Using the Unified Theory of Acceptance and Use of Technology (UTAUT) to predict the behavioral intent of teledentistry utilization amongst United States adults

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DEDICATION

This thesis is dedicated to my husband, Chris, who has been nothing but supportive of my master’s degree journey. Thank you for your patience, support, and encouragement along the way. I would also like to dedicate this thesis to Mrs. Ann Brunick, Mrs. Beverly Kennedy, and all the exemplary educators I had during my undergraduate coursework at the University of South Dakota. Your devotion to the profession has been unforgettable and what ignited my interest in pursuing dental hygiene education.
ABSTRACT

Objectives: Teledentistry is an innovative health care delivery platform that can potentially improve oral health outcomes and access. The purpose of this study was to predict teledentistry utilization intentions of U.S. adults.

Methods: This mixed-methods, cross-sectional study surveyed 899 participants from two independent samples in August and September 2021: Minnesota State Fair attendees and ResearchMatch. Data were analyzed using univariate analysis and multiple linear regression. Qualitative responses were coded using UTAUT constructs.

Results: Univariate analysis showed statistical significance between each construct with BI ($P < 0.0001$). Multiple linear regression revealed statistical significance between PE and SI with BI ($P < 0.0001$). Qualitative responses corroborated quantitative results and revealed a lack of teledentistry knowledge.

Conclusion: Participant BI was significantly associated with PE and SI. The general lack of knowledge suggests that intervention designs building on PE and SI could help develop educational or marketing strategies to increase teledentistry uptake.
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INTRODUCTION

Telehealth is defined as the communication between a provider and a patient or patient’s caregiver through use of one or more technological platforms to provide patient-centered care.\(^1\) Telehealth is an umbrella term that covers telemedicine as well as a number of nonphysician services, including teledentistry and telenursing.\(^2\) Although there is evidence of telecommunication playing a role in medical care dating back centuries, the modern telehealth platform has been in existence since the early 20th century with its development and adoption becoming prominent by the mid-20th century, primarily rooted in medicine and radiology.\(^1,3\) Due to the outbreak of SARS-CoV-2, commonly referred to as COVID-19, established health care systems have been challenged on a global level and health care providers have been forced to re-evaluate practices and create innovative solutions for providing care.\(^4\)

Telemedicine is a branch of telehealth and involves remote telecommunication of medical information between a physician and a patient to deliver health care services.\(^2,3,5,6\) Diagnosis, disease treatment and prevention, research, evaluation, and education for providers and patients can all be achieved through the use of telemedicine.\(^7\) The application of telemedicine is versatile and has been used to address medical needs across a wide spectrum of subspecialties including, but not limited to, care and management of diabetes, cancer, stroke, heart disease, and psychiatric conditions as well as use in pediatric care and emergency medicine.\(^3,8,9\)

Teledentistry is another branch of telehealth that utilizes one or more sources of telecommunication to allow for the exchange of oral health-related findings and imaging across remote distances for consultation, diagnostic, and treatment planning purposes.\(^10\)
The primary applications of teledentistry include risk assessment, triage, and remote management of dental problems and oral health. These applications have been further expanded for preservation of Personal Protective Equipment (PPE) and reducing the spread of COVID-19 in light of the pandemic. Teledentistry in the United States originated as part of the military’s Total Dental Access (TDA) project in 1994, which sought to increase patient access to quality and cost-effective oral health care. Since its introduction, teledentistry has been used as a supplement to address access to oral health care, including application in remote, rural, and underserved communities.

What began as a means for dental professionals to communicate with one another regarding patient care has now provided patient care visits with a dental provider in real-time, regardless of geographic location. While increasing access to care has always been on the forefront of telehealth, COVID-19 exacerbated disparities in how patients access health care, and particularly oral health providers. According to data collected in 2018 by the Minnesota Department of Health, Minnesota had a total of 124 Dental Health Professional Shortage Areas (HPSAs). Teledentistry has the capability to increase patient accessibility to care during the COVID-19 pandemic without having to risk exposure or cancelling a dentist visit. Using teledentistry to reduce geographic variabilities between patients and providers as well as reducing delays to accessing specialty care has shown to be a promising solution to oral health care provision in areas of dental professional shortages.

