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Factors Associated with Telemedicine Usage and Acceptance Pre- and Since COVID-19

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FACTORS ASSOCIATED WITH TELEMEDICINE USAGE AND ACCEPTANCE PRE- AND SINCE COVID-19

By

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Abstract

Background: The COVID-19 pandemic has acted as a catalyst for telemedicine uptake among healthcare providers and patients. Prior research rarely has examined the lack of patient uptake of telemedicine. Known systemic barriers to accessing telemedicine in the U.S. before the COVID-19 pandemic may play a large role in its uptake. The purpose of this study is to assess the factors associated with the usage and acceptance of telemedicine pre- and since the COVID-19 pandemic. **Methods:** In this cross-sectional study, data was collected from adults residing within the U.S. who are 18 years of age or older using an online survey (n=200). Using an integrated model of the Theory of Planned Behavior (TPB) and Technology Acceptance Model (TAM), this study measured barriers to accessing telemedicine before and since the COVID-19 pandemic as well as the six constructs of the integrated model. Descriptive statistics and logistic regression were calculated. **Results:** In the model examining predictors of telemedicine use before COVID-19 ($p<0.001$), racial/ethnic identity ($p<0.05$) was statistically associated with the uptake of telemedicine. In the model examining the predictors of telemedicine use since COVID-19 ($p<0.001$), the devices used to access telemedicine since COVID-19 ($p<0.05$) was statistically associated with its uptake. Gender identity, employment status, healthcare status and selected constructs of the integrated model were among the variables not statistically significant in either of the regression models. **Conclusion:** These findings contribute to the existing literature regarding barriers to telemedicine uptake among patients in the U.S. Future studies should focus on making the survey more accessible to non-English speakers and communities with limited Internet access.

Introduction

According to the Centers for Medicare and Medicaid Services (CMS), telemedicine is the general use of technology which seeks to advance an individual's health by allowing real-time, collaborative communication between a patient and a practitioner that may be physically distant ("*Telemedicine"*). Over time, telemedicine usage in the United States (U.S.) has expanded due to the increased accessibility of technology and broadband Internet access in rural regions of the country that had limited access to quality healthcare otherwise. Though more thorough telemedicine integration into current U.S. healthcare systems has been impelled alongside the increased accessibility of video technology, the further adoption, implementation, and promotion of telemedicine as a whole has been slow due to the ambiguous verbiage of legislation and policy regarding how to practice and bill telemedicine visits compared to in-person visits (Kichloo et al., 2020). Even with the inconsistent policies surrounding telemedicine, the U.S. healthcare infrastructure was forced to promptly adapt its systems to make telemedicine platforms more accessible due to the rapid influx of the coronavirus disease 2019 (COVID-19) pandemic (Hyder & Razzak, 2020).

The COVID-19 pandemic has been a catalyst for hospitals and other healthcare organizations to transition to telemedicine platforms for non-emergency and non-essential services. Telemedicine allows for reduced spread of COVID-19 between patients and practitioners by promoting social distancing (Ramaswamy et al., 2020). With the general increase in COVID-19 cases, the U.S. healthcare system has continually faced an overwhelming influx of new patients requiring medical attention on top of usual patient loads. Telemedicine allows for those infected with COVID-19 to receive access to

medical attention and care while self-isolating and quarantining, thus helping to alleviate the strain on the U.S. healthcare infrastructure (Katzow et al., 2020). With the COVID-19 pandemic, changes in federal and state legislation and funding have also been re-directed to help with the overall systemic integration of telemedicine and allow for more flexibility regarding the previously more ambiguous policies (Fisk et al., 2020). On March 17th, 2020 the Trump administration expanded telehealth and telemedicine coverage through CMS to allow for a wider range of healthcare services to be administered remotely (CMS, 2020). Moreover, the Federal Communications Commission (FCC) allocated $200 million in Federal emergency aid to expand telemedicine and telehealth adoption within U.S. healthcare systems in April 2020 ("*COVID-19 telehealth program,"* 2020).

Despite the progress made in legislation and funding for telemedicine programs in the U.S., little is understood about why patients in the U.S. were not utilizing telemedicine pre-COVID-19, even if they had access to it. A report by the American Medical Association highlights that in 2019, only 11% of patients used telehealth and telemedicine compared to 46% of patients in 2020 due to COVID-19. Furthermore, healthcare professionals are now seeing 50 to 175 times more patients via telemedicine and telehealth technologies than before the COVID-19 pandemic (Henry, 2020). Before COVID-19, telemedicine programs were already being implemented in healthcare systems in each of the 50 states, mainly aimed towards rural communities that were quite distant from healthcare facilities. Yet, even with these systems in place, it's estimated only around 1% of people living in remote areas of the U.S. experienced telemedicine pre-COVID-19 (McElroy et al., 2020). Since telemedicine was once marketed as the

solution to remote healthcare issues, this number demonstrates a clear issue in the lack of telemedicine uptake (Smith et al., 2020). Research also highlights the ineffectiveness and dangers of adopting telemedicine only in times of emergency due to the complex nature of expanding telemedicine effectively. Other aspects such as healthcare provider training, marketing telemedicine to patients, and ensuring telemedicine is integrated into curricula for healthcare providers are necessary components for long-term, stable telemedicine implementation (Fisk et al., 2020).

As telemedicine expands rapidly in the U.S., it is clear to researchers and healthcare providers that telemedicine must be properly integrated due to its range of benefits and for future emergency situations, as demonstrated with COVID-19. With telemedicine's ability to aid in lower-cost healthcare visits, to increase flexibility for both patient and practitioners, and the conclusive potential of telemedicine to play a major role in expanding healthcare access to American communities that need it – such as rural communities – it is evident that U.S. healthcare systems must further expand telemedicine integration, even after COVID-19 ends (Kichloo et al., 2020). Most studies have researched the factors associated with telemedicine usage in the context of healthcare providers. Although this research is important, it is also important to understand what factors affect patient uptake of telemedicine, as telemedicine systems have been in place in the U.S. for years without much patient use (Timpel & Harst, 2020). Furthermore, with the ongoing COVID-19 pandemic, many patients have been forced to adopt telemedicine. Therefore, researching the factors pre-COVID-19 and since COVID-19 are vital to understanding what main factors are integral for a generally higher patient uptake of future telemedicine programs.

This proposed research study plans to address gaps in the existing literature by examining the factors associated with the uptake of telemedicine among individuals both pre-COVID-19 and since the COVID-19 pandemic. For this research, telemedicine and telehealth resources will both be referred to, as the American Telemedicine Association considers the terms to be interchangeable and synonymous (Hyder & Razzak, 2020). The Technology Acceptance Model (TAM) and the Theory of Planned Behavior (TPB) will serve as the theoretical foundation through an integrated model for the study, as both theories relate heavily with the acceptance of novel technical systems such as telemedicine.

Literature Review

Telemedicine's History in the United States

As previously defined, "telemedicine" is the general use of technology which seeks to advance an individual's health by allowing real-time, collaborative communication between a patient and a practitioner that may be physically distant ("*Telemedicine"*). Telemedicine has a vast history in the U.S., with early accounts of its widespread adoption dating back to 1959 when the Nebraska Psychiatric Institute implemented videoconferencing options with a rudimentary, two-way microwave transmission television for telepsychiatry (Kichloo et al., 2020). The National Aeronautics and Space Association (NASA) soon began regularly monitoring the health statuses of in-flight astronauts via satellite technologies in the 1960s. With telemedicine, physicians on Earth were able to track astronaut vitals, as well as provide diagnostic examinations from a remarkable distance (Hyder & Razzak, 2020). Having recognized the impact of telemedicine for in-flight astronauts, NASA pushed for and began to build

telemedicine infrastructure in rural areas of the U.S. throughout the 1970s and 1980s, with the help of Federal funding. With greater accessibility to the Internet, the 1990s bolstered funding and research into ever-evolving telemedicine technologies. The National Library of Medicine (NLM) supported telemedicine projects in 1993 through large-scale funding initiatives (Hurst, 2016). With greater access to stable Internet connections, real-time audio and video communication became a key aspect of telemedicine (Kichloo et al., 2020).

From the 2000s and 2010s, NLM and various other Federal agencies focused on telemedicine access through websites and mobile applications (apps) due to the rise in smartphone and tablet accessibility and use. Apps revolutionized telemedicine by allowing people to interact with health databases and their personal health data through mobile platforms, increasing access to on-demand health information (Hurst, 2016). Within recent years, telemedicine infrastructure in U.S. healthcare systems has drastically increased. From 2010 to 2017 this percentage increased by 41%, demonstrating the federal push towards telemedicine infrastructure. The American Hospital Association (AHA) noted that in 2017 around 76% of hospitals had connected patients and healthcare providers from a distance through telemedicine technologies ("*Telehealth Fact Sheet: AHA*").

COVID-19 has not been the first emergency in the U.S. where telemedicine has been beneficial. During hurricanes Harvey and Irma in 2017, a plethora of telemedicine companies provided free services to those injured and forced to evacuate. This was especially necessary with the overwhelming amount of patient intake occurring at local hospitals that were simultaneously limited due to the devastation of the hurricanes

(Wicklund, 2017). Moreover, the displacement of both healthcare providers and patients by the hurricanes made telemedicine incredibly necessary to connect these groups to one another. Despite the rich history of telemedicine funding and research in the U.S., the overall uptake has been fragmented and with limited reach (Smith et al., 2020).

