributions of pharmaceutical companies like Pfizer-BioNTech and Moderna, vaccines can now be marketed within a year of development in record timing as opposed to over a decade of research and development (Marcellino et al., 2021).

SARs-CoV-2 Outbreak and Infectious Processes

COVID-19, named after the emergence of SARS-CoV-2 in 2019, is a highly contagious virus that resulted in ~6,000,000 deaths worldwide as of March 2022. It is the most recent and consequential global health catastrophe since the 1918 influenza pandemic (Cascella et al., 2021). The term coronavirus originated from the viral family, coronaviridae. Coronavirus received its name from the Latin term "corona" which means crown, resembling the shape of the spike proteins surrounding the lipid bilayer. Before it was declared a pandemic by the World Health Organization, COVID-19 started as an epidemic after being first reported in Wuhan, Hubei Province, in mainland China in December 2019 (Cascella et al., 2021).

Within a year, in March 2020, the World Health Organization (Khubchandani et al.) declared the status of the viral outbreak to be a pandemic (Cascella et al., 2021). SARS-CoV-2 is an enveloped virus with a single-stranded positive-sense RNA (ssRNA) (Cascella et al., 2021). It is about 30kb in length with a 5' cap and 3' poly-a-tail (Cascella et al., 2021). It is one of the largest RNA viruses (Varghese et al., 2020). SARS-CoV2 is composed of four structural proteins: spike proteins, viral membrane, the viral envelope, and the nucleocapsid (Varghese et al., 2020). The spike protein is a transmembrane glycoprotein that projects out of the outer membrane of SARS-CoV-2. Mutations to the spike protein contribute to the numerous variants of the coronavirus (Alpha, Beta, Delta, Gamma, and Omicron) and host tropism (Madjunkov et al., 2020). Host tropism is the specific infectivity of a virus to a particular host. This is why only specific pathogens can infect only certain hosts. The role of the spike protein is to attach to the host cell's receptor and fuse the membranes of the cell and the virus (Madjunkov et al., 2020). The virus's membrane maintains its spherical shape and provides structural support (Madjunkov et al., 2020). Lastly, the envelope is the outermost protein region with ion channels that possibly help with the budding of the virus to continue viral morphogenesis and assembly (Weiss & Navas-Martin, 2005). The capsid contains the nucleocapsid protein barrier surrounding the virus's RNA genetic code (Madjunkov et al., 2020). The nucleocapsid consists of an N-terminal domain for RNA binding, a central linker domain, and a C-terminal domain to dimerize N-proteins (Madjunkov et al., 2020). Dimerization is necessary to regulate translation, transcription, and replication within the invaded host cell (Madjunkov et al., 2020).

The virus is spread through water droplets from coughs. When it invades the human body, it will enter the cell using its spike proteins to bind to its angiotensin-converting enzyme 2 (ACE2) receptor (DiPiazza, Graham, & Ruckwardt, 2021). The biological function of ACE2 is the metabolism of the protein angiotensin I into angiotensin 1-9 and angiotensin II into angiotensin 1-7 (Liu et al., 2020). ACE2 also assists with the absorption of amino acids in the gut (Liu et al., 2020). The ACE2 receptors are found on the respiratory epithelium, such as the type II alveolar epithelial cells. Other organs with the ACE2 receptor include myocardial cells, enterocytes of the ileum, proximal tubular cells of the kidney, esophagus keratinocytes, and urothelial cells (Cascella et al., 2021). SARS-CoV and SARS-CoV-2 can mediate the ACE2 receptor's peptidase-independent function for infection and transmission (Liu et al., 2020). When SARS-CoV-2 uses its spike proteins to bind to the ACE2 receptors, the virus penetrates the cell by fusing its outer envelope layer with the cell's membrane through endocytosis.

The spike protein is composed of a trimer, where each of its subunits is displayed distant from the virus envelope (Fantini, 2021). The first domain is called the receptor-binding domain (RBD), which is located in the central area within the trimer (Fantini, 2021). Its job is to recognize the specific protein receptor of the host cell membrane (Fantini, 2021). The second domain, the N-terminal domain (NTD), is located on the side of the spike protein within a usual tripod topology (Fantini, 2021). The NTDs help with the docking of the spike to ganglioside-rich domains, which serve as lipid rafts (Fantini, 2021). These lipid rafts are where the NTDs bind to stabilize the binding of the RBD to the host receptors (Fantini, 2021). The lipid raft is composed of the phospholipid bilayers and cholesterol that make up the outer membrane of a human cell. At a physiological pH (7.4), the surface potential of gangliosides of the ACE2 receptors is negatively charged, making them acidic (Fantini, 2021). The NTDs of the spike proteins have a surface potential that is positively charged (making them basic) (Fantini, 2021). The initial attachment of the spike protein to the human receptor is, therefore, an electrostatic interaction (Fantini, 2021). The molecular force is then stabilized by Van der Waals, electrostatic, and hydrogen binding (Fantini, 2021). The hydrogen bonding can occur due to the interface of the ACE2/RBD bond having hydrophobic and hydrogen-bonding halves (Fantini, 2021). The hydrogen bond consists of the Y449 and Q498 subunit of RBD binding to the D38 subunit on ACE2 (Fantini, 2021).

The following research paper displays the topology of the SARS-CoV-2 spike trimer. It displays the images of its open conformation of Spike protein trimer binding to the lipid raft of the ACE2, and its closed conformation of Spike protein trimer with blue positively charged NTD receptor and closed spike protein trimer listed within Figure 1.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8172274/

Upon receptor binding, the virus will gain access to the cell's cytosol by acid-dependent proteolytic cleavage of the S2 subunit of the spike protein typically done by the cathepsin, TMPRRS2 (Fehr, 2015). This cleavage is done at two sites of the S2 subunit. The first cleavage will disconnect the RBD from the fusion domain of the spike protein (Fehr, 2015). The second cleavage will reveal the fusion peptide at the S2 cleavage (Fehr, 2015). This fusion peptide will insert into the membrane of the host (Fehr, 2015). Following this, two heptad repeats in the S2 subunit form an antiparallel six-helix bundle (Fehr, 2015). This will allow for the fusion of the viral and cellular membranes and the release of viral RNA into the cytosol (Fehr, 2015). Upon entry, RNA is replicated through the synthetization of the replicase polypeptides 1a/1ab (Cascella et al., 2021). Transcription will occur using a replication-transcription complex (RCT) and the synthesis of subgenomic RNA (Cascella et al., 2021). Transcription will terminate at the transcription regulatory sequence, which is located between the open reading frames of the template RNA (Cascella et al., 2021). The open reading frames are the direct templates for the subgenomic RNA produced (Cascella et al., 2021). The positive ssRNA will act like mRNA to be directly translated with the Open Reading Frames of the RNA encoding to produce multiple viral proteins (nucleocapsid, spike, envelope, and membrane proteins) (Cascella et al., 2021). Following translation, the generated viral particles will be packaged into vesicles and transferred out of the cell membrane to be released for further cellular infection and viral replication (Madjunkov et al., 2020).

SARS-CoV-2 is primarily a respiratory virus known to lead to the development of pneumonia by causing virus-mediated tissue damage (Cascella et al., 2021). This initiates an immune response of activation of T lymphocytes, neutrophils, and monocytes. They will, in turn, release cytokines that will over-activate the immune system (Cascella et al., 2021). There will be a high concentration of interleukin-6 (IL-6) and tumor necrosis factor-α (TNF- α), inflammatory cytokines. This overproduction of cytokines can cause massive lung inflammation and can lead to perivascular inflammation (Cascella et al., 2021). Over-accumulation of cytokines is also known to impede the function of other bodily systems, such as the heart, the upper respiratory tract, and the liver (DiPiazza et al., 2021). Viral replication within the myocardial cells will result in the continued release of pro-inflammatory cytokines like IL-6. These cytokines typically lead to myocarditis, vascular inflammation, and cardiac arrhythmia. In the renal system, infection will lead to hyperinflammation and microvascular injury (DiPiazza et al., 2021).

Overall, common symptoms of COVID-19 infection include fever, sore throat, vomiting, malaise, and headache (Cascella et al., 2021). COVID-19 infection could also potentially affect male fertility. The ACE2 regulator is a significant contributor to the functioning progress of the renin-angiotensin system. Additionally, to assist with the modulation of the cleavage of angiotensin II and Ang (1-7) ligands regulates the essential functions of the reproductive system of males and females (Markiewicz-Gospodarek et al., 2021). This process includes ovulation, oocyte maturation, and endometrial regeneration in females. Males have the highest abundance of the ACE2 receptors (Markiewicz-Gospodarek et al., 2021). Testicular ACE2 can help regulate testicular function, sperm formation, and the sperm's role in the quality of a fertilized embryo (Markiewicz-Gospodarek et al., 2021). Females tend to have lower expression of the ACE2 receptors in the ciliated and endothelial tissue of the fallopian tubes, ovaries, and cervix (Markiewicz-Gospodarek et al., 2021). This testicular vulnerability has led to problems of testicular pain for males infected with COVID-19. One study involved a Covid-infected male who had left spermatic cord tenderness and pain on palpation. There was also spermatic cord inflammation shown on scrotal ultrasound. To clarify that the patient was not experiencing a venereal disease, he had a urinalysis done and tested negative for any STDs (Özveri, Eren, Kırışoğlu, & Sarıgüzel, 2020). Another study involved a COVID-positive 14-year-old boy who developed orchiepididymitis due to his epididymis's inflammation and testicular torsion signs (Gagliardi et al., 2020).

Due to continuous nucleotide replication errors during the translation and transcription of its mRNA, SARS-CoV-2 continues to mutate into different variants of the original strain. Adaptive mutations within the virus's genome can lead to an alteration of the virus's pathogenic potential (Aleem et al., 2022). Being an RNA (ribonucleic acid) virus, SARS-CoV-2 is prone to a rapid mutation rate due to its lack of proofreading methods (Sanjuán & Domingo-Calap, 2016). RNA, in general, is a single-stranded nucleic acid with a catalytic 2'-OH on its five-carbon sugar, in contrast to DNA (deoxyribonucleic acid) with a stable 2'-H on its five-carbon sugar. RNA also has a Uracil base, while DNA has a thymine base. RNA viruses transcribe a reverse transcriptase polymerase that helps duplicate their genetic material. This enzyme can transcribe single-stranded RNA into double-stranded DNA. However, the polymerases usually lack 3' exonuclease proofreading activity (Sanjuán & Domingo-Calap, 2016). This would cause their replication to be more error-prone during transcription. However, coronaviruses are the only members of the positive-strand RNA virus (Class IV on Baltimore Viral Classification) that has a 3' exonuclease domain (Sanjuán & Domingo-Calap, 2016). Despite the perceived sluggish mutation rate, scientists have cataloged more than 12,000 mutations in the SARS-CoV-2 genome (Callaway, 2020).