Although telehealth shows valuable potential to improve health outcomes by reducing health inequities and providing greater access to timely and cost-effective care, telehealth in each of its platforms does not come without barriers. Technology use is a
key barrier to wide acceptance of telehealth.\textsuperscript{2,13} The Unified Theory of Acceptance and Use of Technology (UTAUT) model explains variance of technology acceptance and intentions to use technology through four constructs, which can be applied to health care providers and patients alike.\textsuperscript{18–20} Little research has been conducted surrounding patient intentions to use telehealth services in dentistry. Therefore, understanding perceptions of telehealth and teledentistry framed within the UTAUT model requires further investigation and is feasible to do at a local and national scale. For this reason, this study will focus on an adult population at the 2021 Minnesota State Fair and online using ResearchMatch at a national level. Applied to telehealth, the UTAUT reveals end-user (i.e. patient, provider) variance in technology acceptance and explains intentions to use by integrating human behavior theory methods.\textsuperscript{18} For teledentistry to have a maximum effect on the oral health of adults, these perceptions must be considered moving forward. To achieve this, the first step is to identify telehealth and teledentistry usage amongst United States adults and examine their individual experiences using each construct to determine behavioral intent to use teledentistry in the future.

Purpose of the Study

The purpose of this study is to investigate the behavioral intent of United States adults to use telehealth services and explore an association with the UTAUT constructs of performance expectancy, effort expectancy, social influence, and facilitating conditions.

Statement of the Problem

Ideally, a health care system is one that is organized in a way to ensure timely access to cost-effective, quality care to all its citizens. However, access to oral health care remains a problem for many Americans. Telehealth offers a potential solution for many
people who face economic, physical, and geographic barriers to obtaining oral health care. However, for telehealth to be successful and sustainable, its users must believe in its efficacy. Issues with the technology interfaces, sound and audio limitations, and complexity have been cited as technological concerns that patients have experienced, and this list is not comprehensive. Therefore, understanding patient perceptions, both prior to and after the first experiences with telehealth and teledentistry is essential to identifying and addressing barriers to employing telehealth services.

Significance of the Study

Telehealth has made significant contributions to health service advancements, changing health care delivery for the better, enhancing communication between patients and providers, and expanding care to previously unassisted populations. The results of this study will inform the medical and dental communities of patient perceptions surrounding telehealth and teledentistry use as well as the intent of U.S. adults to use teledentistry services in the future. Associations between teledentistry use and the UTAUT constructs of performance expectancy, effort expectancy, social influence, and facilitating conditions will be identified. These findings will aid in discovering potential barriers hindering the uptake of teledentistry and provide patient perspectives necessary for addressing these barriers and proposing solutions. Teledentistry ultimately has the ability to improve access to oral health care and influence the adoption of innovative health promotion and education programs.

Research Questions

1. What is the behavioral intent of United States adults to use teledentistry services?
2. What is the association between behavioral intent of United States adults and the Unified Theory of Acceptance and Use of Technology constructs of performance expectancy, effort expectancy, social influence, and facilitating conditions?

Hypotheses

H10: There is no association between United States adults’ behavioral intent to use teledentistry services and the UTAUT construct of performance expectancy with age, gender, and education level as modifying factors.

H20: There is no association between United States adults’ behavioral intent to use teledentistry services and the UTAUT construct of effort expectancy with age, gender, and education level as modifying factors.

H30: There is no association between United States adults’ behavioral intent to use teledentistry services and the UTAUT construct of social influence with age, gender, and education level as modifying factors.

H40: There is no association between United States adults’ behavioral intent to use teledentistry services and the UTAUT construct of facilitating conditions with age, gender, and education level as modifying factors.
REVIEW OF THE LITERATURE

A systematic review of literature relevant to the patient perceptions of telehealth was conducted in PubMed, OVID, and Google Scholar databases. Key search terms were “telehealth”, “telemedicine”, and “teledentistry” in combination with “patient perception” or “patient perceptions”. Searches conducted in March 2022 yielded 308 results. The following items were excluded: duplications, inaccessible online, not printed in English, and editorial letters in response to published studies. Original articles and literature reviews with publication dates between 2000 and 2022 were included, as were reviews of the histories of telehealth, telemedicine, and teledentistry. As interest in telehealth continues to grow, the parameters for inclusion for this study were broad, which allowed for a collection of scholarly articles related to telehealth and its subspecialties.