Barriers to Telemedicine Uptake in the United States

As highlighted previously, Federal funding for telemedicine integration into U.S. healthcare systems has not been limited in the past few decades. Though telemedicine programs have been installed in each of the 50 states, many known systemic barriers have prevented patients from utilizing telemedicine. One of the most prominent barriers has been the lack of standardized legislation regarding telemedicine, with no two states having identically worded policy regarding how to practice and reimburse telemedicine in comparison to conventional, in-person healthcare provider appointments (Fisk et al., 2020). Some states having no laws regarding what telehealth services and modalities are covered plus their reimbursement rate, with others having full coverage services available to the public. Oftentimes issues arise from federal telemedicine rules and state telemedicine legislation conflicting when it comes to reimbursement policies and geographic coverage limitations. There are also no Federal licensure laws allowing healthcare providers to provide telemedicine services across state lines, limiting the geographic reach and complicating the adoption of telemedicine technologies for healthcare providers (Lee et al., 2020). The lack of standardized legislation deeply fragments the overall uptake of telemedicine among healthcare practitioners due to worries surrounding the costs and potential legal implications of practicing via telemedicine technologies (Hyder & Razzak, 2020).

Telemedicine training and consulting is limited in standardized professional healthcare curricula – such as in nursing or medical schools – and healthcare certification programs. This lack of training severely impedes a sustainable uptake of telemedicine technologies by not emphasizing its various uses and subtly brushing telemedicine off as ineffective and too complex to learn for healthcare providers (Smith et al., 2020). Although research on healthcare provider willingness to integrate and practice via telemedicine is incredibly important, it is equally as imperative to research and focus on the factors associated with patient willingness to be seen through and utilize telemedicine. This gap in the current research is one this study proposes to address.

A large systemic factor known to be hindering the general acceptance of telemedicine in the U.S. is ambiguous reimbursement policies nationwide from both government and private insurance payers (Lee et al., 2020). Due to disparate administrative rules across the nation, different insurance companies and federal agencies are divided in their telemedicine billing reimbursement policies (Hyder & Razzak, 2020). Disjointed reimbursement policies de-incentivizes healthcare providers in exploring telemedicine options especially within the U.S, where there is no universal healthcare system (Lee et al., 2020). Certain Medicare guidelines pre-COVID-19 oftentimes had strict geographic locations, with reimbursement for telemedicine services mainly oriented towards those only in Health Professional Shortage Areas or counties outside of a Metropolitan Statistical Area. These guidelines discouraged healthcare providers in metropolitan areas to utilize telemedicine (Hyder & Razzak, 2020). Since COVID-19, some Medicare guidelines have expanded their telemedicine coverage in response. For example, Medicare began covering some audio-only telemedicine services and virtual

check-ins for patients to communicate with healthcare providers, which were previously not reimbursed *("Medicare and Coronavirus"*). Though a step in the right direction for telemedicine, how these temporary guideline changes will hold up in a post-COVID-19 U.S. is unclear.

Even with most pre-COVID-19 telemedicine policies regarding reimbursement focused on rural communities, issues in terms of accessing telemedicine exist within these communities. Almost all forms of telemedicine require a stable Internet connection. Many rural communities of the U.S. lack access to high-speed, fixed broadband networks (Lee et al., 2020). It is estimated that within rural communities of the U.S., one in four individuals do not have access to a fixed broadband service. A paid subscription to an accessible fixed broadband service allows for high-speed access to the public Internet (Julien et al., 2020).

It is important to highlight that *access* to a fixed broadband service does not necessarily indicate a *subscription* to a fixed broadband service, oftentimes due to high costs and affordability. In 2018, New York City – a city with access to high-speed, fixed broadband networks – had around 31% of households lacking a home Internet subscription, with Black and Hispanic residents disproportionally affected when compared to their non-Hispanic White counterparts. This finding highlights how a lack of sustainable Internet connection disproportionately impacts communities of color in the U.S. (Julien et al., 2020). Adults aged 65 and older within the U.S. are also less likely to have sufficient Internet access at home (McElroy et al., 2020). Though 80% of adults in the U.S. have access to a smartphone in 2020, these numbers drastically decrease among those persons with lower educational completion and/or lower income individuals

(Katzow et al., 2020). These barriers to telemedicine access are important to consider when overviewing telemedicine infrastructure within the U.S.

While the research mentioned above highlights incredibly important information regarding barriers to telemedicine uptake in the U.S., these studies have limitations. More research is necessary to address current gaps in the literature. Research is needed to understand peoples' attitudes regarding telemedicine since the COVID-19 pandemic, due to the disruptive and mostly involuntary uptake of telemedicine many faced (Ramaswamy et al., 2020). Some of the studies that have focused on behavioral attitudes have limited geographic sample areas due to the COVID-19 pandemic, focusing on one hospital or medical center. Moreover, research regarding factors associated with telemedicine uptake has been primarily focused on systemic factors. More research is needed to understand the degree of influence that behavioral factors have on peoples' satisfaction, acceptance, and usage of telemedicine (Timpel & Harst, 2020). This proposed study aims to address these gaps by collecting data pre-COVID-19 and since COVID-19 to better understand factors affecting users' acceptance and usage of telemedicine.

COVID-19 within the United States

For this study to examine the factors associated with the uptake of telemedicine pre- and since COVID-19, it is important to contextualize the impact of COVID-19 within the U.S. COVID-19 was declared a global pandemic on March 11th, 2020, by the World Health Organization (Smith et al., 2020). The U.S. contains approximately 4% of the world's population; yet it accounted for nearly 26% of COVID-19 cases worldwide as of July 16th, 2020 (Blumenthal et al., 2020). According to the Centers for Disease Control

and Prevention (CDC), as of March 2021 the U.S. has had approximately over 28,515,000 COVID-19 cases and 515,280 COVID-19 deaths ("*Coronavirus Disease 2019,"* 2021). Though COVID-19 is rapidly evolving, the U.S. has been, and continues to be, deeply impacted by the ongoing COVID-19 pandemic.

Within the U.S., however, substantial disparities exist in terms of COVID-19 and which communities are being affected the most. Research has clearly shown a heightened incidence of COVID-19 among communities of color across the U.S. Specifically, disparities in COVID-19 are substantially higher among Black or African American, Hispanic or Latinx, and American Indian/Alaska Native persons – with these populations being overrepresented in both COVID-19 hospitalizations and deaths (Moore et al., 2020). As of March 2021, non-Hispanic Black or African American persons were 2.9x more likely to be hospitalized and 1.9x more likely to die in comparison to non-Hispanic White persons if infected with COVID-19. Hispanic or Latinx persons were 3.1x more likely to be hospitalized and 2.3x more likely to die when compared. American Indian or Alaska Native persons were 3.7x more likely to be hospitalized and 2.4x more likely to die when compared ("*Hospitalization and Death by Race/Ethnicity*," 2021). The COVID-19 pandemic highlights the long-standing, systemic issues that disproportionally harm communities of color. Issues such as housing insecurities, lack of fixed broadband network access, food insecurities, social inequities, limited access to healthcare, and social factors – such as essential worker status which requires in-person employment – all contribute to the substantial COVID-19 disparities among marginalized racial and ethnic groups within the U.S. (Julien et al., 2020; Moore et al., 2020).

Age is also an important factor when overviewing COVID-19 within the U.S. The CDC has stated that 8 of every 10 adult COVID-19 deaths reported nationwide have been in those 65 years old and older ("*Older Adults*," 2021). It is important to focus on age within COVID-19 because there are significant telemedicine barriers present within the U.S. for older adults, too. One barrier is that older adults are less likely to have sufficient Internet access at home, hindering this group's ability to utilize telemedicine (McElroy et al., 2020).

Integrated Model as the Theoretical Framework

To understand the factors associated with telemedicine usage and acceptance pre- and since COVID-19 within the U.S., the theoretical foundation for this study will be an integrated model of the Theory of Planned Behavior (TPB) and the Technology Acceptance Model (TAM). In the following, the TPB and the TAM will be explained individually as well as in an integrated model

Stemming from the Theory of Reasoned Action (TRA), the TPB bases itself in four constructs: (1) behavioral intent (BI), (2) attitude (ATT), (3) subjective norms (SN), and (4) perceived behavioral control (PBC). Both the TPB and the TRA place emphasis on behavioral intention, which is assumed to be the most important factor in determining future behavior (Ramírez-Correa et al., 2020). According to the TPB, behavioral intention is greatly influenced by an individual's attitude and the subjective norms surrounding that behavior. Attitude is one's personal beliefs surrounding a behavior, whereas subjective norm is the beliefs held by certain individuals one seeks approval from, and their beliefs regarding a certain behavior. TPB differs from TRA with the addition of one construct – perceived behavioral control (Rimer & Glanz, 2005).

Perceived behavioral control is belief one has in how much control they have over performing a specific behavior and directly affects behavioral intention. If general perceived behavioral control is higher in someone, they are more likely to have a higher intention to take part in that behavior due to their sense of control (Ramírez-Correa et al., 2020). Previous research studies and evidence have demonstrated TPB to be effective in research regarding novel technologies due to its focus on behavioral intention and perceived behavioral control (Chau & Hu, 2002).