RNA viral methods of replication are sharply different from DNA viruses. Not only does the DNA virus' more extended genetic code encode for hundreds of viral proteins. In contrast, RNA viruses are more diminutive and encode for fewer proteins. However, DNA viruses also integrate massive sequences transferred from their hosts to their genome through evolution (Durmuş, S., & Ülgen, K. Ö. 2017). This, in turn, leads to their genomes being able to encode for proteins that contain a eukaryotic-originated complex of functional domains that will help DNA viruses exploit the metabolism of their hosts and replicate using the host's organelles (Durmuş, S., & Ülgen, K. Ö. 2017). RNA viruses cannot exhibit these homologies but can communicate with host cells through the host cell's complex network of PHIs (pathogen-host interactions) (Durmuş, S., & Ülgen, K. Ö. 2017). These PHIs do this by using protein-binding motifs specific to RNA viruses that will interact with the host proteins (Durmuş, S., & Ülgen, K. Ö. 2017).

Prior to recently, human CoV was antigenically stable, receiving 1-1.5 amino acid substitutions per year (Yewdell, 2021). Throughout the previous 32 years before the outbreak, the 229E CoV (one of the earliest strains) spike received forty-six substitutions (Yewdell, 2021). Fortunately, most of the substitutions were quickly recognized by neutralizing antibodies (Yewdell, 2021). Most viral mutations do not enhance the virus's ability to infect its host (Callaway, 2020). Most mutations do not alter the shape of the proteins within the virus. If a protein was changed within the virus, it could be more harmful to the virus itself than to the actual host (Callaway, 2020). Mutations to a specific amino acid can change a virus's ability to avoid the immune system and evade vaccine-induced antibodies (Sanjuán & Domingo-Calap, 2016). These mutations contributed to the rapid antigenic drift of the SARS-CoV-2 spike protein. Antigenic drift is defined as an evolutionary collection of amino acid substitutes within viral proteins that are often targeted by the adaptive immune system of the host body (Yewdell, 2021). Antigenic drift will limit the length of immunity towards mutated receptors through natural and artificial immunity. This mechanism is why booster shots and updated vaccines are necessary to counteract the antigenic drift of SARS-COV-2 and influenza (Yewdell, 2021).

There are multiple factors that can lead to an increased rate of antigenic drift. This could include an intrinsic viral polymerase mutation rate, the ability for the viral proteins to receive amino acid substitutions that will reduce an antibody's affinity to the epitope, the number of virions that cause infection, an increase in the number of viruses that are replicated during infection, and the immune selection pressure that viruses face when trying to find a suitable environment in which to replicate, such as cells with receptors that match their receptor-binding domains (RBDs) (Yewdell, 2021).

Frequent genomic sequencing has led to the detection of new variants of SARS-CoV-2, especially in areas of current significant outbreaks. Multiple variants have been discovered, but only a few have been identified as variants of concern (VOC) (Aleem et al., 2022). These VOCs have shown increased transmissibility or virulence, decreased neutralization by antibodies, and an ability to avoid detection from the immune system (Aleem et al., 2022). As of early 2022, there have been five VOCs of SARS-CoV-2, listed in chronological order of discovery.

Table 1: SARS-CoV-2 Variants of Concern

Variant of Concern	Country Identified	Date Identified	Mutations
Alpha (B.1.1.7)	United Kingdom	Nov-20	8 mutations to its spike protein
Beta (B.1.351)	South Africa	Dec-20	9 mutations to their spike protein (3 mutations within the RBD leading to increased affinity to ACE2 receptors)
Delta (B.1.617.2)	India	Dec-20	10 mutations to its spike protein
Gamma (P.1)	Brazil	Jan-21	10 mutations to their spike protein (additional 3 mutations within the RBD)
Omicron (B.1.1.529)	South Africa	Nov-21	30 changes to its spike protein with mutations to envelope and nucleocapsid protein. Its spike mutation, K417N and E484A, have been predicted to lead to a disruptive contribution to the possibility of the variant being resistant to antibodies

All five VOCs have had mutations to their receptor-binding domain (RBD) and their N-terminal domain (NTD) located within the spike protein of SARS-CoV-2 (Aleem et al., 2022). The most common mutation was an N501Y mutation within the RBD, which enhanced the affinity of the spike proteins when attached to the host cell's ACE2 receptors (Aleem et al., 2022). These new variants have been the result of natural section, with many VOCs becoming the dominant variant in the country that they cause outbreaks due to their increased transmissibility (Gómez, 2021). The virus mutates to resist host cell defenses and increase its virulence. In order to slow down the mutation rate, the replicability of the virus must slow down (Gómez, 2021). To slow down the mutation rate, organizations and institutions like WHO, CEPI (Coalition for Epidemic Preparedness Innovations), and GAVI (Global Alliance for Vaccine and Immunizations) push to make universal vaccination possible to slow down the spread of SARS-CoV-2 (Gómez, 2021).

Despite the meticulous work put into creating vaccines that can prevent symptoms associated with COVID-19, many people in the United States have little trust in the vaccine process or do not see COVID-19 as a threat to their health (Khubchandani et al., 2021). Efforts by organizations such as the World Health Organization and the Centers for Disease Control have been undermined by antivaccination movements through their spread of vaccination criticism on the internet and social media (Khubchandani et al., 2021). A study completed by the Department of Family Medicine and Clinical Epidemiology, University of Pittsburgh School of Medicine, found that “anti-vax” groups on the internet claim that the vaccinations cause illness, conventional medicine is wrong, and vaccines are against their civil liberties (Zimmerman et al., 2005). This widespread criticism impacts public health and the emergence of vaccination-preventable diseases such as measles (Badur et al., 2020). In 2018, New York, New Jersey, Kansas, and Missouri had a measles outbreak with 220 confirmed cases (Hotez, 2019). Most cases emerged from an unvaccinated population (Hotez, 2019). This outbreak was during the same year of one of the worst flu endemics in decades, where 80,000 citizens lost their lives, with 80% of the child deaths being from unvaccinated children, despite recommendations for vaccination (Hotez, 2019).

This study will investigate college student vaccine hesitancy will analyze thoughts and opinions about COVID-19 and their vaccines. These opinions could potentially lead to discovering effective strategies to promote vaccinations. This study will also investigate the misinformation that students believe about COVID-19 and develop a solution to ensure that the students receive the correct information about COVID-19. Two hypotheses were made for this study: 1. There is a significant effect on vaccination status within people of different political parties, field of study, living conditions, masking frequency, and scores on the knowledge-based questions portion. 2. There will also be a significant effect on knowledge-based scores with political party and field of study.

RESEARCH DESIGN AND METHODS

This study consisted of a Qualtrics survey distributed throughout the University of Central Florida (UCF) student body to learn the reasoning behind vaccination choice in an educated society of young adults. The participants need to be at least 18 years of age and students at UCF. The survey will consist of questions pertaining to the demographic of the students, their stance on COVID vaccinations, and prior knowledge of COVID-19. Respondents will be anonymous.

Survey Description

The survey consisted of three sections (Appendix B). The first section included nine opinion-based questions. Opinion-based questions asked about their concerns and knowledge of COVID-19, their vaccination status, the reasoning behind not receiving the vaccine, and any factors that would encourage them to receive it. The second section included six demographic questions. Demographic questions asked the students about their race and ethnicity, their political party identity, and their living location (rural/urban/suburban). The survey did not collect personal identifying information, and responses were kept anonymous. Demographic questions were placed after the opinion-based questions of the survey to prevent stereotype threat, a psychological and situational situation where people feel a need to conform with the social group that they identify with and take on their stereotypical beliefs. The final section included six true or false content-based questions. After completion of the survey, students received the correct answers for the knowledge-based question section. The survey was designed by finding published COVID-19 survey questions from the Nebraska Medicine Survey, the University of South Florida, and U.S. News Today. Participants were informed that they were going to participate in a survey regarding their opinions and knowledge of the COVID vaccine and their vaccination status. Students were directed to the explanation of the research page, where they saw the informed consent form. They completed 11 opinion-based, 8 demographic-based, and 6 content-based questions following their consent. The data results will be presented to the UCF Health Center to provide solutions to possibly combat vaccine hesitancy. The UCF Institutional Review Board approved the survey in January 2022.

Survey Distribution

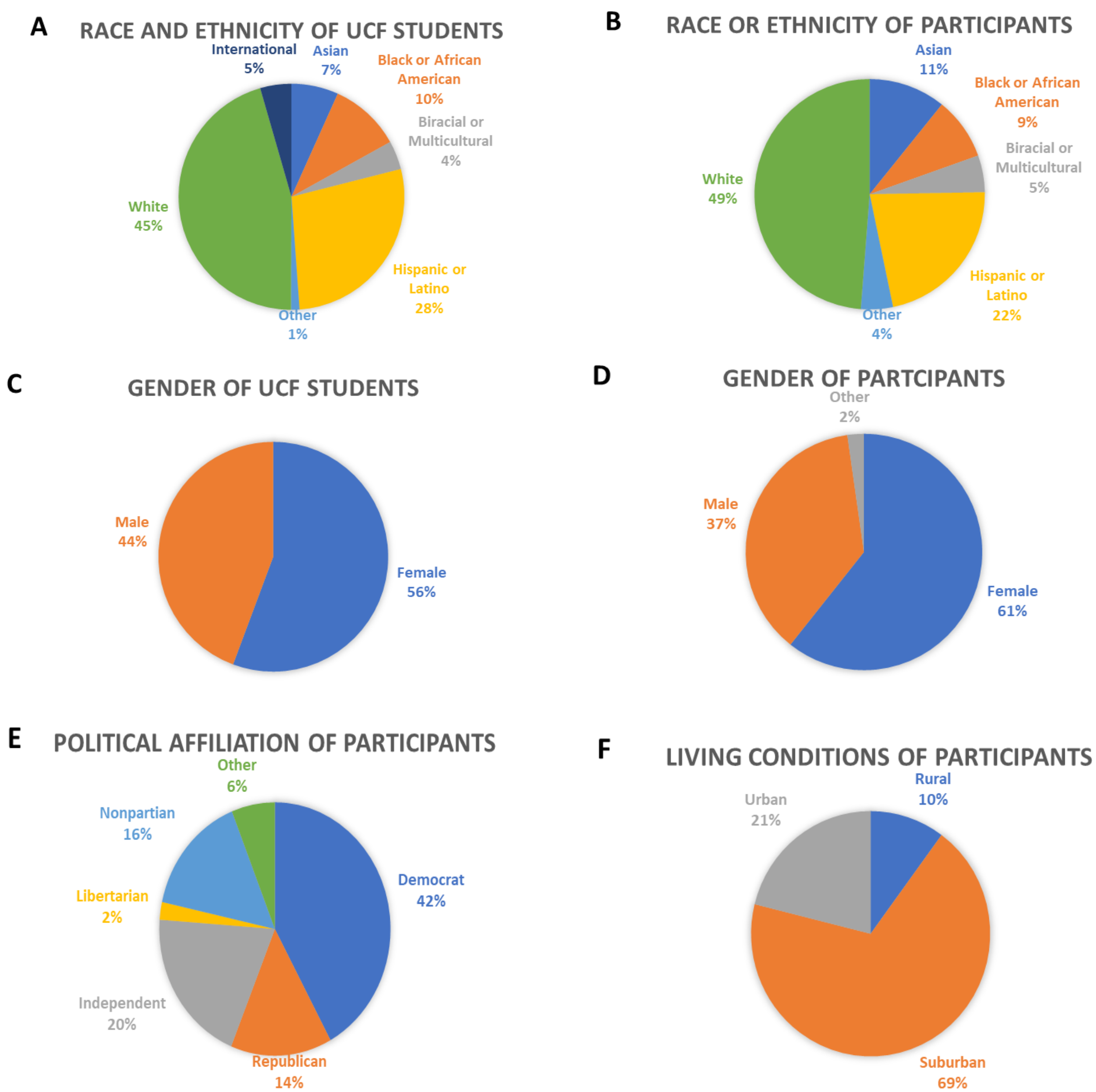
The survey was offered online only. Students received access to the survey through a QR code to Qualtrics or a link to Qualtrics. A flyer with a QR code for the survey was placed on the walls of common student areas such as UCF Health Center and Tech Commons. Tabling was done in the UCF Memory Mall field to ask students if they would be willing to participate in the survey. They were informed that taking this survey is optional. Instructors and professors were asked to send the QR code or survey link to their students. Using resources from Student Government, the QR code and link were emailed to multiple registered student organizations on campus to send to their club members if they are willing to help. Lastly, the QR code and link were posted on social media on Instagram, Reddit, and Snapchat to reach more UCF students. Survey distribution started in January 2022 and concluded at the end of February 2022 (during the Omicron variant wave).