Physical distance between patients and providers, access to equipment, and information transmission have been cited as barriers to health care access dating back centuries.7 Perhaps the first achievement in addressing access to care barriers came with the invention of the printing press in 1451, which allowed health care providers to circulate health information to the public as a whole.7 Since then, advancements in technology and communication since then have contributed to the transmission of a broad amount of health care information at an exponentially increasing rate.7 The COVID-19 pandemic renewed an interest in telehealth as a means to manage chronic and acute diseases, communicable or noncommunicable alike.24 By providing triage and provisional care services in a convenient and accessible manner, telehealth has the opportunity to minimize exposure risks of communicable diseases, such as COVID-19, typically associated with a traditional hospital or clinic waiting room setting.24 The
demand for a safe alternative to care in the midst of a global pandemic cast a spotlight on the different services offered by telehealth.

As technology evolves, so have the methods in which telehealth services are delivered. Currently, there are four accepted telehealth platforms being used: synchronous, asynchronous, remote patient monitoring (RPM) and mobile health (mHealth). Synchronous telehealth involves live, two-way video conferencing between a patient and their provider. Use of a speaker or microphone system along with the visual component allows each participant to verbally clarify, physically point to, and comment on different points, which enhances discussion and personal contact compared to other telehealth platforms. Alternatively, synchronous telehealth can also be carried out through use of a telephone, where the involved parties communicate through verbal conversation; however, this form of telehealth is suboptimal for care where visual evaluation is necessary.

Asynchronous, commonly referred to as “store and forward”, involves data collection for a patient by the patient themselves or another provider, which is then saved as a file and securely sent electronically for review by a consultant. Data includes digital files of still images, text, audio, video, or a combination of these file types. The consultant is typically a general physician, dentist, or specialist who reviews the file content and makes recommendations, which are then returned in the same manner in which they were received. While this interaction typically occurs between two or more health care providers, the increasing quality of cameras and video-recording devices allows patients to directly forward digital files containing images, video, audio, or text to
their providers.\textsuperscript{27} This system still provides for a wide range of applications and is often just as effective as case presentation in a real-time setting.\textsuperscript{25}

Remote patient monitoring (RPM) is a subunit of asynchronous telehealth that allows digital transmission of physiologic data between a patient and medical staff in order to monitor and diagnose certain health conditions.\textsuperscript{28} This platform has been adopted for use in managing and treating neurological, cardiovascular, and respiratory conditions, weight management, substance abuse, and sleep disorders, such as Obstructive Sleep Apnea.\textsuperscript{8,21} While the medical field has established RPM systems, RPM has gained popularity within the field of dentistry in recent years, particularly in regard to the “Do-It-Yourself” orthodontics.\textsuperscript{29}

Mobile health (mHealth) is a vastly expanding subunit of asynchronous telehealth that involves the use of services supported by mobile communication devices including cellular smartphones, tablets, personal digital assistants, and wireless patient monitoring devices.\textsuperscript{2} Current health care applications on mobile devices provide patient education, direct provision of care, real-time monitoring, transmission of patient information to providers, and community health care data collection.\textsuperscript{2} While hundreds of applications are now available, one example of mHealth use in dentistry is the Bluetooth-enabled toothbrush, which can be synched to each manufacturer’s respective mobile app and delivered to the patient’s dentist.\textsuperscript{30}

With the continued enhancement of technology, each platform has made adaptations to fit within telemedicine and teledentistry. This response has included the use of two-way video-based programs, use of email to transmit health information, devices to monitor patients outside of a clinic or hospital, and the constant introduction of
health-based mobile applications. While telehealth has opened the door of opportunity for patients in need of health care, understanding benefits, barriers, and implications for use is essential for the successful uptake of telehealth.\textsuperscript{1,31–33}

A relatively small body of literature currently exists that is concerned with patient perceptions and intentions to use telehealth, with even less literature surrounding teledentistry. Technology acceptance of telehealth has been measured amongst current and future health care providers in several studies to date. Results from these studies are optimistic that telehealth utilization will have positive impacts on patient health.\textsuperscript{10,34–37} Exploring perceptions and intentions of United States adults to use teledentistry may be one of the first steps necessary to fill areas of need and distribution of resources. This information will be helpful to overcome some, if not all, of these barriers for its development and utilization.