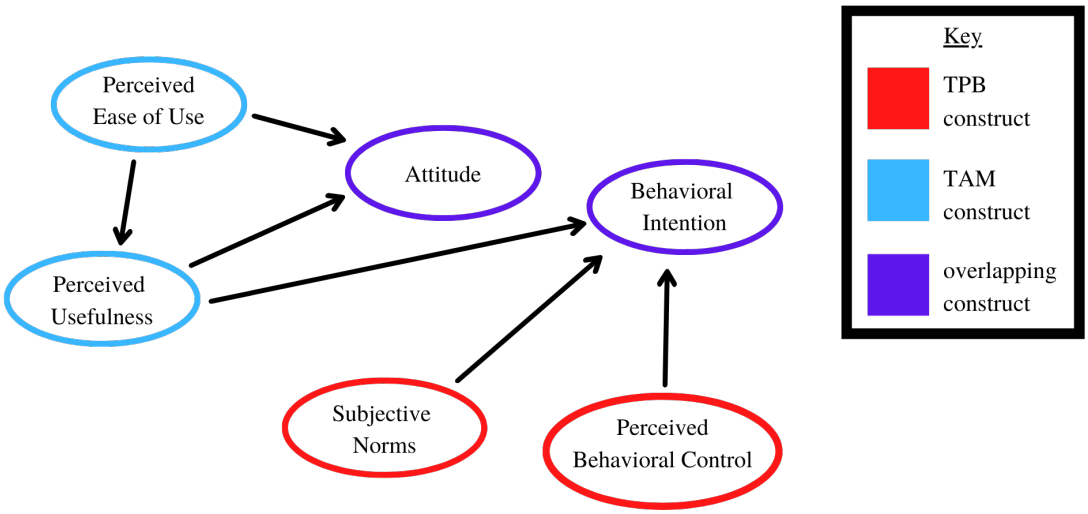
Next, the TAM also stemmed from the TRA and was proposed by Fred Davis in 1989. The TAM, alongside the TPB, have been dominant theoretical models when investigating factors affecting users' acceptance of novel technical systems. Telemedicine has been extensively researched in other countries using the TAM as the theoretical grounds, in studies that mainly have focused on healthcare provider willingness and acceptance of telemedicine (Rahimi et al., 2020).

Extremely similar to the TPB, the TAM also examines users' acceptance of new technologies with the assumption that behavioral intention is the most important factor when predicting patterns of future behavior (Ramírez-Correa et al., 2020). The TAM is based on four constructs: (1) perceived ease of use (PEOU), (2) perceived usefulness (PU), (3) attitude (ATT), and (4) behavioral intention (BI) (Chau & Hu, 2002). Attitude and behavioral intention are the same in the TAM as previously defined for the TPB. Perceived ease of use is how much effort a user believes a novel technology requires of them, and perceived usefulness is how an individual believes a technology can be helpful to them. Perceived ease of use directly affects a users' attitude and perceived usefulness of a novel technical system and perceived usefulness directly affects users' attitudes and

behavioral intentions (Ramírez-Correa et al., 2020). Previous research has noted that future studies should integrate other theoretical frameworks to facilitate its efficacy in predicting and explaining factors relevant to users' acceptance of unfamiliar technologies (Huang, 2013).

The integrated TAM and TPB model aims to facilitate and exemplify the explanatory powers that both models hold. As discussed above, both models have been successful in predicting factors associated with users' usage and acceptance of novel technologies separately and are grounded within the TRA. Integrating TAM and TPB can enhance dimensions necessary to investing factors regarding user acceptance of telemedicine. Figure 1 displays the integrated model, underscoring the complementary nature of both the TAM and the TPB. In this study, individuals' behavioral intention to utilize telemedicine is influenced by their attitude, their surrounding subjective norms, and their perceived behavioral controls – coming from the TPB. Corresponding with the above, individuals' attitude is directly determined by their perceived usefulness of telemedicine and their perceived ease of use of telemedicine technologies – coming from the TAM (Chau & Hu, 2002). This integrated model will be used in this study to identify important factors that affect users' acceptance and usage of telemedicine pre- and since COVID-19 within the U.S.

Figure 1: Integrated TAM and TPB Model



Research Questions

Based on the known barriers to telemedicine uptake within the U.S. and the impact of the COVID-19 pandemic within the U.S., this research study aimed to answer the following research questions:

1. What are the predictors of use of telemedicine before the COVID-19 pandemic?
2. What are the predictors of use of telemedicine since the start of the COVID-19 pandemic?

Methodology

The methodology section is composed of study participants, data collection, survey instrument, and data analysis. Study participants explains how individuals were chosen as eligible to participate in this study. The second section, data collection,

overviews how survey participants were recruited. The survey instrument section describes the online survey that was used in this cross-sectional study. Lastly, the data analysis section examines the data gathered and how it was analyzed to answer the research questions for this study.

Study Participants

This study surveyed persons of 18 years of age and older who reside within the U.S. and have access to the Internet to complete an online survey. Previous research indicated an odds ratio (OR) of 1.68 which is equivalent to a small effect size (Cohen's d = 0.2) to be appropriate for the a priori power analysis (Chen et al., 2010). At 80% power using an alpha of 0.05, the required sample size is 133 to detect an odds ratio of 1.68. Accounting for additional predictors and possible missing data on variables of interest, the minimum sample size was 200 respondents for this study. Screening questions were presented to participants to ensure they meet the eligible criterion to participate. Two-hundred sixteen individuals accessed the survey; however, 16 respondents were excluded based on the screening questions, resulting in a final sample size of 200 for analysis.

Data Collection Procedure

The research protocol and recruitment flyer were approved by the UNLV Institutional Review Board before any data was collected (1756495-1). The survey was disseminated via various social media platforms, email, and through snowball techniques. The survey link and recruitment flyer were periodically posted on platforms such as organizational Facebook groups, personal Twitter pages, organizational Discord chats, personal and organizational Instagram accounts, and LinkedIn. They were often reposted by those who interacted with them. Convenience sampling was also used to sample

eligible individuals within the United States. Survey participants were asked to complete the cross-sectional survey on the Qualtrics platform.

Survey Instrument

Previous studies completed outside of the U.S. with research surveys addressing telemedicine usage with theoretical frameworks grounded in the TAM and the TPB were the references to which Qualtrics survey questions were adapted from (Chau & Hu, 2002; Huang, 2013). The Qualtrics survey instrument was made available in English. A copy of the drafted Qualtrics survey has been included as "Appendix A" below.

Demographics

Questions regarding demographics were asked to describe the survey sample population. Demographic questions collected data on participants' zip code, gender identity, education, employment status, racial/ethnic identity, health insurance status, and prior primary healthcare provider visits. Demographic questions were mostly close ended, except for questions with fill-in options and "other" options such as the zip code question. Questions that related to gender identity, employment status, and racial/ethnic identity had "select all that apply" for participants to accurately describe themselves. For those that self-reported more than one race/ethnicity, a separate variable was coded "multi-racial" which was used in the data analysis. For respondents who said that they were unemployed and a student, then the respondent was coded as a student for the data analysis. For those respondents who said that they were employed either part-time or full-time and were a student, then the respondent was coded as either being employed part-time or full-time for the data analysis. These demographic questions were only asked once at the beginning of the survey (view Q6-Q14 in Appendix A).

Barriers to Accessing a Primary Healthcare Provider – pre- and since COVID-19

A question was asked to determine whether survey participants have seen a primary healthcare provider within the past 24 months (pre-COVID-19) and within the past 12 months (since COVID-19), with each having the options of "yes" and "no." If participants had not seen a primary healthcare provider within the past 24 months, they were asked about barriers that may have impacted their ability to do so (view Q15 in Appendix A). Options such as lack of insurance coverage, financial strain to do so, lack of transportation, inconvenient clinic hours, lack of time, general distrust of healthcare providers, general fear of visiting, general embarrassment of visiting, and other (with a written explanation) were provided. Survey participants were allowed to select numerous options. If participants had not seen a primary healthcare provider 12 months, they were asked about barriers that may have impacted their ability to do so to determine the impact of the COVID-19 pandemic (view Q16 in Appendix A). Options such as lack of insurance coverage, financial strain to do so, lack of transportation, inconvenient clinic hours, lack of time, general distrust of healthcare providers, general fear of visiting, general embarrassment of visiting, fear of exposure to COVID-19, and other (with a written explanation) were provided. Survey participants were allowed to select numerous options, and this was considered during data analysis. This entire section of questions was housed under demographics to better analyze the data collected and provide a better survey flow for participants.

Device Used to Connect to the Internet – pre- and since COVID-19

With Internet access being a known barrier to telemedicine access, it was important to assess what devices individuals are utilizing to connect to the Internet.

Devices with cameras and microphones allow for videoconference-based telemedicine appointments that differ from telemedicine appointments that are audio only (Julien et al., 2020). A question was asked regarding what devices the participant has used to access the Internet with options such as mobile phone, laptop, desktop, tablet, none, and other (open ended response option). Survey participants were allowed to select numerous options, and this was considered during data analysis. This question was asked twice in the contexts of pre-COVID-19 and since COVID-19 to determine if the COVID-19 pandemic impacted access to the Internet and, if so, which devices (view Q18 and Q27 in Appendix A).