Survey Analysis

A power analysis was done using an approximation of twenty million college students in the United States listed in the National Center of Education Statistics as population size. Using Qualtrics XM with a confidence interval of 95% and a margin of error of 8%, 151 student responses were needed to have statistically significant data. There were 546 responses on the survey collected from the students. However, 445 responses were analyzed due to students not completing the survey, being under 18, and not being UCF students. The data were analyzed using the chi-square test for non-parametric data and the one-way ANOVA or two-way ANOVA test with a Least Significant Difference post-hoc test for parametric data. SPSS software was used to analyze the data from the survey.

RESULTS

Figure 1: Non-Academic Demographics of UCF Participants



The survey had 541 participants that worked on the survey. Of the 541 participants, 465 of the participants finished the survey. 16 of 465 participants were excluded due to them not being UCF students, and 3 participants were excluded for not being over the age of 18. The final analysis used the data collected from 445 students that completed the survey and met the minimum requirements. Figures 1-2 display the demographics of the UCF students that completed the survey. Figure 1A refers to the racial/ethnical demographics of UCF students that were collected from the UCF website, www.ucf.edu, which stated that the university contains 32,004 (45.5%) White students, 19,585 (27.8%) Hispanic/Latino students, 7,197 (10.2%) Black /African American students, 4,738 (6.7%) Asian students, 3,148 (4.5%) International students, 2,882 (4.1%) Multiracial students, and 852 (1.2%) students that are Native Hawaiian/Other Pacific Islander/American Indian/Alaska Native or other. Figure 1B illustrates the racial/ethnical demographics of the UCF students that participated in the survey. There was a total of 217 (48.7%) White students, 90 (20.2%) Hispanic or Latino students, 48 (10.8%) Asian students, 39 (8.7%) Black/African American students, 23 (5.2%) Biracial/Multiracial students, and 20 (4.5%) students that identified as another race/ethnicity. The racial/ethnical demographics in Figure 1B have shown to reflect the approximate racial/ethnical demographics of the UCF population seen in Figure 1A.

Figure 1C refers to the demographics of UCF students collected from the UCF website, www.ucf.edu, which states that the university contains 31,197 (44%) males and 39,206 (56%) females. Only 3 (>1%) students did not identify with either gender. Figure 1D contains the gender that participants identified with. The graph showed that 270 (61%) females and 165 (37%) males completed the survey. The remanding 10 (2%) students that took the survey identified as a different gender. While there was an underrepresentation of the males and a bit of overrepresentation of the females, the gender demographics of the study can still be considered close to reflective of the gender demographics of UCF.

Figure 1E refers to the political affiliation of UCF students that completed the survey. In Figure 1E, 187 (42%) students identified as Democrats, 89 (20%) students identified as independents, 69 (16%) students identified as Nonpartisan, 63 (14%) students identified as Republicans, 10 (2%) students identified as Libertarian, and 27 (6%) students identified as another political party.

Figure 1F demonstrates the living conditions of the students. Of the participants, 45 (10%) students were from rural areas, 306 (69%) students were from suburban areas, and 94 (21%) students were from urban areas. There was no significance between living conditions and vaccination status.

Figure 2: Academic Demographics of UCF Participants

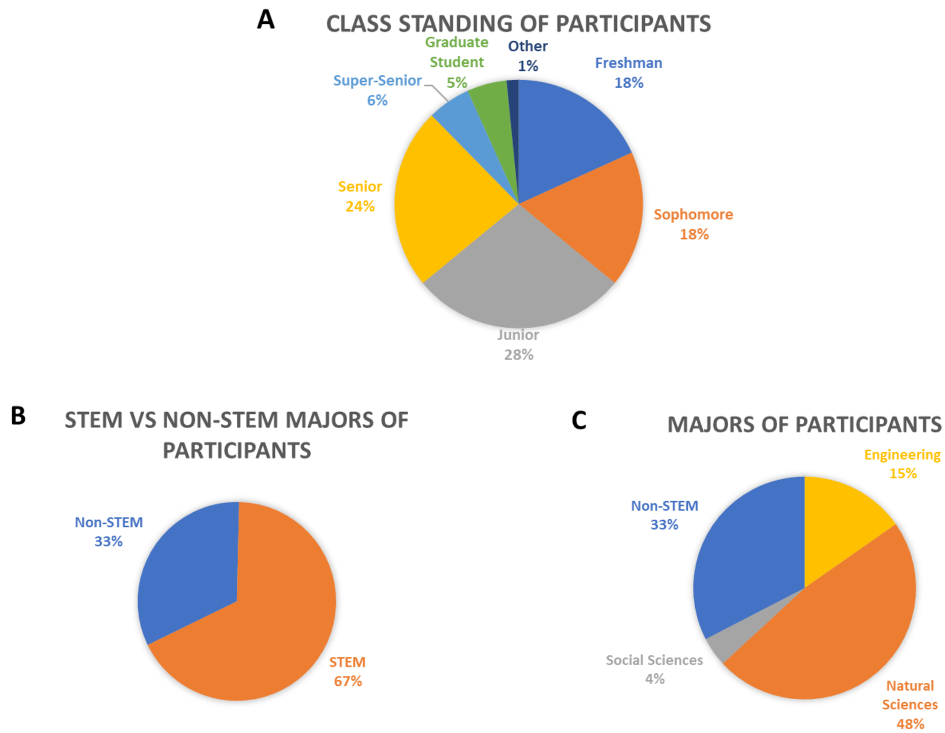


Figure 2A refers to the class standings of the UCF students that completed the survey. There were 81 (18%) students that were freshmen, 79 (18%) students were sophomores., 125 (28%) students were juniors, 105 (24%) students were seniors, 25 (6%) students were super-seniors (fifth-year student), 23 (5%) students that were graduate students, and 7 (1%) of the students were not certain about their class standing. Figure 2B illustrates the margin of participants that were STEM (Science, Technology, Engineering, and Mathematics) and Non-STEM majors. In Figure 2B, 145 (33%) UCF students described their major as non-STEM-related, and 300 (67%) students considered their major STEM-related. Figure 2C describes the type of specific major that the students had. 213 (48%) of the UCF students described their major as being a Natural Science major (Biology, Chemistry, Biomedical Sciences, Health Sciences, Biochemistry, Physics, etc.), 145 (33%) students described their major as Non-STEM (Business, Hospitality, Art, Education, etc.), 68 (15%) UCF students identified as an Engineering/Computer Science Major, and 19 (4%) of the UCF Students identified as a Social Sciences major (Psychology, Philosophy, Humanities). There was no significance between field of study (STEM vs. Non-STEM, Natural Science Majors, Social Science, Engineering/Computer Science, Non-STEM) and vaccination status.

Figure 3: COVID-19 Knowledge Perception and Knowledge-Based Scores Analysis

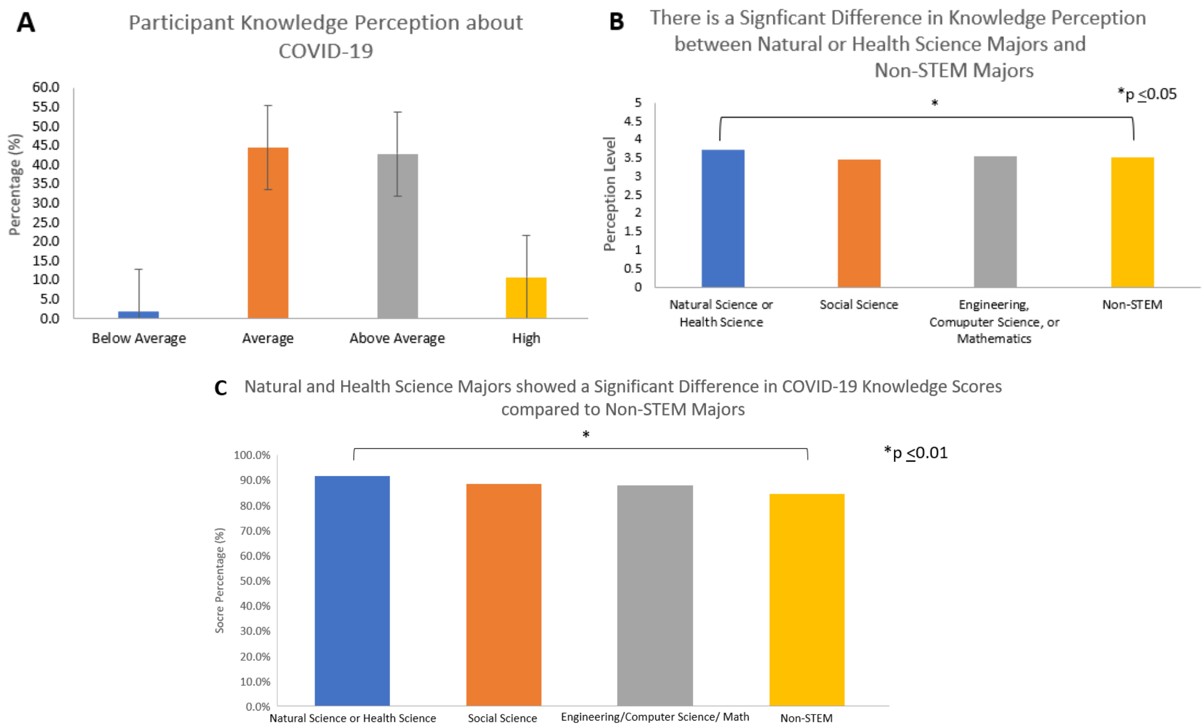


Figure 3A displays the knowledge that UCF students felt they have about COVID-19. The graph shows that 8 (1.8%) of students felt that they have below-average knowledge about COVID-19. 198 (44.5%) UCF students felt that they had average knowledge about COVID-19. 191 (42.9%) UCF students felt that they had above-average knowledge about COVID-19. Lastly, 48 (10.8%) UCF students felt that they had high knowledge about COVID-19. No students said that they had no knowledge about COVID-19. Figure 3B displays the knowledge perception level of the participants within their field of study. This test was run using one-way ANOVA. For the one-way ANOVA, level of perception was broken into categorical numbers (1= None, 2=Below Average, 3=Average, 4=Above Average, and 5=High). The perceptions were averaged together for each field of study. Natural and Health Science majors had a perception level of 3.73. Social Science majors had a knowledge perception level of 3.43. There was no significance with Social

Science majors because a small number of students claimed to be Social Science majors (n=19). Engineering, Computer Science, or Mathematics majors had a knowledge perception level of 3.54. Lastly, Non-STEM majors had a perception level of 3.53. There was a significant difference in knowledge perception between Natural and Health Science Majors and Non-STEM majors. A potential idea that could have been attributed to this reasoning is due to Natural and Health Science majors typically studying biological information in their studies.