Government and Regulatory Policy

A potential obstacle that successful telehealth uptake faces and that cannot be overlooked requires governmental or regulatory intervention.\textsuperscript{2,4,13,14} Change in governmental and regulatory policy, which includes addressing a lack of reimbursement from third-party payors, is necessary to break through another barrier to telehealth uptake.\textsuperscript{2,4,13} The gap in coverage for telehealth services impedes the uptake of telehealth by limiting which providers are willing to utilize telehealth services, ultimately affecting both patients and providers.\textsuperscript{2,4,13,14} While reimbursement from third-party payers for services provided via telehealth is attainable, legislation is required to make adjustments to the scope of who can provide services and from where; unfortunately, this is further complicated when Medicaid and Medicare are involved.\textsuperscript{2,4,13,14} Insufficient financial
reimbursement has been a result of absent or inconsistent health policies.\textsuperscript{4,13,14} Providers have recognized this, as described by Al-Khalifa et al.\textsuperscript{35}, where over 60\% of practitioners agreed that teledentistry should be covered by dental insurance plans.

In terms of policy implementation, telehealth within the United States health care system has historically been slow to find compatibility with each other.\textsuperscript{4,14} This has led to complications with interstate medical licensure and hospital credentialing. National policies have a direct impact on the use of telehealth by sanctioning regulatory authorities to recommend telehealth use to health care workers.\textsuperscript{2,14} In order to combat these issues, research has identified the following solutions: adequate funding and reimbursement, authenticating telehealth within the health care systems, careful infrastructure planning and development, revising telecommunication, licensure, credentialing regulations when necessary, and implementing policies that improve public health.\textsuperscript{4,13,14}

Provider Perceptions of Telehealth Benefits

Previous research on the topic of telehealth has identified several benefits that telehealth offers as well as barriers to successful uptake from both provider and patient perspectives. Telehealth involves at least two end-users (i.e. a patient and their health care provider) and requires that parties involved accept the system.\textsuperscript{38}

Improvement of access to care. Several positive perceptions of telehealth have been identified by health care providers. Of the perceived benefits to patients, studies of telemedicine and teledentistry consistently reported that 65-75\% of providers believed that telehealth increased access to care, especially in rural populations.\textsuperscript{35,39,40} Delivery of psychiatric and cancer care through telehealth studies have found that nearly all of the providers using the platforms agreed that it increased patient access to care while saving
time and travel for the patient.\textsuperscript{41,42} Studies have shown that 70-80\% of providers have also perceived telehealth to improve practice by enhancing communication between colleagues, continuing education and guidance, and referral systems.\textsuperscript{35,40}

**Improvement of patient health outcomes.** Telehealth has shown to be effective regarding managing and treating a range of medical conditions, improving patient health outcomes. A 2019 study by Friedman et al.\textsuperscript{43} concluded that on average, patients undergoing care for migraines using synchronous telemedicine showed greater improvements in migraine disability scores and the number of headache days in a twelve-month span compared to patients treated in-person; comparably, synchronous telehealth has demonstrated success in past studies examining conditions such as diabetes mellitus, peritoneal dialysis, osteoarthritis, chronic obstructive pulmonary disease (COPD), and congestive heart failure (CHF).\textsuperscript{5,32,33,44} Similarly, Fitzsimmons et al.\textsuperscript{28} found that use of an RPM telehealth system contributed to COPD patients receiving 50\% fewer home visits from a clinician compared to patients who received traditional care.

**Provider Perceptions of Telehealth Barriers**

Providers have also perceived disadvantages to using telehealth services, despite its benefits. The inability to complete a comprehensive examination and lack of clinical presentation is a significant limitation in disciplines such as dentistry and dermatology, where diagnostic and treatment procedures must be completed in a clinic setting. Many studies in the literature have cited this limitation as a serious disadvantage of telehealth utilization.\textsuperscript{13,14,36,42,45} Absence of face-to-face presentation has also been cited as a concern where comforting patients is an essential component of the job, such as in cancer care. Heyer et al.\textsuperscript{42} uncovered provider-reported concerns that telehealth limited the
ability to comfort patients with cancer in a virtual setting. Conversely, changes in the patient-provider relationship were inversely correlated in one study focusing on surgical consultations delivered using synchronous video or telephone-based telehealth. Wiadji et al.\textsuperscript{46} found that a significant number of providers did not feel as though the same quality of care could be delivered using telehealth compared to in-person treatment.