Device Used to Connect to Telemedicine – pre- and since COVID-19

The survey asked participants through which devices they had accessed telemedicine. How individuals connect to telemedicine is vital to understand because access to and the quality of a microphone and video camera impacts the diagnostic accuracy of a telemedicine appointment (Katzow et al., 2020). A question was asked regarding what devices the participant has used to access telemedicine with options such as mobile phone, laptop computer, desktop computer, tablet, none, and other (open ended response option). Survey participants were allowed to select numerous options. The data was recoded into a new variable for data analysis, such that if someone chose more than one type of device then they were given a sum score of 7 to reflect the use of multiple devices. This question was asked twice in the contexts of pre-COVID-19 and since COVID-19 to better determine if participants had ever accessed telemedicine and if there is a change in how people had accessed telemedicine with COVID-19 (view Q19 and 28 in Appendix A).

Barriers to Accessing Telemedicine – pre- and since COVID-19

To further understand the factors associated with telemedicine usage, this study asked participants about their barriers to accessing telemedicine. Firstly, study participants were asked if they've accessed telemedicine before and since the COVID-19 pandemic, with each having the options of "yes" and "no." If respondents answer "no" to either, they were then asked about whether they have faced barriers in accessing telemedicine (view Q20, Q21, Q29, and Q30 in Appendix A). Options for barriers included: a lack of insurance coverage, lack of knowledge surrounding telemedicine options available, healthcare providers not having telemedicine options, lack of a secure Internet connection, lack of devices suitable for telemedicine appointments, general skepticism of telemedicine, concern regarding privacy with telemedicine, and other (with a written explanation). Survey participants were allowed to select numerous options, and this was considered during data analysis. This question was asked twice in the contexts of pre-COVID-19 and since COVID-19 to better determine if systemic barriers had perhaps lessened or developed with COVID-19, given the numerous legislative changes surrounding telemedicine within the U.S. (Fisk et al., 2020; Kichloo et al., 2020; Lee et al., 2020).

Integrated Model Questions – pre- and since COVID-19

Questions surrounding the integrated model of the TAM and TPB had been adapted from previous research studies (Chau & Hu, 2002; Huang, 2013). Many questions were modified to fit the purpose of this research and the target audience of this survey. For example, one previous study asked healthcare providers to respond to, "[u]sing telemedicine technology is beneficial to my patient care and management,"

(Chau & Hu, 2002). This was modified into, "[u]sing telemedicine is beneficial to me," (see Table 1 below). This section of questions was the focus when evaluating the factors associated with telemedicine use pre- and since COVID-19 (see Q25 and Q31 in Appendix A). This series of questions was asked twice, once with participants answering with their beliefs pre-COVID-19 (before March 2020) and since COVID-19 (March 2020 to present date). The response options for the questions were on a Likert-type scale, with options including strongly agree (5 points), agree (4 points), neutral (3 points), disagree (2 points), and strongly disagree (1 point). During data analysis, some variables were reverse coded due to the nature of the question (view Q25_2, Q25_21, Q31_2, and Q31_21 in Appendix A). For these specific variables, the response options were measured as follows: strongly agree (1 point), agree (2 points), neutral (3), disagree (4 points), and strongly disagree (5 points). The six constructs of the integrated model (ATT, SN, PBC, PU, PEOU, and BI) all had at least three questions with a maximum of five questions per construct (see Table 1 below).

Table 1: Integrated Model Questions

CONSTRUCT	**QUESTIONS**
Attitude (ATT)	I like using the telemedicine. I find telemedicine unpleasant to use. Using telemedicine is beneficial to me. I believe telemedicine is convenient to me.
Subjective Norms (SN)	People I talk to about my healthcare believe I should use telemedicine. My family supports and encourages me to use telemedicine. Trusted medical professionals encourage me to use telemedicine. Media outlets I trust support the use of telemedicine.
Perceived Behavioral Control (PBC)	I have sustainable access to telemedicine. I am confident when I use telemedicine.

	I have the necessary knowledge to use telemedicine independently. I have the resources available to me to use telemedicine easily and effectively.
Perceived Usefulness (PU)	I find telemedicine useful. Telemedicine enhances my access to medical care. Telemedicine allows me to better monitor my health. Telemedicine has given me greater control with my healthcare. Telemedicine reduced my risk of being infected with or spreading illness.
Perceived ease of use (PEOU)	Learning to operate telemedicine is easy for me. I find telemedicine easily understandable and clear. It is easy for me to access telemedicine. I need help from others when using telemedicine. I find telemedicine easy to use overall.
Behavioral Intention (BI)	I will use telemedicine in the future. I will consider telemedicine as my first choice for healthcare. I will recommend telemedicine to those important to me.

Study Variables

This study measured three independent variables and two dependent variables. The three independent variables were: demographics, integrated model questions, and the devices used to access telemedicine. Telemedicine uptake and acceptance pre-COVID-19 and since COVID-19 were the two dependent variables.

Data Analysis

All analyses were conducted using SPSS v. 27.0. Overall data analysis included descriptive statistics, sum scores, chi-square tests of independence, and logistic regressions. The overall sample included 200 participants that met the criteria to participate after the dataset was cleaned to remove those respondents who either did not

consent to participate in the study or who did not indicate being 18 years of age and older.

Descriptive Statistics

Descriptive statistics were calculated to describe the population sample that was surveyed and to describe the uptake of telemedicine pre- and since COVID-19. Demographic variables that underwent descriptive statistics included gender identity, education, employment status, racial/ethnic identity, health insurance status, and prior primary healthcare provider visits. The types of devices people used to access telemedicine and the Internet with pre- and since COVID-19 underwent descriptive statistics. Whether people had accessed telemedicine within the past 24 months (pre-COVID-19) or past 12 months (since COVID-19) also underwent descriptive statistics. Only the frequency was calculated for the above variables. For several variables with missing data or multiple response options (e.g., "select all that apply"), the total frequencies did not add up to 100%.

Sum Scores

Sum scores were calculated for the questions associated with each construct of the integrated TAM and TPB model that were asked on a Likert-type scale (Chau & Hu, 2002; Huang, 2013). The response options were measured as follows: strongly agree (5), agree (4), neutral (3), disagree (2), and strongly disagree (1). Questions with "yes" and "no" options will be measured with "yes" receiving 1 point and "no" receiving 0 points. A few variables were reverse coded due to the nature of the question (see Q25_2, Q25_21, Q31_2, and Q31_21 in Appendix A). For these specific variables, the response options were measured as follows: strongly agree (1), agree (2), neutral (3), disagree (4),

and strongly disagree (5). The sum scores for each construct were then used in the Chi-square tests of independence and logistic regression calculations, as appropriate.

Chi-square Tests and Logistic Regressions

Chi-square tests of independence were used to assess the bivariate relationships between independent and dependent variables. These results informed research questions one and two. Independent variables that had a statistically significant bivariate relationship with the uptake and acceptance of telemedicine pre- and since COVID-19 were then included in a multivariate logistic regression model. An alpha of 0.05 was used to determine statistically significant results. A backwards entry process was utilized when building the logistic regression model until the model became statistically significant. This analysis provided an idea of the predictors to answer research questions one and two (Pallant, 2016).

Results

Descriptive Characteristics of the Sample

Of the 200 respondents, all (100%) reported their gender identity, with some selecting more than one of the options. Generally, 41 respondents (20.5%) were male, 150 (75.5%) were female, 1 (0.5%) was transgender male-to-female, 1 (0.5%) was transgender female-to-male, 6 (3.0) were non-binary, and 2 (1.0%) reported as other. All respondents reported their level of education. The majority reported having completed a Bachelor's degree (n-58, 29.0%). Regarding employment, all 200 respondents self-reported their employment status with numerous respondents choosing more than one option. Most participants (86 or 43.0%) reported working full-time, followed by 65

(32.5%) identifying as students, 55 (27.5%) working part-time, 21 (10.5%) being unemployed, and 10 (5.0%) were retired.

All 200 respondents self-reported their health insurance status. Many (n=76, 38.0%) noted having health insurance through their parent's plan, followed by 63 (31.5%) having insurance through their employment. All 200 respondents self-reported their racial/ethnic identity, with numerous respondents choosing more than one. For 24 respondents that self-reported more than one race/ethnicity, a separate variable was coded "multi-racial" which was used in the data analysis. More than half of the respondents (n=106, 53.0%) reported themselves as White, non-Hispanic individuals. If respondents chose both White and Hispanic or Latinx, they were included in the coded "multi-racial" variable. Out of the 200 respondents, 198 self-reported whether they visited a primary healthcare provider within the past 24 or 12 months. Additionally, 154 (77.0%) reported having visited a primary healthcare provider within the past 24 months while 44 (22.0%) did not. Lastly, 129 (64.5%) reported having visited a primary healthcare provider within the past 12 months while 69 (34.5%) did not. The descriptive data for the participants is presented in Table 2.