Figure 3C refers to the statically significant relationship between fields of study with the knowledge-based questions. Natural Sciences/Health Sciences students (n=213) scored an average of 91.8% on the knowledge-based questions section. Social Science students (n=19) scored an average of 88.6% on the knowledge-based questions section. Engineering/Computer Science/Mathematics students (n=68) scored an average of 87.9% on the knowledge-based question section. Non-STEM students (n=145) scored an average of 84.5% on the knowledge-based questions section. There was a significant difference between Natural Science/Health Science students and non-STEM students ($p < 0.01$).

A two-way ANOVA test was run to see a significant difference between knowledge perception and field of study with knowledge scores. There was an LSD-Post Hoc. There was a significant effect between those categories. There was a significant main effect for perception, $F(3, 430) = 5.011$, $p < .01$, and a significant interaction with field of study, $F(3, 430) = 3.067$, $p = 0.028$. Perception and field of study together significantly affected knowledge-based scores, $F(8,430) = 2.521$, $p = 0.01$. LSD-Post Hoc showed a significant difference between average COVID-19 perception and above-average COVID-19 perception on knowledge-based scores ($p < 0.05$). There was also a significant difference between above-average COVID-19 perception and high COVID-19 perception on knowledge-based scores ($p < 0.05$).

Figure 4: Immunocompromised Status and Previous Infections of COVID-19

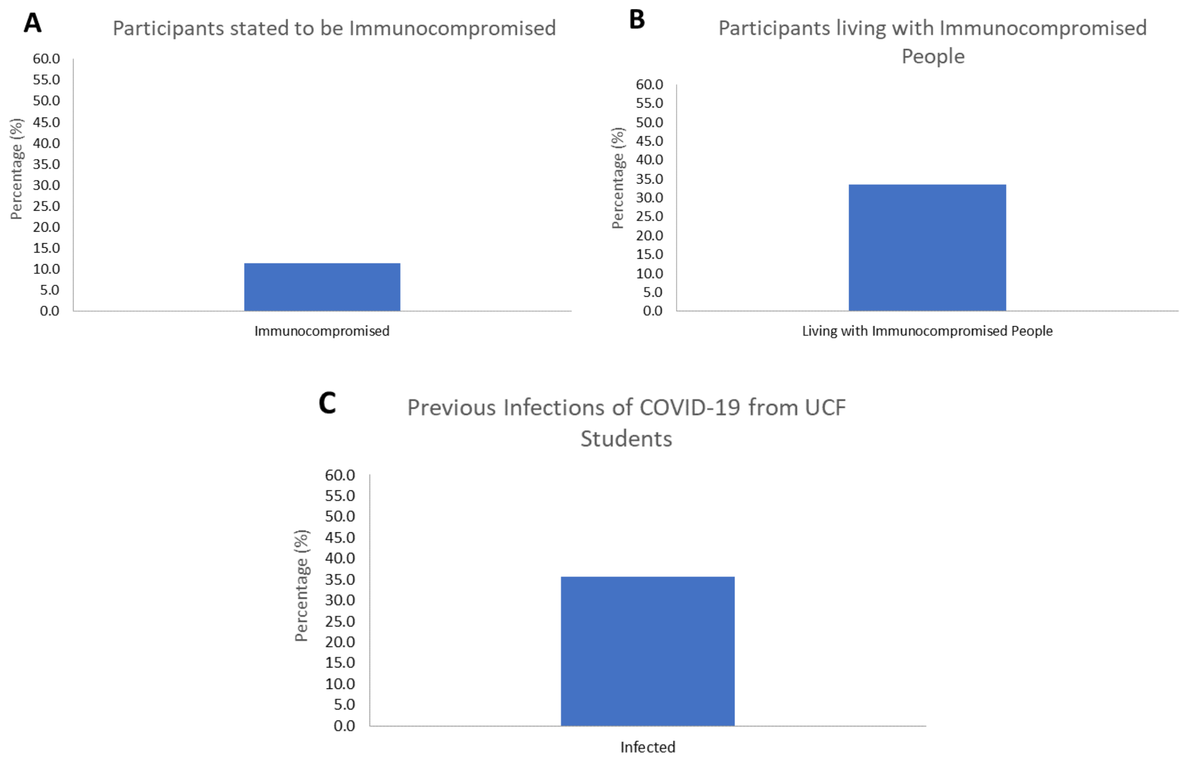


Figure 4 refers to the immunocompromised population of students and the immunocompromised students that they live with. Figure 4A shows that 51 (11.5%) students felt that they are immunocompromised with any of the following conditions that would worse COVID-19 symptoms: over the age of 65, cancer, chronic kidney disease, chronic obstructive pulmonary disease (COPD), Heart conditions, such as heart failure, coronary artery disease, or cardiomyopathies, obesity or severe obesity, Sickle cell disease, Type 2 diabetes mellitus, immunocompromised due to solid organ transplant, and/or current smoker. The remaining 394 (88.5%) students believed that they were not immunocompromised. Figure 4B displays the health status of the residents that live with the students. 149 (33.5%) students believed that their roommates/suitemates are immunocompromised with any of the following conditions that would worse COVID-19 symptoms: over the age of 65, cancer, chronic kidney disease, chronic obstructive pulmonary disease (COPD), Heart conditions, such as heart failure, coronary artery disease, or cardiomyopathies, obesity or severe obesity, Sickle cell disease, Type 2 diabetes mellitus, immunocompromised due to solid organ transplant, and/or current smoker. The remaining 296 (66.5%) students believed their roommates/suitemates were not immunocompromised. Figure 4C refers to the previous contractions of COVDI-19 that the students had. 159 (35.7%) students had previously contracted COVID prior to taking the survey. The remaining 286 (64.3%) students have never contracted COVID-19 prior to taking the survey. There was no significance between immunocompromised people or people living with immunocompromised people with vaccination status.

Figure 5: COVID-19 Vaccinations Status

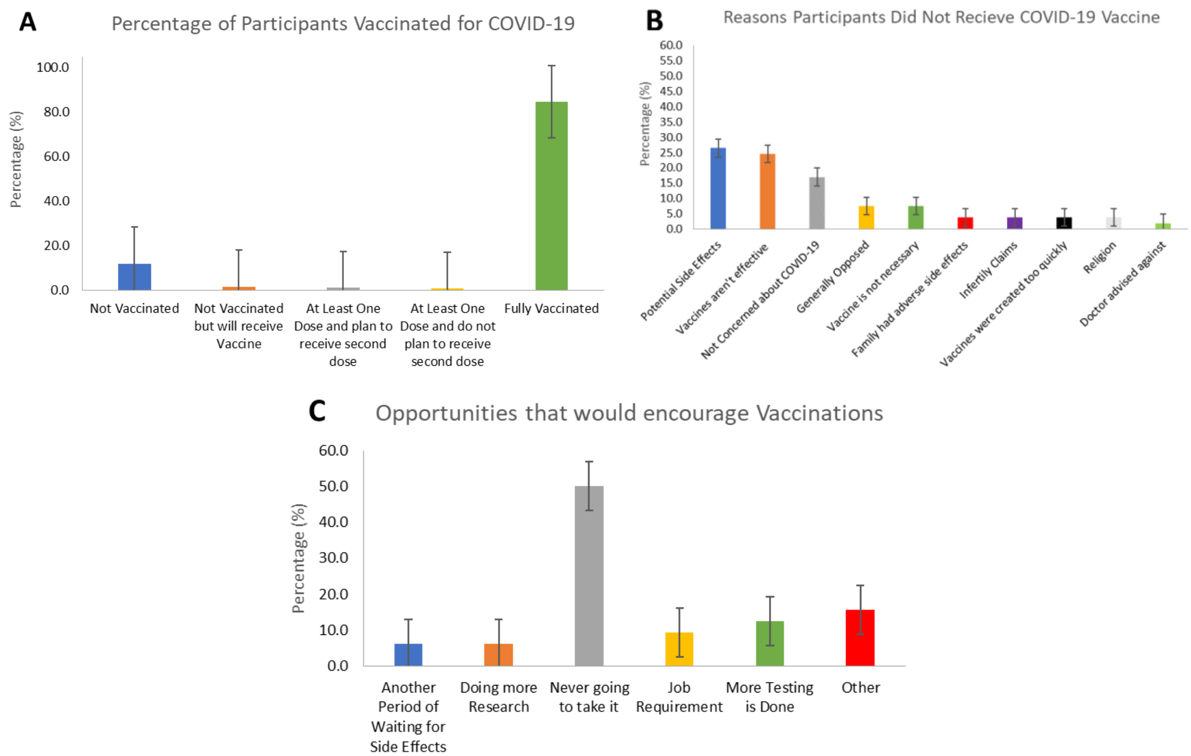


Figure 5 refers to the COVID-19 vaccination status of the UCF students that completed the survey. Figure 5A displays the percentage of student survey participants that received the COVID-19 vaccine. A total of 60 (13.5%) students were unvaccinated for COVID-19. Of the 60 students, 7 (1.6%) students plan on receiving a COVID vaccine. 8 (1.8%) students have at least one dose of the COVID-19 vaccine. 377 (84.7%) students have confirmed that they are fully vaccinated (2 or more vaccine doses). Figures 5B and 5C are from responses of the unvaccinated population. Figure 5B states the reasons that the students did not want to receive the vaccine as of now. 14 (24.5%) students felt hesitant due to potential side effects that the vaccines could cause. 13 (24.5%) students felt that the vaccines are not effective. 9 (17.0%) students were not concerned about COVID-19. 4 (7.5%) students were generally opposed to the use of vaccinations to prevent diseases. Another 4 (7.5%) students believed that the COVID-19 vaccines are not necessary for the eradication of COVID-19. 2 (3.8%) students have family members that have experienced adverse side effects from vaccines. 2 (3.8%) students felt that receiving a vaccine will likely lead to infertility. 2 (3.8%) students felt that the vaccines were made much too quickly for it to be distributed to the general population. 2 (3.8%) students did not receive a vaccine due to religious reasons. Lastly, 1 (1.9%) student did not receive a vaccine due to being advised against it by their primary physician.

Figure 5C referred to potential opportunities that would encourage students to receive a COVID-19 vaccine. 16 (50.0%) students claim that they will never receive the vaccine. 4 (12.5%) students felt that the vaccine requires more testing in order for them to want to receive it. 3 (9.4%) students will receive the vaccine if their job requires that they must be vaccinated. 2 (6.3%) students want to wait for another period of time to hear more about potential side effects. 2 (6.3%) students want to do more research on the COVID-19 vaccine before considering whether to receive it. Lastly, 5 (15.6%) students would receive the vaccine for other reasons.