Table 2: Demographic Characteristics of the Study Participants

VARIABLE	FREQUENCY (N)	PERCENTAGE (%)
Gender Identity		
- Male	41	20.5
- Female	150	75.0
- Transgender (Male-to-Female)	1	0.5
- Transgender (Female-to-Male)	1	0.5
- Non-binary	6	3.0
- Other	2	1.0

Education		
- High school graduate or the equivalent	17	8.5
- Some college, no degree	37	18.5
- Associate degree	6	3.0
- Vocational/technical training	2	1.0
- Some Bachelor's, no degree	30	15.0
- Bachelor's degree	58	29.0
- Completed graduate degree	50	25.0
Employment Status		
- Employed (full-time)	86	43.0
- Employed (part-time)	55	27.5
- Unemployed	21	10.5
- Retired	10	5.0
- Student	65	32.5
Health Insurance Status		
- None	14	7.0
- Medicaid	10	5.0
- Medicare	9	4.5
- Private insurance plan	18	9.0
- Insurance through employment	63	31.5
- On my parent's plan	76	38.0
- Other	10	5.0
Racial/Ethnic Identity		
- White	106	53.0
- Hispanic or Latinx	42	21.0
- American Indian or Alaska Native	5	2.5
- Asian	43	21.5
- Native Hawaiian or Pacific Islander	1	0.5
- Black or African American	24	12.0
- Other	7	3.5
Seen a Primary Healthcare Provider within the past 24 months		
- Yes	154	77.0

Of the 200 participants, 195 (97.5%) reported whether they had accessed telemedicine within the past 24 months. Of those 195, 117 (58.5%) reported having accessed telemedicine while 78 (39.0%) had not for a variety of reasons presented in

Table 3 below. Many respondents (n=102, 51.0%) had not accessed telemedicine with any of the listed devices in the survey before COVID-19. This included the 79 (39.0%) participants who had not accessed telemedicine within the past 24 months. Mobile phones were the devices used to access telemedicine the most before COVID-19, with 73 (36.5%) of participants reporting so. Of the 200 participants, 186 (93.0%) reported if they accessed telemedicine within the past 12 months. Of the 186, 111 (55.5%) reported accessing telemedicine while 75 (37.5%) had not for a variety of reasons presented in Table 3 below. The majority of participants (n=107, 53.3%) reported using mobile phones to access telemedicine the most since COVID-19.

Table 3: Telemedicine and Device Characteristics of the Study Participants

VARIABLE	FREQUENCY (N)	PERCENTAGE (%)
Accessed Telemedicine Within the Past 24 Months (before COVID-19)		
- Yes	117	58.5
- No	78	39.0
o My insurance plan didn't cover it	3	1.5
o I didn't know if telemedicine options were available to me	32	16.0
o My healthcare providers didn't use telemedicine	18	9.0
o I didn't have a secure, high-speed Internet connection	1	0.5
o I didn't know how telemedicine works	19	9.5
o I was concerned about my privacy using telemedicine	5	2.5
o Other	30	15.0
Devices Used to Access Telemedicine before COVID-19		
- Mobile Phone	73	36.5
- Desktop Computer	26	13.0
- Laptop Computer	66	33.0

- Tablet	21	10.5
- None of the above	102	51.0
- Other	1	0.5
Devices Used to Access the Internet before COVID-19		
- Mobile Phone	191	95.5
- Desktop Computer	121	60.5
- Laptop Computer	186	93.0
- Tablet	120	60.0
- None of the above	1	0.5
- Other	2	1.0
Accessed Telemedicine Within the Past 12 Months (since COVID-19)		
- Yes	111	55.5
- No	75	37.5
o My insurance plan didn't cover it	4	2.0
o I didn't know if telemedicine options were available to me	24	12.0
o My healthcare providers didn't use telemedicine	17	8.5
o I didn't have a secure, high-speed Internet connection	1	0.5
o I didn't know how telemedicine works	12	6.0
o I was concerned about my privacy using telemedicine	4	2.0
o Other	31	15.5
Devices Used to Access Telemedicine since COVID-19		
- Mobile Phone	107	53.5
- Desktop Computer	31	15.5
- Laptop Computer	98	49.0
- Tablet	29	14.5
- None of the above	54	27.0
- Other	0	0.0
Devices Used to Access the Internet since COVID-19		
- Mobile Phone	185	92.5
- Desktop Computer	112	56.0
- Laptop Computer	181	90.5
- Tablet	113	56.5
- None of the above	0	0.0
- Other	3	1.5

Research Question 1: What are the predictors of use of telemedicine before the COVID-19 pandemic?

Independent and Dependent Variables

For Question 1, the three independent variables were: demographics, integrated model questions, and the devices used to access telemedicine pre-COVID-19. The Chi-square tests and following logistic regression were used to examine the relationships between the three independent variables and the uptake of telemedicine pre-COVID-19.

Chi-Square Tests

Pearson Chi-square tests were computed for the demographics, integrated model construct questions, and devices used to access telemedicine before COVID-19 questions. Gender identity was not associated with the uptake of telemedicine pre-COVID-19, χ^2 [8.036, p=0.154, df=5, n=195], alongside employment status, χ^2 [6.283, p=0.179, df=4, n=194], and health insurance status, χ^2 [11.146, p=0.084, df=6, n=195]. Racial/ethnic identity was statistically significant, χ^2 [20.772, p=0.004, df=7, n=194]. The type of device(s) people used to access telemedicine before COVID-19 revealed no statistical significance with the uptake of telemedicine pre-COVID-19, χ^2 [10.041, p=0.123, df=6, n=194]. For the integrated model questions asked within the context of before COVID-19, it was discovered that prior ATT, χ^2 [27.556, p=0.016, df=14, n=189], PBC, χ^2 [32.019, p=0.004, df=14, n=190], and PEOU, χ^2 [32.002, p=0.006, df=15, n=187], were statistically significant with the uptake of telemedicine. Prior SN, χ^2 [21.401, p=0.164, df=16, n=190], PU, χ^2 [26.196, p=0.051, df=16, n=188], and BI, χ^2 [18.319, p=0.074, df=11, n=188] were statistically insignificant with the uptake of telemedicine before COVID-19.

Logistic Regression Analysis

With prior ATT, prior PBC, prior PEOU, and racial/ethnic identity the model was statistically significant, χ^2 [0, n=185] = 29.5, $p < 0.001$ indicating that the model was able to distinguish between respondents who had and had not reported using telemedicine before the COVID-19 pandemic. The model explained between 14.7% (Cox and Snell R square) and 19.9% (Nagelkerke R squared) of the variance in taking up telemedicine before COVID-19, and correctly classified 65.9% of cases. As shown in Table 4, only racial/ethnic identity made a statistically significant contribution to the model ($p<0.05$). The strongest predictor of telemedicine uptake pre-COVID-19 was racial/ethnic identity, recording an odds ratio of 1.237. See Table 4 for the logistic regression analysis results.

Table 4: Step 1 Logistic Regression Analysis Results of Prior ATT, Prior PBC, Prior PEOU, and Racial/Ethnic Identity to the Uptake of Telemedicine before COVID-19

Variables	*B*	S.E.	Wald	df	Sig	Odds Ratio (OR)	95.0% C.I. of OR (Lower)	95.0% C.I. of OR (Upper)
Prior ATT	0.057	0.059	0.912	1	0.339	1.058	0.942	1.189
Prior PBC	0.072	0.082	0.768	1	0.381	1.074	0.915	1.261
Prior PEOU	0.097	0.068	2.028	1	0.154	1.102	0.964	1.259
Racial/Ethnic Identity	0.212	0.065	10.606	1	0.001	1.237	1.088	1.405
Constant	-3.243	0.663	23.965	1	0.000	0.039	-	-

Research Question 2: What are the predictors of use of telemedicine since the COVID-19 pandemic?

Independent and Dependent Variables

For Question 2, the three independent variables are: demographics, integrated model questions, and the devices used to access telemedicine since COVID-19. The Chi-square tests and following logistic regression were used to examine the relationships between the three independent variables and the uptake of telemedicine since COVID-19.

Chi-Square Tests

The Pearson Chi-square tests were computed for the demographics, integrated model construct questions, and devices used to access telemedicine since COVID-19 questions. Gender identity was not significantly associated with the uptake of telemedicine since COVID-19, χ^2 [6.091, p=0.297, df=5, n=186], alongside employment status, χ^2 [4.730, p=0.316, df=4, n=185], and health insurance status, χ^2 [9.960, p=0.126, df=6, n=186]. Racial/ethnic identity was statistically significant, χ^2 [20.787, p=0.004, df=7, n=185]. The type of device(s) people used to access telemedicine since COVID-19 also revealed a statistical significance with the uptake of telemedicine since COVID-19, χ^2 [113.259, p=0.000, df=4, n=186]. For the integrated model questions asked within the context of since COVID-19, it was discovered that since COVID-19 ATT, χ^2 [49.685, p=0.000, df=13, n=168], SN, χ^2 [25.524, p=0.013, df=12, n=169], PBC, χ^2 [30.968, p=0.001, df=11, n=168], PU, χ^2 [42.073, p=0.000, df=16, n=167], BI, χ^2 [37.793, p=0.000, df=12, n=165], and PEOU, χ^2 [32.141, p=0.001, df=13, n=167], were very statistically significant with the uptake of telemedicine.

Logistic Regression Analysis

With racial/ethnic identity, devices used access telemedicine since COVID-19, since ATT, since SN, since PBC, since PU, since PEOU, and since BI the model was statistically significant, χ^2 [0, n=161] = 46.2, $p < 0.001$ indicating that the model was able

to distinguish between respondents who had and had not reported using telemedicine since the COVID-19 pandemic. The model explained between 24.9% (Cox and Snell R square) and 33.9% (Nagelkerke R squared) of the variance in taking up telemedicine since COVID-19, and correctly classified 72.7% of cases. As shown in Table 5, only the devices used access telemedicine since COVID-19 made a statistically significant contribution to the model ($p<0.05$). The strongest predictor of telemedicine uptake since COVID-19 was the devices used to access telemedicine, recording an odds ratio of 1.271. See Table 5 for the logistic regression analysis results.

Table 5: Step 1 Logistic Regression Analysis Results of Racial/Ethnic Identity, Devices Used to Access Telemedicine since COVID-19, Since ATT, Since SN, Since PBC, Since PU, Since PEOU, and Since BI to the Uptake of Telemedicine since COVID-19

Variables	*B*	S.E.	Wald	df	Sig	Odds Ratio (OR)	95.0% C.I. of OR (Lower)	95.0% C.I. of OR (Upper)
Since ATT	0.152	0.116	1.707	1	0.191	1.164	0.927	1.462
Since PBC	-0.103	0.144	0.515	1	0.473	0.902	0.680	1.196
Since SN	0.100	0.101	0.990	1	0.320	1.106	0.907	1.348
Since PU	0.150	0.099	2.304	1	0.129	1.162	0.957	1.411
Since PEOU	0.185	0.110	2.824	1	0.093	1.203	0.970	1.494
Since BI	-0.084	0.129	0.422	1	0.516	0.920	0.714	1.184
Racial/Ethnic Identity	0.047	0.081	0.334	1	0.563	1.048	0.894	1.229
Since Device	0.240	0.111	4.703	1	0.030	1.271	1.023	1.579
Constant	-6.265	1.232	25.843	1	0.000	0.002	-	-

Discussion

The purpose of this study was to assess the factors associated with the usage and acceptance of telemedicine pre- and since the COVID-19 pandemic. To do so, this study created and sent out a cross-sectional Qualtrics survey that adapted questions related to the integrated model of the TPB and the TAM (Chau & Hu, 2002; Huang, 2013). Other questions regarding the devices used to access telemedicine pre- and since COVID-19 alongside the barriers to accessing telemedicine were also asked based on existing studies on the barriers to telemedicine (Fisk et al., 2020; Katzow et al., 2020; Kichloo et al., 2020; Lee et al., 2020). To make this study as inclusive as possible, the survey was open to all who were above the age of 18 and resided within the United States.

Before COVID-19, it was discovered that prior attitude regarding telemedicine (ATT), prior perceived behavioral control surrounding telemedicine (PBC), and the perceived ease of use of telemedicine (PEOU) were the only statistically significant integrated model variables according to the Chi-square tests. This is inconsistent with one major study which noted that perceived usefulness of telemedicine (PU) was the most significant factor affecting physicians' acceptance of telemedicine technology and that PEOU was insignificant, which was noted by the authors to be inconsistent with the results of prior studies (Chau & Hu, 2002). However, this is consistent with another major study which noted that ATT was the most significant factor associated with the uptake and acceptance of telemedicine technologies. Also, PEOU had a significant positive effect on the PU, indicating that the ease of use of the telemedicine technology greatly affected PU (Huang, 2013). PBC was not noted as significant in either study (Chau & Hu, 2002; Huang, 2013). Prior social norms surrounding telemedicine (SN),

perceived usefulness of telemedicine (PU), and behavioral intent (BI)were statistically insignificant with the uptake of telemedicine before COVID-19. SN was the third most significant factor in a prior study (Huang, 2013). However, SN also had no statistical significance in another important study (Chau & Hu, 2002). To account for some of these discrepancies, one reason may be the sociodemographic differences such as racial/ethnic identity, gender identity, healthcare status, and familiarity with telemedicine pre-COVID-19.

The strongest predictor of telemedicine uptake and acceptance pre-COVID-19 was racial/ethnic identity, recording the highest odds ratio of 1.237 for the relevant logistic regression. Therefore, those who self-identified being from marginalized racial/ethnic identities —specifically Black or African American, Asian, American Indian or Alaska Native, Hispanic or Latinx, and Other — were less likely to uptake and accept telemedicine pre-COVID-19. This is supported by past research regarding the barriers to the uptake of telemedicine for underrepresented racial and ethnic groups. These underrepresented racial and ethnic groups were and still are less likely to have Internet access at home which could have affected the way in which individuals of these groups accessed and understood telemedicine. Furthermore, telemedicine services with audio-video visits were markedly less accessible to Black patients (McElroy et al., 2020). This affects the quality and diagnostic capabilities of telemedicine as well as the reimbursement from private and governmental insurance agencies pre-COVID-19, potentially having deterred communities of color from telemedicine significantly (Katzow et al., 2020; McElroy et al., 2020).

For those that did not access telemedicine prior to COVID-19, the most stated reason was “I didn’t know if telemedicine options were available to me” (32 or 16.0%). This was followed by “I didn’t know how telemedicine works” (19 or 9.5%). This is consistent with the known research, as COVID-19 increased awareness of telemedicine technologies (Lee et al., 2020). Furthermore, a general understanding of telemedicine and its function also increased because of COVID-19 (Fisk et al., 2020).

Since COVID-19, it was discovered that attitudes surrounding telemedicine (ATT), social norms around telemedicine usage (SN), perceived behavioral control when using telemedicine (PBC), perceived usefulness of telemedicine (PU), behavioral intent (BI), and the perceived ease of use of telemedicine (PEOU) were very statistically significant with the uptake of telemedicine. This means that all six of the integrated model variables were significant since the onset of the COVID-19 pandemic according to the Chi-square tests. ATT, PU, PEOU, and SN were all statistically significant in one previous study. In this study, SN was found to have both a direct and indirect effect on the BI meaning that the intention of telemedicine use was affected by the support of a close-knit social circle (Huang, 2013). In a separate study, PBC had a significant influence on BI but not to the extent of ATT. With the high-threat situation of COVID-19, the integrated TPB and TAM model had greater explanatory power compared to pre-COVID-19.

The strongest predictor of telemedicine uptake and acceptance since COVID-19 were the devices people used to access telemedicine, recording an odds ratio of 1.271 for the relevant logistic regression. Therefore, the types of devices people used to access telemedicine since the onset of the COVID-19 pandemic greatly affected the acceptance

and uptake of telemedicine. This is supported by extant research regarding the barriers to the uptake of telemedicine when it comes to device differences and capabilities. Moreover, this result makes sense because the ongoing COVID-19 pandemic also increased the awareness of telemedicine technologies for healthcare providers and patients (Lee et al., 2020). It is understood that a successful telemedicine appointment requires an Internet-enabled device compatible with the telemedicine platform necessary alongside sufficient technology literacy (Julien et al., 2020; Katzow et al., 2020). High-quality devices with proper microphone and video capabilities can provide higher quality and higher diagnostic capabilities for telemedicine appointments (Katzow et al., 2020). As noted during COVID-19, the uptake of technology set up numerous challenges for new users due to the high-risk nature of this ongoing pandemic (Fisk et al., 2020). Furthermore, for both healthcare providers and patients the necessity for videoconferencing capabilities on devices for audio-video telemedicine appointments posed an accessibility barrier (Hyder & Razzak, 2020). Respondents noted that since COVID-19, mobile phones (185 or 92.5%) and laptop computers (181 or 90.5%) were the two most used devices to access telemedicine. This is supported by existing research which has noted that 80% of adults in the United States have access to a smart phone (Katzow et al., 2020).

For those that did not access telemedicine since COVID-19, the most stated reason was “I didn’t know if telemedicine options were available to me” (24 or 12.0%). This was followed by “[m]y healthcare providers didn’t use telemedicine” (17 or 8.5%). As can be seen, there was a 4.0% increase in telemedicine awareness from the pre-COVID-19 to since COVID-19 data. This is consistent with the extant data on the role of

COVID-19 in increasing awareness of telemedicine (Lee et al., 2020). Even with COVID-19, however, it is evident that many were unable to access telemedicine due to their healthcare providers. This supports the previously noted idea that the sustainability of telemedicine remains an issue, especially due to the issues in training healthcare providers to deliver care via telemedicine in emergency situations (Fisk et al., 2020).

Limitations of the Study

This study has a variety of limitations that should be considered. To gather results, this survey used convenience sampling. Unlike other sampling techniques, convenience sampling may not always be representative of the target population. Furthermore, this survey was only accessible as an online instrument due to the nature of the ongoing COVID-19 pandemic. Individuals who may have met the criteria for the survey but who did not have access to a high speed, secure Internet connection or to a device were not able to participate. This is especially important to consider due to the nature of this study on telemedicine access and uptake. Furthermore, individuals who may not be familiar with online surveys may not have participated due to personal discomfort with the platform. This is particularly possible for older adults. Also, the survey was only available in English. This may be imposed limits onto those who met the screening criteria to complete the survey but were uncomfortable doing so in English.

Two previously proposed research questions were unable to be answered because the final Qualtrics survey did not have the questions regarding age that were necessary for their analyses. One question was also poorly worded, with a mistype in the final survey sent out to respondents. This was Q20 which had the incorrect note of “since COVID-19” even though it was housed under the “pre-COVID-19” section of questions

and clearly stated “past 24 months.” No respondents reached out to ask for any clarifications, so it is uncertain whether this created a great deal of confusion or not for participants. The devices used to access the Internet pre- and since COVID-19 questions were difficult to analyze due to the variety of “other” responses that were unexpected. This did not make it clear whether devices used to access the Internet were an important factor in the uptake of telemedicine pre- or since COVID-19. Lastly, it was difficult to distinguish which healthcare providers people felt more comfortable seeing via telemedicine because of the variety of specialties typed within the “other” responses that were unaccounted for.