Figure 6: Level of Concern and Vaccination Status Analysis

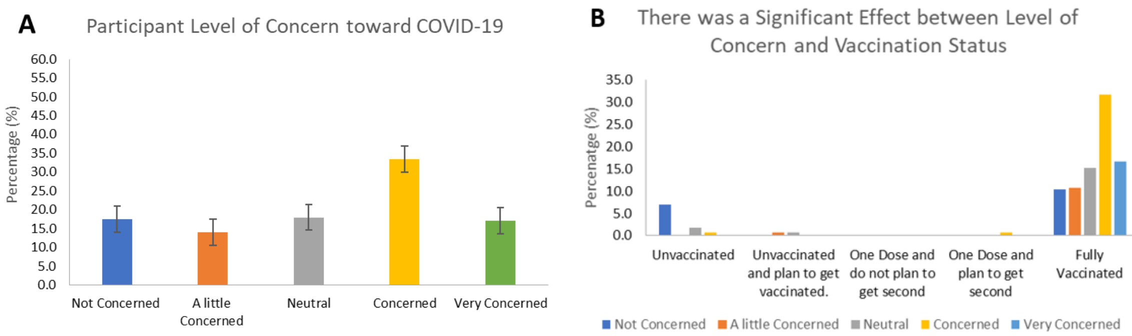


Figure 6A refers to the level of concern that the students have about COVID-19. 78 (17.5%) students stated to have no concern about COVID-19. 62 (13.9%) students have a little concern about COVID-19. 80 (18.0%) students felt indifferent (neutral) about COVID-19. 149 (33.5%) students felt concerned about COVID-19. Lastly, 76 (17.1%) students felt very concerned about COVID-19. Figure 6B refers to the level of concern that participants have at each vaccination status. There is a significant effect between level of concern and vaccination status. 7.0% of the participants were unvaccinated with no concern about COVID-19 and had the highest percentage of the unvaccinated and not planning on receiving the vaccine category. 2.25 % of the participants were unvaccinated and were a little concerned about COVID-19. 1.8% of the participants were unvaccinated and were neutral about COVID-19. 0.7% of the participants were unvaccinated and were concerned about COVID-19. 0.2% of the participants were unvaccinated and were very concerned about COVID-19. The fully vaccinated category is much more variable in participants' percentage than the unvaccinated category. Within the fully vaccinated category, 10.3% of the participants were not concerned about COVID-19. 10.8% of the participants were fully vaccinated and were a little concerned about COVID-19. 15.8% of the participants were fully vaccinated and were neutral about COVID-19. 31.69% of the participants were fully vaccinated and were concerned about COVID-19. 16.63% of the participants were fully vaccinated and were very concerned about COVID-19. There is a chance that these results are not reflective of the attitudes towards COVID-19 as of April 2022. This data was collected during the height of the Omicron Wave (January and February 2022) in the United States.

Figure 7: Political Party Vaccination Rates Analysis

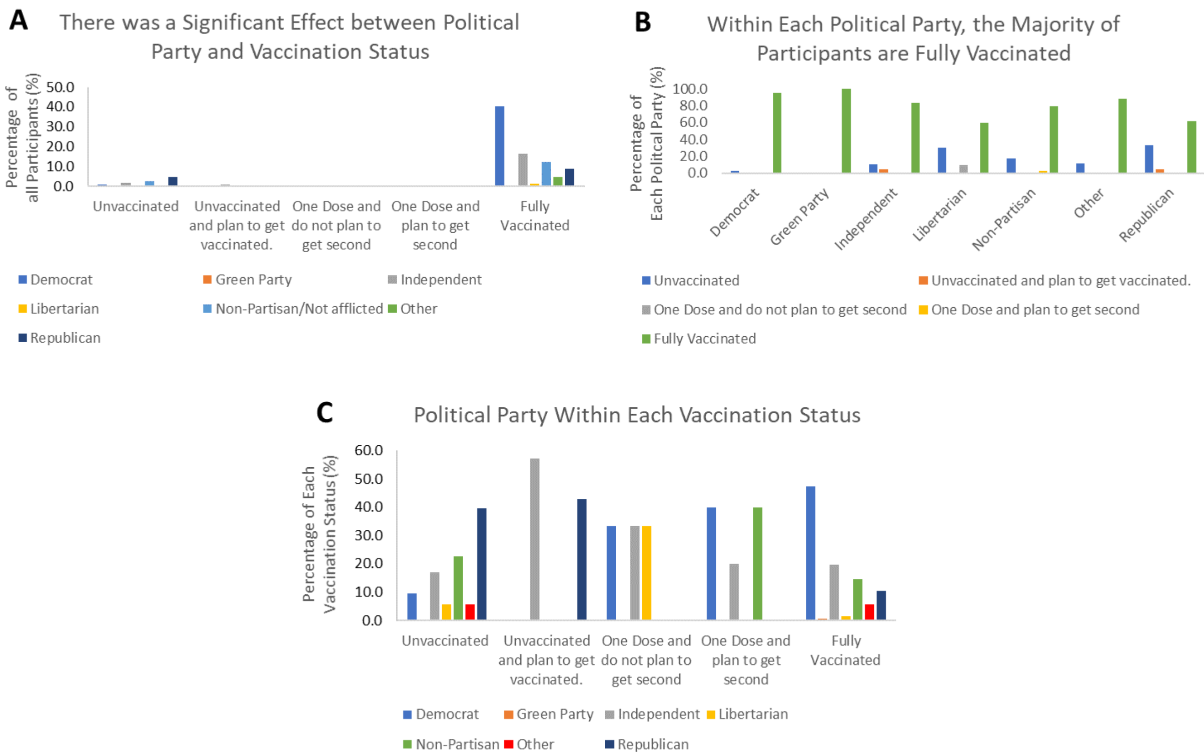


Figure 7 refers to the statistical tests that used chi-square to analyze if there was a relationship between the participants' demographics and their vaccination status. Figure 7A displays the vaccination status of all participants within their respective political parties. The graph includes the number of participants factoring into their political party. There is a significant effect between political party and vaccination status ($p<0.001$). The highest fully vaccinated rate of vaccinations, with 40.4% of the participants being fully vaccinated, were Democrats. The highest unvaccinated rate comes from 4.8% of the participants being unvaccinated Republicans. Figure 7B shows that most participants from each political party are fully vaccinated.

Figure 7C displays the vaccination status of each political party. Of the unvaccinated and not planning on receiving the vaccine population, there is an upward trend from Democrats to

Republicans with participants of the Republican party have the majority with 39.2% of the unvaccinated population consisted of participants that are a part of the Republican Party. Of the unvaccinated and planning on receiving the vaccination population, participants that were Independents had the highest percentage with 57.1% of participants that are unvaccinated and planning to become vaccinated being Independents. Of the participants that received one dose and planned not to receive the second dose, Libertarians, Independents, and Democrats all had the same percentage of 33.3%. Of the participants that received one dose and planned to receive the vaccine, participants of the Democratic party and Non-Partisans had the highest percentage with 40.0% of the participants from each party that were unvaccinated and planning to become vaccinated. Of the fully vaccinated participants, there is a downward trend from Republicans to Democrats in vaccination status with participants of the Democratic party having the highest percentage of 47.5%.

Figure 8: Influenza and COVID-19 Vaccination Status Analysis

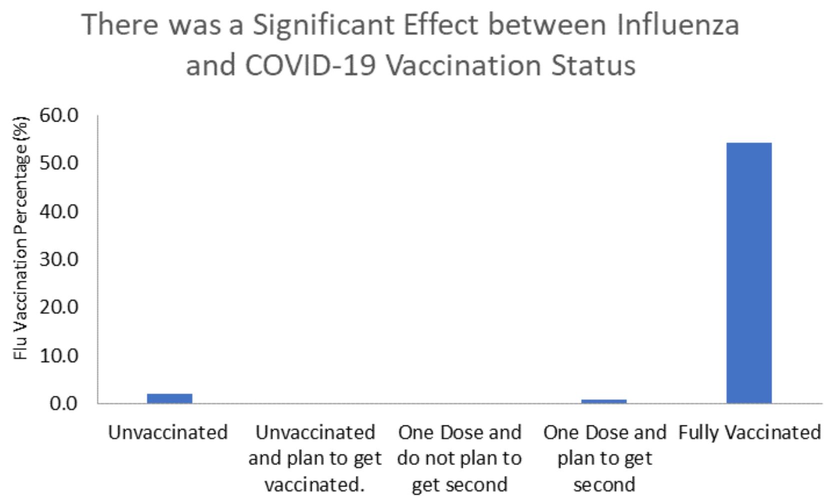


Figure 8 refers to the Influenza vaccination status for all participants of every COVID-19 vaccination status. The participants were asked about their influenza vaccination status. 189 (42.5%) students were not vaccinated for influenza at the time of them taking the survey. 256 (57.5%) students were vaccinated for influenza at the time of them taking the survey. There was a significant effect between influenza and COVID-19 vaccination status. The majority of the 256 participants that were vaccinated for influenza were fully vaccinated for COVID-19. 54.4% of the participants are vaccinated for influenza (out of 57.5%) are fully vaccinated for COVID-19. 2.0% of the participants vaccinated for influenza (out of 57.5%) are unvaccinated and not planning to be vaccinated for COVID-19. The remaining 1.1% of students vaccinated for influenza have had at least one dose of the COVID-19 vaccine and are planning on receiving the second dose.

Figure 9: Mask Wearing Frequency and Vaccination Status Analysis

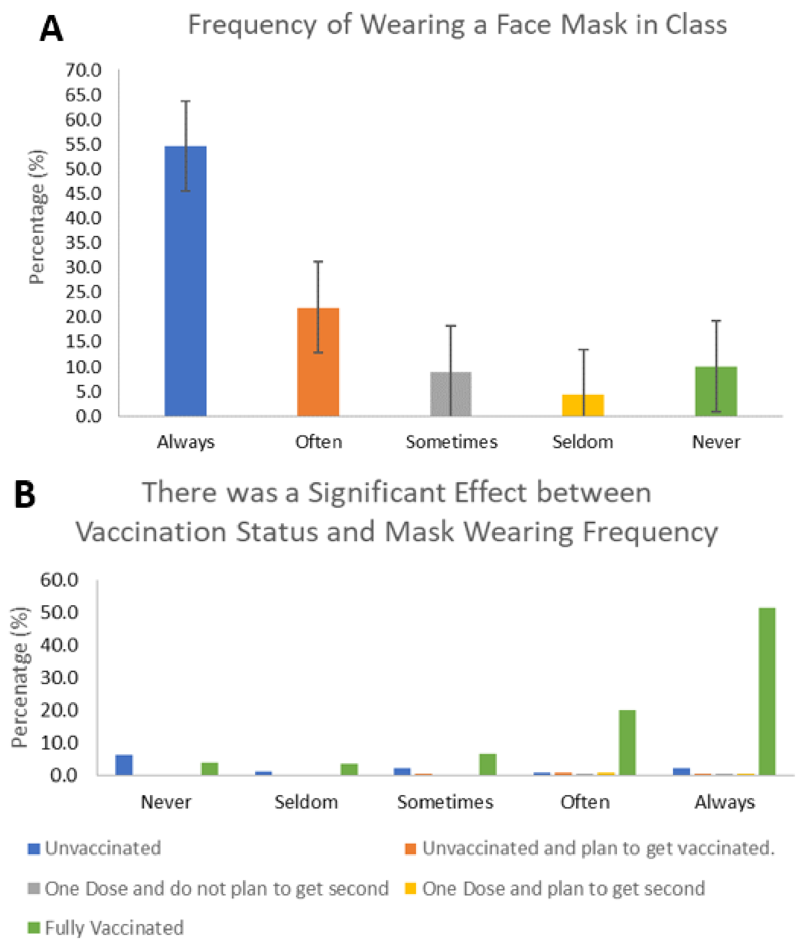


Figure 9A refers to the frequency of the mask-wearing that the students participate in while in their classes. 45 (10.1%) students claim to never wear a face mask while in class. 19 (4.3%) students claim to seldom wear a face mask in their class. 40 (9.0%) students claim to sometimes wear a face mask in their class. 98 (22.0%) students claim to often wear their face masks in their classes. Lastly, 243 (54.6%) students claim to always wear their face masks in their classes.