Conclusions and Recommendations

Telemedicine has been an essential component in the healthcare response to COVID-19 by reducing the strain on the U.S. healthcare infrastructure and ensuring healthcare needs are being met for the general population. Overall, reducing exposure to COVID-19 for both patients and healthcare professionals (Ramaswamy et al., 2020). COVID-19 has presented a unique opportunity for people to access telemedicine in the United States. Due to the onset of the COVID-19 pandemic, many of the restrictions regarding licensing, reimbursement coverage, geographic limitations, and more have been lifted with the hopes that they will remain permanently lifted in post-COVID-19 United States (McElroy et al., 2020). Furthermore, COVID-19 increased the awareness of telemedicine technologies for both healthcare providers and patients (Lee et al., 2020). The lockdowns and high-pressure environment of the COVID-19 pandemic provided a distinct set of pressures onto individuals to access their healthcare and other necessary services such as their work and education virtually. This required many individuals to

update their previous devices and get comfortable using technology that may have been unfamiliar with them (Lee et al., 2020; Smith et al., 2020).

Despite this study having its limitations, the findings reveal that factors such as racial/ethnic identity and the devices used to access telemedicine were significant with the likelihood to uptake and accept telemedicine. Furthermore, the integrated model of the TPB and the TAM revealed a greater explanatory power under the high-stress, high-threat situation of the COVID-19 pandemic than prior to the COVID-19 pandemic (Chau & Hu, 2002; Huang, 2013). Healthcare professionals and policy makers must understand the difficulties that certain communities may have, such as marginalized racial/ethnic identities that have already been disproportionately impacted by COVID-19, need to be accounted for in future healthcare policy and long-standing telemedicine implementation (Katzow et al., 2020; Lee et al., 2020; Moore et al., 2020). Efforts towards increasing the uptake and acceptance of telemedicine in the future should focus on increasing the access to devices that allow for audio-visual telemedicine appointments with quality microphone and video capabilities to heighten the quality and diagnostic accuracy of future telemedicine appointments (Katzow et al., 2020). On that note, developing culturally responsive, directed interventions in partnership with leaders and trusted organizations within communities of color is important in preventing the exacerbation of existing healthcare disparities that have been highlighted due to COVID-19 (Moore et al., 2020).

Future research should further examine the integrated model within various contexts, such as in rural communities, populations with low health literacy, and focusing on essential workers who perhaps did not necessarily need access to the Internet and specific devices for their work. It is also recommended that future studies include the

anticipated survey question regarding age and examine the factors associated with uptake within the context of older adults. As noted, a limitation of this study was the online nature of it. Future studies should also examine a potential paper option or a potential phone option for the survey in numerous languages to make the survey more representative respondent population. A larger and more representative sample size as well as the refinement of the questions that were asked in this study may yield results that more accurately understand the factors associated with the uptake and acceptance of telemedicine.

Though COVID-19 may be coming to an end, the use of telemedicine should still be integrated within the existing healthcare systems in the U.S. for a variety of reasons (e.g., lowered healthcare costs, increased access to healthcare, etc.). As noted in previous research, the sporadic uptake of telemedicine within times of crisis is deleterious to existing healthcare systems due to the complicated nature of that process – involving training healthcare professionals, providing the correct technologies, accessing high speed Internet, and more (Smith et al., 2020). Moreover, although telemedicine has a critical function in times of crisis, telemedicine is also an inevitable shift for the future and vital in increasing healthcare access to rural and traditionally underserved communities (Fisk et al. 2020; Kichloo et al., 2020; Lee et al., 2020).

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Appendix A – Qualtrics Survey Copy

Assessing Factors Associated with Telemedicine Usage and Acceptance pre- and since COVID-19

Start of Block: Informed Consent

Q1 TITLE OF STUDY:
Factors Associated with Telemedicine Usage and Acceptance pre- and since COVID-19

Q2

INVESTIGATOR(S) AND CONTACT PHONE NUMBER:
Shivangi Sinha and Dr. Melva Thompson-Robinson (702-895-1127)

The purpose of this study is to assess the predictors of the use of telemedicine pre- (before March 2020) and since (March 2020 to present) the COVID-19 pandemic in order to identify service gaps, develop comprehensive plans, and create strategies for more effective telemedicine uptake. Telemedicine is defined as the general use of technology that allows real-time, collaborative communication between a patient and a healthcare provider that may be physically distant.

You are being asked to participate in the study because you meet the following criteria: 1) Age: 18 years or older and 2) Currently reside within the United States.

If you volunteer to participate in this study, you will be asked to do the following: Complete an online survey using the Qualtrics platform.

This study includes only minimal risks. The study will take 12-15 minutes of your time. You will not be compensated for your time.

For questions regarding the rights of research subjects, any complaints or comments regarding the manner in which the study is being conducted you may contact **the UNLV Office of Research Integrity – Human Subjects at 702-895-2794, toll-free at 888-581-2794, or via email at IRB@unlv.edu.**
Your participation in this study is voluntary. You may withdraw at any time. You are encouraged to ask questions about this study at the beginning or any time during the research study.

Participant Consent:

I have read the above information and agree to participate in this study. I am at least 18 years of age.

Q3 Do you provide consent to participate in this study?

- ○ Yes (1)
- ○ No (2)

End of Block: Informed Consent

Start of Block: Screening Questions

Q4 Do you currently reside within the United States?

- ○ Yes (1)
- ○ No (2)

Q5 Are you currently 18 years of age or older?

- ○ Yes (1)
- ○ No (2)

End of Block: Screening Questions

Start of Block: Demographic Information

Q6 These next questions will ask about you.

Q7 What is the zip code where you live? Responses will be used to identify where survey participants are from.

_____

Q8 Which of the following describes your gender identity? (select all that apply)

- ☐ Male (1)
- ☐ Female (2)
- ☐ Transgender (Male-to-Female) (3)
- ☐ Transgender (Female-to-Male) (4)
- ☐ Non-binary (5)
- ☐ Other (6) _____

Q9 What is the highest level of education you have completed?

- ○ Less than high school diploma (1)
- ○ High school graduate or the equivalent (2)
- ○ Some college, no degree (3)
- ○ Associate degree (4)
- ○ Vocational/technical training (5)
- ○ some Bachelor's, no degree (6)
- ○ Bachelor's degree (7)
- ○ Completed graduate degree (8)

Q10 Which statement best describes your current employment status? (select all that apply)

- ☐ Employed (Full-time) (1)
- ☐ Employed (Part-time) (2)
- ☐ Unemployed (3)
- ☐ Retired (4)
- ☐ Student (5)

Q11 How do you racially/ethnically identify? (select all that apply)

- [ ] White (1)
- [ ] Hispanic or Latinx (2)
- [ ] American Indian or Alaska Native (3)
- [ ] Asian (4)
- [ ] Native Hawaiian or Pacific Islander (5)
- [ ] Black or African American (6)
- [ ] Other (7) _____

Q12 What type of health insurance do you have?

- ○ None (1)
- ○ Medicaid (2)
- ○ Medicare (3)
- ○ Private insurance plan (4)
- ○ Insurance through employment (5)
- ○ On my parent's plan (6)
- ○ Other (7) _____

Q13 Have you seen a primary healthcare provider within the past 24 months?

- ○ Yes (1)
- ○ No (2)

Q14 Have you seen a primary healthcare provider within the past 12 months?

- ○ Yes (1)
- ○ No (2)

Q29 Which of the following healthcare providers would you be comfortable seeing through telemedicine platforms? (select all that apply)

Telemedicine is defined as the general use of technology that allows real-time, collaborative communication between a patient and a healthcare provider that may be physically distant.

- ○ Primary Healthcare Provider (1)
- ○ Dermatologist (2)
- ○ Neurologist (3)
- ○ Obstetrician/Gynecologist (4)
- ○ Opthamologist (5)
- ○ Optometrist (6)
- ○ Urologist (7)
- ○ Psychiatrist (8)
- ○ Therapist (9)
- ○ Cardiologist (10)
- ○ Dietician (11)
- ○ Other (12) _____

End of Block: Demographic Information

Start of Block: Attention Question

Q30 What is 2+2?

This is to ensure no bots are taking this survey.

- ○ 2 (1)
- ○ 3 (2)
- ○ 4 (3)
- ○ 5 (4)

End of Block: Attention Question

Start of Block: Barriers to Accessing a Primary Healthcare Provider: Pre-COVID-19

Q15 Since you answered "no" to seeing a primary healthcare provider within the last 24 months, what were some reasons? (select all that apply)

- ☐ I didn't have health insurance (1)
- ☐ I couldn't afford to go (2)
- ☐ I didn't have a ride to go (3)
- ☐ The office hours weren't convenient for me (4)
- ☐ I didn't have time to go (5)
- ☐ I don't trust healthcare providers (6)
- ☐ I was scared to go (7)
- ☐ I was embarrassed to go (8)
- ☐ Other (9) _____

End of Block: Barriers to Accessing a Primary Healthcare Provider: Pre-COVID-19

Start of Block: Barriers to Accessing a Primary Healthcare Provider: since COVID-19

Q16 Since you answered "no" to seeing a primary healthcare provider within the last 12 months, what were some reasons? (select all that apply)

- ☐ I didn't have health insurance (1)
- ☐ I couldn't afford to go (2)
- ☐ I didn't have a ride to go (3)
- ☐ The office hours weren't convenient for me (4)
- ☐ I didn't have time to go (5)
- ☐ I don't trust healthcare providers (6)
- ☐ I was scared to go (7)
- ☐ I was embarrassed to go (8)
- ☐ I was scared of being exposed to COVID-19 (9)
- ☐ Other (10) _____

End of Block: Barriers to Accessing a Primary Healthcare Provider: since COVID-19

Start of Block: pre-COVID-19 Data

Q17

Please answer the following questions considering what your responses would have been before the COVID-19 pandemic (before March 2020)

Q18 What devices have you used to access the Internet with BEFORE the COVID-19 pandemic (pre-March 2020)? (select all that apply)

- ☐ Mobile phone (1)
- ☐ Desktop computer (2)
- ☐ Laptop computer (3)
- ☐ Tablet (4)
- ☐ Other (5) _____
- ☐ ⊗ None of the above (6)

Q19 What devices have you used to access telemedicine with BEFORE the COVID-19 pandemic (pre-March 2020)? (select all that apply)

Telemedicine is defined as the general use of technology that allows real-time, collaborative communication between a patient and a healthcare provider that may be physically distant.