Figure 9B refers to the mask-wearing frequency of the participants within their vaccination status. There was a significant effect between vaccination status and masking frequency. There was a downward trend in mask frequency from never to always in the unvaccinated category. 6.3% of participants were unvaccinated and never wear a face mask in the classroom. 3.8% of the participants are fully vaccinated and never wear a face mask in the classroom. In the fully vaccinated category, there was an upward trend from never to always. 2.0% of participants are unvaccinated and always wear a face mask in the classroom, and 54.5% of participants are fully vaccinated and always wear a face mask in the classroom.

Figure 10: Race/Ethnicity Vaccination Status

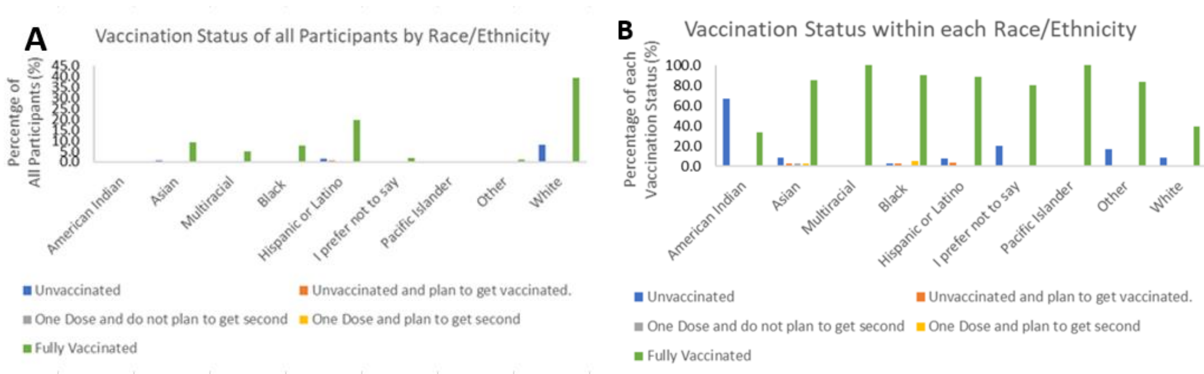


Figure 10A refers to the vaccination status of the participants by race/ethnicity. The majority of the percentages came from fully vaccinated participants of every race/ethnicity. The only prominent unvaccinated percentage came from 8.1% of the participants being unvaccinated of the white race/ethnicity.

Figure 10B refers to the vaccinated status of each race/ethnicity that the participants were. The majority of the races/ethnicities had a much higher vaccination rate compared to their unvaccinated rate. The only race with a higher unvaccinated percentage is the participants that were American Indian race/ethnicity. 66.6% of the participants of that race/ethnicity were unvaccinated and not planning on receiving the vaccine compared to 33.3% of the participants that were fully vaccinated. There was a low number of participants identified themselves as American Indian (n=3). There was no significant effect between race/ethnicity and vaccination status (p=0.330).

Figure 11: Knowledge Based Questions Results

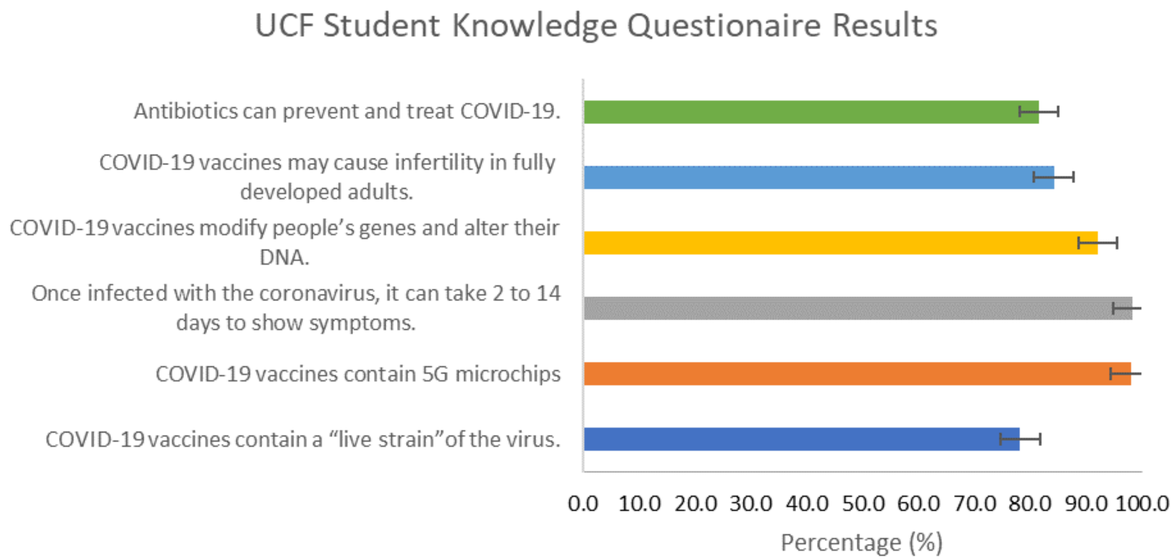


Figure 11 refers to the answers of the students that took the knowledge-based question portion of the survey. 348 (78.2%) students correctly answered that COVID-19 vaccines do not contain a "live strain" of the virus. 436 (98.0%) students correctly answered that COVID-19 vaccines do not contain 5G microchips. 438 (98.4%) students correctly answered that it could take 2 to 14 days to show symptoms once infected with the coronavirus. 410 (91.2%) students correctly answered that COVID-19 vaccines do not modify people's genes and alter their DNA. 375 (84.3%) students correctly answered that COVID-19 vaccines do not cause infertility in fully developed adults. Lastly, 363 (81.6%) students correctly answered that antibiotics could not prevent and treat COVID-19.

Figure 12: Knowledge Based Questions Analysis

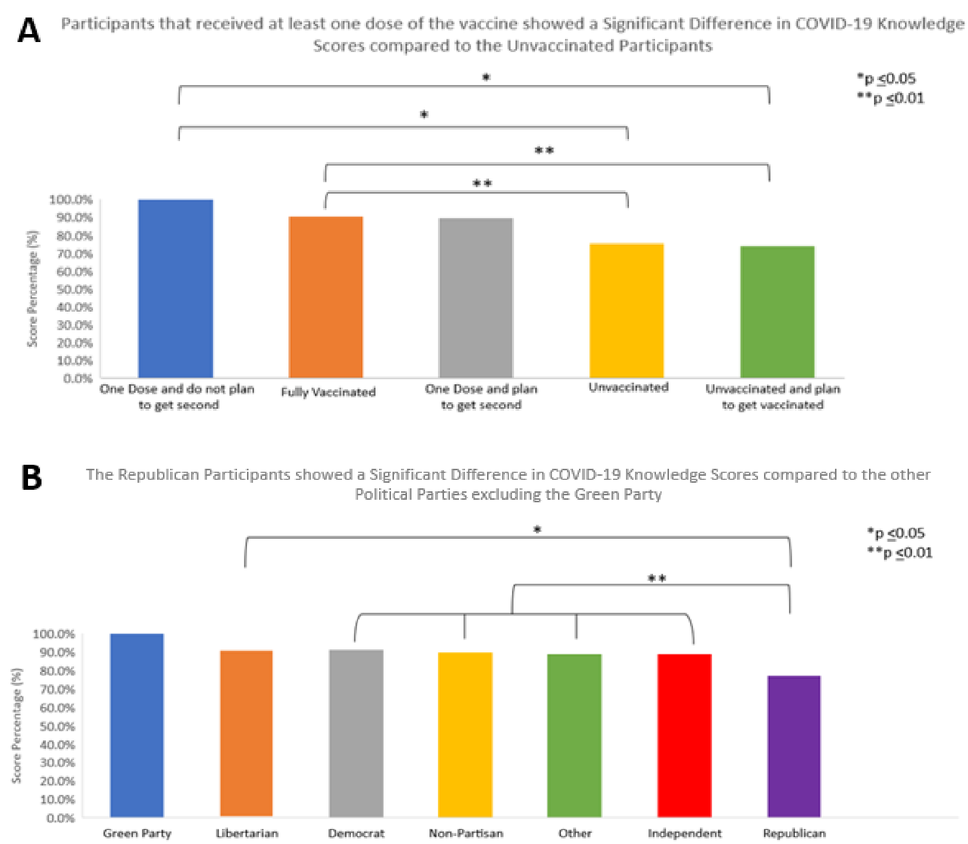


Figure 12 shows statistical tests that used one-way ANOVA (LSD-Post Hoc) to analyze if there was a relationship between the demography of the participants and their knowledge-based scores. The graphs listed above all have a p-value less than 0.001. Figure 12A refers to the statistically significant relationship between vaccination status with knowledge-based questions. Participants that received one dose and planned on not receiving the second dose (n=3) scored an average of 100.0% on the knowledge-based questions. Fully vaccinated participants (n=377) scored an average of 90.7% on the knowledge-based questions. Participants that received one dose and planned on receiving the second dose (n=5) scored an average of 89.9% on the knowledge-based questions. Participants that are unvaccinated and planned on not receiving the vaccine (n=53) scored an average of 75.3% on the knowledge-based questions. Participants who were unvaccinated and planned on receiving the vaccine (n=7) scored an average of 73.5% on the knowledge-based questions. There was a significant difference between the fully vaccinated participants with the unvaccinated participants that were not planning on receiving the vaccine ($p \leq 0.01$). There was also a significant difference between the participants with one dose and not planning to get vaccinated with the participants that were unvaccinated and not planning on getting vaccinated ($p \leq 0.05$). There was a significant difference between the participants that were unvaccinated and planning on receiving the vaccine and the participants that received at least one dose of the vaccine ($p < 0.05$). Lastly, there was a significant difference between the participants that were unvaccinated and planning to receive the vaccine and the participants that were fully vaccinated ($p < 0.01$).

Figure 12B refers to the statistically significant relationship between political party and knowledge-based questions. Participants in the Green Party (n= 2) scored an average of 100.0% on the knowledge-based question section. Participants in the Libertarian Party (n=10) scored an average of 91.6% on the knowledge-based question section. Participants in the Democratic Party (n=187) scored an average of 91.4% on the knowledge-based question section. Participants that consider themselves to be Non-Partisan/Non-Affiliated (n=69) scored an average of 90.2% on the knowledge-based question section. Participants that aligned their beliefs with another party (other) scored an average of 89.2% on the Knowledge-based question section. Lastly, participants that consider themselves to be Independents (n=89) scored an average of 89.0% on the knowledge-based questions section. Lastly, participants in the Republican Party (n=63) scored an average of 77.4% in the knowledge-based questions section. There was a significant difference between participants that identified with the Republican Party and participants that identified with the Libertarian Party ($p \leq 0.05$). There was also a significant difference between participants that identify with the Republican Party and participants that are Democratic, Independent, Libertarian, Non-Partisan/ Not Affiliated, and Other political parties ($p \leq 0.01$). There was no significant relationship between participants that aligned their beliefs with the Green Party because there were only two participants.

DISCUSSION

The results displayed in Figures 3-12 (excluding Figures 4, 5, and 10) demonstrated statistical significance ($p<0.001$). The investigation's main findings showed a significant effect on vaccination status among people of different political parties, masking frequency in class, and scores on the knowledge-based questions. Political Party and Field of Study significantly affected the knowledge-based questions.

As for the graphs that displayed the reasons behind the lack of COVID-19 vaccinations from 13.1% of the participants, the fact that the top reason is that students are waiting to hear more about the COVID-19 vaccine's potential side effects, highlights a lack of confidence in the effectiveness of vaccinations (26.2%). These results were similar to the results of another University of South Florida (USF) COVID-19 survey. 74.2% of their unvaccinated participants were hesitant to receive the COVID-19 vaccine due to potential side effects (Neely & Stevens, 2021). However, unlike the survey that was created for this investigation, students were able to choose multiple reasons for why they chose not to be vaccinated. 50.0% of their unvaccinated participants also stated that they believed the vaccine was created much too quickly (Neely & Stevens, 2021). This is unlike our results, where the second most popular reason for not being vaccinated was due to the unvaccinated UCF participants' belief that the vaccine was not effective (24.5%). There was a total of 214 students out of 600 USF students (35.7%) that were unvaccinated as of June 2021 when the survey was distributed (Neely & Stevens, 2021).

When the UCF participants were asked if any opportunities would encourage them to receive the vaccine, 50.0% of the participants stated that they would never receive the vaccine. Following this, 12.5% of participants wanted another period of testing to be done on the vaccines. None of the participants felt that an informational workshop about the COVID-19 vaccine would encourage them to receive it. Of knowledge-based questions, five of the six questions were answered correctly by at least 80% of the students. 78.2% of students correctly confirmed that the COVID-19 vaccines do not contain the virus's "live strain." Following that question, 81.6% of participants answered correctly that antibiotics could not prevent and treat COVID-19. Pamphlets or a COVID-19 Facts page that addresses misinformation about COVID-19 can help provide further insight.

Students need to be informed about all potential side effects that each COVID-19 vaccine can potentially cause. The literature about COVID-19 vaccine side effects elaborates on the effects seen during the clinical trials completed in 2020. There were no severe side effects from the Pfizer/BioNTech vaccine and the Moderna vaccine (Anand & Stahel, 2021). The mild side effects that participants witnessed were redness, heat, swelling, and pain (Anand & Stahel, 2021). These effects were common compared to the patients who received the saline placebo vaccine (Anand & Stahel, 2021). Symptoms that the placebo group did not express were headaches, myalgia, arthralgia, fatigue, and fever (Anand & Stahel, 2021). Those symptoms are typically attributed to regular vaccination inoculation (Anand & Stahel, 2021). The most adverse symptoms seen with the Pfizer-BioNTech vaccine were rare allergies and anaphylaxis (Mascellino, 2021). The Moderna vaccine's most adverse symptom was rare facial paralysis (Bell's Palsy) (Mascellino, 2021). The Johnson & Johnson vaccine's potential side effects include rare cases of blood clots, thrombocytopenia, and Guillain-Barré Syndrome (Mascellino, 2021). There were six cases of blood clots caused by the Johnson & Johnson vaccine received by millions of people (Mascellino, 2021).

From the UCF student sample results, students need to know more about the molecular components of the vaccines (mRNA, adenoviruses, and spike proteins) and the vaccine's short- and long-term effects to combat vaccine hesitancy and COVID-19 misinformation. This knowledge could encourage confidence and trust in the vaccination process and procedures. Despite not being the top picked answer in trustworthy sources about COVID-19, the social media option still attracted a significant margin of students for every category from the primary to the tertiary source. Social Media can still be considered an influential outlet for students to receive accurate information about COVID-19 vaccines that explain their efficacy and genetic components. Social media that can potentially be utilized include Instagram channels, Snapchat channels, and Reddit posts.

A prominent statistic that was observed in the investigation was that participants of the Republican Party had a significant difference ($p<0.001$) in vaccination status compared to the participants of other political parties. This is supported by Sharma's investigation of COVID-19 vaccine hesitancy on a southern college campus (Sharma et al., 2021). Participants of Republican political affiliation showed significant association with increased hesitancy to receive the COVID-19 vaccine. They had a 0.464 reduction in initiation score for receiving the COVID-19 vaccine ($b=0.464$, $p=0.004$) compared to participants of other political affiliations.

Despite literature detailing that Americans of an African or Hispanic background are the prominent race/ethnicity to be hesitant to receive COVID-19 vaccinations, there was no significant effect between race/ethnicity and vaccination status ($p=0.330$). The majority of the participants from almost every race/ethnicity had a high vaccination status. There are three potential reasons for these results: the participants at UCF are a college-educated group of people, UCF provides resources that include reliable information on the COVID-19 vaccines, and/or UCF has a Health Center located on campus to provide more information from healthcare professionals (nurses and physician assistants). The only race/ethnicity that had a much lower vaccination status were students of the American Indian race/ethnicity. However, only three students identified as that race/ethnicity. The results did not make a significant difference.

Additionally, according to the literature, Americans who lived in rural settings were likely to be hesitant to receive the COVID-19 vaccine treatment (Khubchandani, 2021). This is due to Americans living in rural settings having lower health literacy and lower awareness, lack of trust in medical professionals, and cost-related concerns regarding treatment (Khubchandani, 2021). However, this was no significance between living conditions and vaccination status ($p=0.756$). This could be because only 10% of the participants consider themselves to live in a rural environment which could have potentially skewed the results. However, no matter what their living condition is, students can receive free vaccinations at the UCF Health Center and learn more about the vaccines through UCF's health websites and the medical professionals at the UCF Health Center.

For caveats in the study, there was an underrepresentation in the population of social science majors ($n=19$). Psychology is known to be one of the most common majors at UCF. Future survey studies need to focus on better outreach to social science professors for survey distribution. Commonly used social science survey websites like SONA can be utilized to receive more responses from social science majors. Additionally, there was a choice listed as “other” for the opportunities that could encourage students to receive vaccines question. In the future, this choice needs to include a write-in section for students to be able to express what they feel needs to happen before they consider receiving a vaccine.

Further studies are needed to learn more about student opinions that would explore how students feel about the booster shots and if workshops held by UCF would be helpful to learn more information about the COVID-19 vaccines. The COVID-19 survey was approved by the IRB just shortly after booster shots were widely available to the adult population. The survey should also ask students who were planning on receiving the vaccine why they have yet to receive it. USF recently concluded and published a COVID-19 survey a year after their previous COVID-19 survey that was used for this investigation (Neely & Stevens, 2022). This survey was distributed from March 31 to April 12, 2022. Their survey consisted of 600 USF students (Neely & Stevens, 2022). In the study, they were asked how likely they were to receive a COVID-19 booster shot (Neely & Stevens, 2022). 211(35.2%) students did not put down very likely for their decision to receive a booster shot and were asked a follow-up question regarding their reasoning for not putting down very likely (Neely & Stevens, 2022). 86 (40.7%) students felt that the booster shots are not necessary (Neely & Stevens, 2022). 51 (24.2%) students said that the COVID-19 vaccines gave them side effects. 43 (20.3%) students believed that receiving routine booster shots would be an inconvenience (Neely & Stevens, 2022). 39 (18.5%) students were no longer worried about COVID-19 (Neely & Stevens, 2022). 36 (17.1%) students believed that vaccines could not prevent the spread of COVID-19 (Neely & Stevens, 2022). 34 (16.1%) students are concerned about the potential costs of booster shots (Neely & Stevens, 2022). The remaining 13 (6.2%) students listed their reasoning as other (Neely & Stevens, 2022). A UCF COVID-19 booster shot survey study can investigate other college student feelings toward the COVID-19 booster shots for further analysis.

Another study that can be investigated in the future within the student body is exploring Influenza vaccine hesitancy in the student population. As stated in the results, 57.5% of the participants were vaccinated for Influenza compared to 84.7% of the participants being vaccinated for COVID-19. The influenza vaccine was developed in 1945, many decades before the COVID-19 vaccine was developed. This outcome would hypothesize that COVID-19 was deemed infectious and potentially dangerous compared to Influenza, which has been deemed a seasonal endemic with humankind for centuries. This information would also be sent to the Health Center of UCF for further analysis to understand Influenza vaccine hesitancy.

APPENDIX A:

Table of Hypotheses

Theme	Hypothesis	Questions	Statistical Test	Significance (p value)
Major	Natural Sciences and Health Sciences students will have the highest vaccination rates compared with other categories of majors.	#10 and #14	Chi Square	0.534
	STEM majors will have a significantly higher vaccination rate than non-STEM majors	#10 and #14	Chi Square	0.798
	Natural Sciences students in the stem field will score significantly higher on the content questions than other majors	#14 and #18-23	ANOVA	0.001*
Political Party	People who identify with the Republican party are more likely to be unvaccinated.	#10 and #16	Chi Square	<0.001*
	Students who identify themselves as Democrats will score higher on the content statements than students that identify themselves as Republicans.	#16 and #18-23	ANOVA	<0.001*
Vaccinated vs. Unvaccinated	COVID-19 unvaccinated individuals are more likely to be unconcerned about COVID-19.	#10 and #11	Chi Square	<0.001*
	Students who are vaccinated score significantly higher on the content questions than unvaccinated students.	#10 and #18-23	ANOVA	<0.001*
Living Conditions	Students who grew up in a rural setting will have a significantly lower number of vaccinations than students who grew up in an urban or suburban setting.	#10 and #17	Chi Square	0.756
Reasons for Vaccine Hesitancy	The most common reason for vaccine hesitancy is that students felt the vaccines were created too quickly (*waiting for side effects and vaccine is considered ineffective).	#10	Chi Square	<0.001*
	Students that are unvaccinated have sources skewed towards social media, while students that are vaccinated have sources skewed towards scientific information.	#4 and #10	Chi Square	0.191
Risk Factors	There is a significantly higher number of vaccinations among students who have COVID risk factors.	#7 and #10	Chi Square	0.672
	Students that live with at least one individual over the age of 65 in their primary household are more likely to be vaccinated.	#6 and #10	Chi Square	0.307
Influenza	Students who did not receive the Influenza vaccine were more likely to not receive the COVID-19 vaccine.	#5 and #10	Chi Square	<0.001*
Mask Wearing	Students who are not vaccinated are less likely to wear a mask than vaccinated students.	#9 and #10	Chi Square	<0.001*