- ☐ Mobile phone (1)
- ☐ Desktop computer (2)
- ☐ Laptop computer (3)
- ☐ Tablet (4)
- ☐ Other (5) _____
- ☐ ⊗None of the above (6)

Q20 Have you accessed telemedicine within the past 24 months (after COVID-19)

Telemedicine is defined as the general use of technology that allows real-time, collaborative communication between a patient and a healthcare provider that may be physically distant.

- ○ Yes (1)
- ○ No (2)

End of Block: pre-COVID-19 Data

Start of Block: Attention Question 2

Q31 Please select "strongly agree" below.

This is to ensure no bots are taking this survey.

- ○ Strongly agree (1)
- ○ Somewhat agree (2)
- ○ Neither agree nor disagree (3)
- ○ Somewhat disagree (4)
- ○ Strongly disagree (5)

End of Block: Attention Question 2

Start of Block: Barriers to Accessing Telemedicine: before COVID-19

Q21 Since you did not access telemedicine within the past 24 months, what were some reasons why? (select all that apply)

Remember, telemedicine is defined as the general use of technology that allows real-time,

collaborative communication between a patient and a healthcare provider that may be physically distant.

- [ ] My insurance plan didn't cover it (1)
- [ ] I didn't know if telemedicine options were available to me (2)
- [ ] My healthcare providers didn't use telemedicine (3)
- [ ] I didn't have a secure, high-speed Internet connection (4)
- [ ] I didn't have a device to access telemedicine from (5)
- [ ] I didn't know how telemedicine works (6)
- [ ] I was concerned about my privacy using telemedicine (7)
- [ ] Other (8) _____

End of Block: Barriers to Accessing Telemedicine: before COVID-19

Start of Block: Integrated Model Questions (pre-COVID-19)

Q25 Please answer the following questions considering what your responses would have been before the COVID-19 pandemic (before March 2020)

Kindly remember, telemedicine is defined as the general use of technology that allows real-time, collaborative communication between a patient and a healthcare provider that may be physically distant.

	Strongly Agree (1)	Agree (2)	Neutral (3)	Disagree (4)	Strongly Disagree (5)
I like using telemedicine (1)	○	○	○	○	○
I find telemedicine unpleasant to use (2)	○	○	○	○	○
Using telemedicine is beneficial to me (3)	○	○	○	○	○
I believe telemedicine is convenient to me (4)	○	○	○	○	○
People I talk to about my healthcare believe I should use telemedicine (5)	○	○	○	○	○
My family supports and encourages me to use telemedicine (6)	○	○	○	○	○
Trusted medical professionals encourage me to use telemedicine (7)	○	○	○	○	○

Media outlets I trust support the use of telemedicine (8)	○	○	○	○	○
I have sustainable access to telemedicine (9)	○	○	○	○	○
I am confident when I use telemedicine (10)	○	○	○	○	○
I have the necessary knowledge to use telemedicine independently (11)	○	○	○	○	○
I have the resources available to me to use telemedicine easily and effectively (12)	○	○	○	○	○
I find telemedicine useful (13)	○	○	○	○	○
Telemedicine enhances my access to medical care (14)	○	○	○	○	○
Telemedicine allows me to	○	○	○	○	○

better monitor my health (15)					
Telemedicine has given me greater control with my healthcare (16)	○	○	○	○	○
Telemedicine has reduced my risk of being infected with or spreading illness (17)	○	○	○	○	○
Learning to operate telemedicine is easy for me (18)	○	○	○	○	○
I find telemedicine easily understandable and clear (19)	○	○	○	○	○
It is easy for me to access telemedicine (20)	○	○	○	○	○
I need help from others when using telemedicine (21)	○	○	○	○	○
I find telemedicine easy to use overall (22)	○	○	○	○	○
I will use telemedicine	○	○	○	○	○

in the future (23)					
I will consider telemedicine as my first choice for healthcare (24)	○	○	○	○	○
I will recommend telemedicine to those important to me (25)	○	○	○	○	○

End of Block: Integrated Model Questions (pre-COVID-19)

Start of Block: Attention Question 3

Q32 From the list of vegetables below, please select "cabbage."

This is to ensure no bots are taking this survey.

- ○ Carrot (1)
- ○ Onion (2)
- ○ Cabbage (3)

End of Block: Attention Question 3

Start of Block: since COVID-19 data

Q26 Please answer the following questions keeping in mind the onset of the COVID-19 pandemic (since March 2020)

Q27 What devices have you used to access the Internet with SINCE the COVID-19 pandemic (since March 2020)? (select all that apply)

- ☐ Mobile phone (1)
- ☐ Desktop computer (2)
- ☐ Laptop computer (3)
- ☐ Tablet (4)
- ☐ Other (5) _____
- ☐ ⊗ None of the above (6)

Q28 What devices have you used to access telemedicine with SINCE the COVID-19 pandemic (since March 2020)? (select all that apply)

Telemedicine is defined as the general use of technology that allows real-time, collaborative communication between a patient and a healthcare provider that may be physically distant.

- [ ] Mobile phone (1)
- [ ] Desktop computer (2)
- [ ] Laptop computer (3)
- [ ] Tablet (4)
- [ ] Other (5) _____
- [ ] ⊗None of the above (6)

Q29 Have you accessed telemedicine within the past 12 months (since COVID-19)?

Telemedicine is defined as the general use of technology that allows real-time, collaborative communication between a patient and a healthcare provider that may be physically distant.

- ○ Yes (1)
- ○ No (2)

End of Block: since COVID-19 data

Start of Block: Barriers to Accessing Telemedicine: Since COVID-19

Q30 Since you did not access telemedicine within the past 12 months, what were some reasons why? (select all that apply)

Remember, telemedicine is defined as the general use of technology that allows real-time, collaborative communication between a patient and a healthcare provider that may be physically distant.

- ☐ My insurance plan didn't cover it (1)
- ☐ I didn't know if telemedicine options were available to me (2)
- ☐ My healthcare providers didn't use telemedicine (3)
- ☐ I didn't have a secure, high-speed Internet connection (4)
- ☐ I didn't have a device to access telemedicine from (5)
- ☐ I didn't know how telemedicine works (6)
- ☐ I was concerned about my privacy using telemedicine (7)
- ☐ Other (8) _____

End of Block: Barriers to Accessing Telemedicine: Since COVID-19

Start of Block: Integrated Model Questions (since COVID-19)

Q31 Please answer the following questions keeping in mind the onset of the COVID-19 pandemic (since March 2020)

Kindly remember, telemedicine is defined as the general use of technology that allows real-time, collaborative communication between a patient and a healthcare provider that may be physically distant.

	Strongly Agree (1)	Agree (2)	Neutral (3)	Disagree (4)	Strongly Disagree (5)
I like using telemedicine (1)	○	○	○	○	○
I find telemedicine unpleasant to use (2)	○	○	○	○	○
Using telemedicine is beneficial to me (3)	○	○	○	○	○
I believe telemedicine is convenient to me (4)	○	○	○	○	○
People I talk to about my healthcare believe I should use telemedicine (5)	○	○	○	○	○
My family supports and encourages me to use telemedicine (6)	○	○	○	○	○
Trusted medical professionals	○	○	○	○	○

encourage me to use telemedicine (7)					
Media outlets I trust support the use of telemedicine (8)	○	○	○	○	○
I have sustainable access to telemedicine (9)	○	○	○	○	○
I am confident when I use telemedicine (10)	○	○	○	○	○
I have the necessary knowledge to use telemedicine independently (11)	○	○	○	○	○
I have the resources available to me to use telemedicine easily and effectively (12)	○	○	○	○	○
I find telemedicine useful (13)	○	○	○	○	○
Telemedicine enhances my access to	○	○	○	○	○

medical care (14)					
Telemedicine allows me to better monitor my health (15)	○	○	○	○	○
Telemedicine has given me greater control with my healthcare (16)	○	○	○	○	○
Telemedicine has reduced my risk of being infected with or spreading illness (17)	○	○	○	○	○
Learning to operate telemedicine is easy for me (18)	○	○	○	○	○
I find telemedicine easily understandable and clear (19)	○	○	○	○	○
It is easy for me to access telemedicine (20)	○	○	○	○	○
I need help from others when using telemedicine (21)	○	○	○	○	○
I find telemedicine	○	○	○	○	○

easy to use overall (22)					
I will use telemedicine in the future (23)	○	○	○	○	○
I will consider telemedicine as my first choice for healthcare (24)	○	○	○	○	○
I will recommend telemedicine to those important to me (25)	○	○	○	○	○

End of Block: Integrated Model Questions (since COVID-19)