*$p \leq 0.05$ is considered to be significant

APPENDIX B:

Additional Graphs

Figure 1: Trustworthy COVID-19 Scources

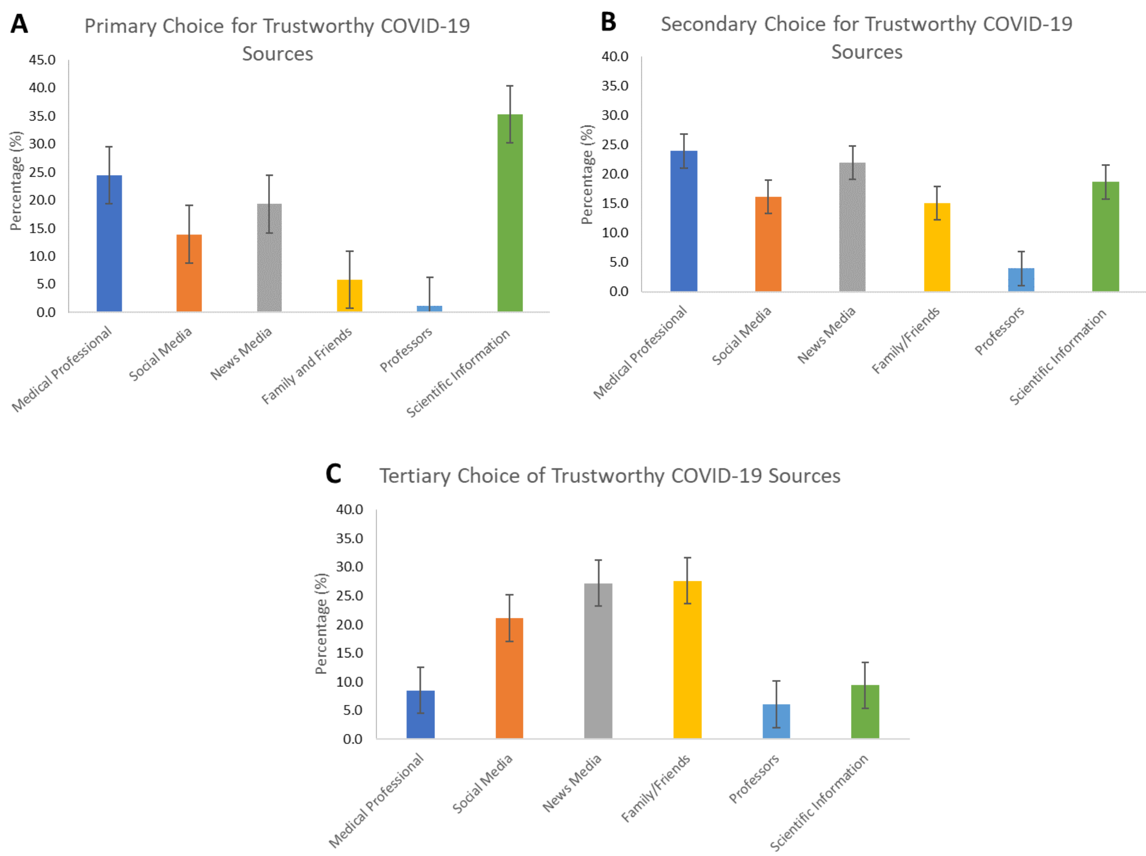


Figure 3 displays the trustworthy sources that the students rely on for information about COVID-19. Figure 3A shows the primary trustworthy sources of COVID-19 information that the students rely on. 157 (35.3%) of students believed that scientific information (Websites, Magazines, and Journals) is the most trusted source, 109 (24.5%) students believed that physicians, medical professionals, and health centers are the most trusted source, 86 (19.3%) students felt that News Media is the most trusted source, 62 (13.9%) students believed that social media is the most trusted source, 26 (5.8%) of students believed that family and friends are the most trusted source, and 5 (1.1%) students felt that professors are the most trusted source. There is no significance between primary choice of trustworthy information with vaccination. Figure 3B displays the secondary trustworthy sources that the students rely on for information about COVID-19. 107 (24.0%) students felt that physicians, medical professionals, and health centers are the second most trusted source of information. 98 (22%) students believed that news media is the second most trusted, 83 (18.7%) students believed that scientific information is their second most trusted source, 72 (16.2%) students believed that social media is their second most trusted source, 67 (15.1%) students believed that family and friends are their second most trusted source, and 18 (4.0%) students believed that professors are their second most trusted sources of COVID-19 information.

Figure 3C refers to the tertiary choice for trustworthy information about COVID-19. 123 (27.6%) students believed that family and friends are their third most trusted source, 121 (27.2%) of students believed that news media is their third most trusted source, 94 (21.1%) students believed that social media is their third most trusted source, 42 (9.4%) students believed that scientific information is their third most trusted source, 38 (8.5%) students believed that physicians, medical professional, and the health center are their third most trusted source, and 27 (6.1%) students believed that professors are their third most trusted source of COVID-19 information.

APPENDIX C:

Survey Questionnaire

Survey Demographic Requirement Questions

1. **Are you a current student at UCF?**

   -Yes
   -No

   If no, then end survey

2. **Are you under the age of 18?**

   If yes, end survey
   If no, please specify your age

Opinion Based Questions

3. How would you categorize your knowledge on COVID-19?

-I've done extensive research on COVID-19 (High)
-I felt that I can actively discuss COVID-19 (Above Average)
-I know the main issues with COVID-19 (Average)
-I know very little on COVID-19 (Below Average)
-I do not know about COVID-19 (None)

4. Consider the sources that you use to learn about COVID-19. Rank your top three sources.

What is your top source?

- Physician/Medical Professional/Health Center
-Social Media
-News Media
-Family/Friends
-Professors
-Scientific information (Websites/Magazines/Journals)

What is your second source?

- Physician/Medical Professional/Health Center
-Social Media
-News Media
-Family/Friends
-Professors
-Scientific information (Websites/Magazines/Journals)

What is your third source?

- Physician/Medical Professional/Health Center
-Social Media
-News Media
-Family/Friends
-Professors
-Scientific information (Websites/Magazines/Journals)

5. **Have you received the influenza vaccine this year or are you planning on receiving the influenza vaccine?**
   -Yes
   -No

6. **Do you live with someone vulnerable to COVID-19 who has any of the following conditions?**

   Over the age of 65
   Cancer
   Chronic kidney disease
   Chronic obstructive pulmonary disease (COPD)
   Heart conditions, such as heart failure, coronary artery disease, or cardiomyopathies
   Obesity or severe obesity
   Sickle cell disease
   Type 2 diabetes mellitus
   Immunocompromised due to solid organ transplant
   Current smoker

   -Yes
   -No

7. **Do you have one or more of the following conditions?**

   Cancer
   Chronic kidney disease
   Chronic obstructive pulmonary disease (COPD)
   Heart conditions, such as heart failure, coronary artery disease, or cardiomyopathies
   Obesity or severe obesity
   Sickle cell disease
   Type 2 diabetes mellitus
   Immunocompromised due to solid organ transplant
   Current smoker

   -Yes
   -No

8. **To your knowledge, have you ever tested positive for COVID-19?**
   -Yes
   -No
   -Waiting on results

9. How often do you wear a face mask in class on campus?

-Always
-Often

-Sometimes

-Seldom

-Never

10. Please select the statement that best describes you

-I have received all of my vaccine doses and am fully vaccinated
-I have received one dose of the Pfizer or Moderna vaccine, and I intend to receive the second dose.
-I have received one dose of the Pfizer or Moderna vaccine, but I do not intend to receive the second dose
-I am unvaccinated and plan to get vaccinated.
-I am unvaccinated and do not plan to get vaccinated.

If they chose that they are not vaccinated:

What is your primary reason for not receiving the vaccine?

-I'm concerned about the potential side effects of the vaccine
-I felt the vaccines were created too quickly
-I don't believed the vaccines are effective at preventing the spread of COVID-19
-It has the potential to cause infertility
-I'm not concerned about contracting COVID-19
-I'm generally opposed to vaccinations
-A friend or family member had a bad reaction to the vaccine
-I don't think that a vaccine is necessary because COVID-19 is not a serious threat
-My religion is opposed to receiving the COVID-19 vaccines
-My primary care doctor advised me not to get vaccinated
-Other

What could encourage you to get vaccinated?

-FDA Approval
-Another period of waiting to hear about side effects
-More testing is done
-I'm never taking it
-Doing more research
-Job requires it
-Workshops about COVID-19 vaccines
-Other

11. How concerned are you about getting COVID-19?

-Very Concerned
-Concerned
- Neutral
-A little concerned
-Not concerned

Demographic Questions

12. What is your race or ethnicity?

-White/Caucasian
-Black/African American
-Hispanic/Latino
-Asian
-Native Hawaiian or Pacific Islander
-American Indian/Alaska Native
-Biracial or Multiracial
-Other
-I prefer not to say

13. What is your gender?

-Male
-Female
-Transgender Female
-Transgender Male
-Other
-I prefer not to say

14. Is your field of study within the STEM Field (Science, Technology, Engineering, Mathematics)?

-Yes
-No

You have selected yes. Please indicate your specific category of study

-Natural Science or Health Science
-Social Sciences
-Engineering, Computer Science, or Mathematic

15. What is your class standing at UCF?

-Freshman
-Sophomore
-Junior
-Senior
-Super Senior/ 5th Year or higher
-Graduate Student
-Medical Student
-Other
-You have selected other for class standing. Please fill out in your class standing

16. With which political party are you afflicted?

-Democrat
-Republican
-Libertarian
-Green Party
-Independent
-Non-Partisan/Not afflicted
-Other

-You have selected other for political party. Please indicate your political party

17. How would you describe the main geographic setting where you grew up? (CDC Vaccine Confidence Survey Question Bank)

-Rural
-Urban
-Suburban

Common Knowledge Questions

True or False? Content Claims (USF COVID-19 Vaccine Survey)

18. COVID-19 vaccines contain a "live strain" of the virus

True
False

19. COVID-19 vaccines contain 5G microchips

True
False

20. Once infected with the coronavirus, it can take 2 to 14 days to show symptoms (Nebraska Medicine Survey)

True
False

21. COVID-19 vaccines modify people's genes and alter their DNA

True
False

22. COVID-19 vaccines may cause infertility in full developed adults

True
False

23. Antibiotics can prevent and treat COVID-19. (US Today News)

True
False

Answers

18. COVID-19 vaccines contain a "live strain" of the virus

True
False

19. COVID-19 vaccines contain 5G microchips

True
False

20. You can carry the coronavirus for 14 days after infection before showing any symptoms.

True
False

21. COVID-19 vaccines modify people's genes and alter their DNA

True
False

22. COVID-19 vaccines may cause infertility in full developed adults

True
False

23.Antibiotics can prevent and treat COVID-19.

True

False

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