**Lack of telehealth education.** For proper telehealth usage, education of both patients and health care providers needs to be considered.\textsuperscript{14,47} A variety of studies and reviews have identified that inadequate knowledge of telehealth and teledentistry software capabilities may be hindering its function in health care.\textsuperscript{4,14,35,48–50} Collins et al.\textsuperscript{36} surveyed 36 general physicians delivering care via teledermatology. Provider lack of confidence was identified by 28% of respondents, leading to issues surrounding the quality of health information and delivery which has also been supported by subsequent articles.\textsuperscript{4,13,36} A lack of provider knowledge or resistance to learning new skills surrounding telehealth delivery has been cited in past studies. Conversely, it has been noted that extensive education on telehealth systems and applications has increased provider confidence and reduced reports of complexity.\textsuperscript{45,50,51} A 2020 study conducted by Weintraub et al.\textsuperscript{52} discovered that the knowledge North Carolina dental hygienists had of teledentistry increased from 38.1% to 92.9% following a statewide teledentistry summit in 2018.\textsuperscript{4,13} Another component of telehealth education is ensuring that students in health professional programs are educated about telehealth systems and exposed to utilizing it as part of the curriculum.\textsuperscript{4,24} Telehealth courses have slowly been integrated into health education curriculums across the country, including dental and dental hygiene programs. Cooper & Engeswick\textsuperscript{51} surveyed dental hygiene students’ knowledge, attitudes, and
confidence levels prior to and upon completion of a teledentistry course; results from this pilot study and others found that knowledge, attitudes, and confidence levels were positively changed as a result of their increased knowledge of teledentistry effectiveness.\textsuperscript{53,54} These findings have found relevance within other teledentistry studies and can be applied to other health professional programs.\textsuperscript{13,45,55} With the sudden expansion of telehealth services due to COVID-19, providers will need to continue expanding their knowledge of what telehealth is, the benefits it can provide to patients, and applications for use, including utilization as a solution for infectious disease prevention and transmission.\textsuperscript{4,55}

Patient Perceptions of Telehealth Benefits

During the past two decades, a variety of studies have sought to identify and explain evidence of the perceived benefits of telehealth from a patient perspective. In order to elicit the highest level of responses, several studies took a qualitative or mixed methods approach using qualitative and quantitative measures.\textsuperscript{1,5,6,9,16,22,28,33,44} These studies measured several aspects of telehealth from the patient perspective, including telehealth as a component of treatment, the role of telehealth in disease management, effect on access to care, convenience factors, and comparisons to in-person care.

**Telehealth as component of treatment.** Patient perceptions of RPM have been evaluated when used as part of treatment for other medical conditions such as heart disease, although benefits of such devices are congruent with findings from studies evaluating other methods of telehealth.\textsuperscript{21,44} Research surrounding patient perceptions has clearly shown an increase in disease awareness, management, and improvements resulting from the use of telehealth technologies.\textsuperscript{5,21,28,32,33,43,44,56} Andrews et al.\textsuperscript{5} found that regardless
of changes in hemoglobin A1c (HbA1C), most patients with persistent poorly-controlled diabetes mellitus (PPDM) reported an increase in blood glucose awareness as a result of using a telemonitoring system. Similarly, the RPM device used for Fitzsimmons et al. demonstrated an increased awareness in blood pressure and oximetry for all study participants with COPD. Further, Laframboise et al. found that patients with CHF using an RPM device experienced increased awareness of body weight, which in turn led to motivation to improve self-management of CHF.

**Telehealth in disease management.** Patients have also perceived telehealth to be effective in managing health conditions. Whitten and Mickus conducted a study using both video conferencing technology as well as an RPM device for treatment of COPD and CHF, and found 68% of participants believed telehealth services improved the management of their disease. These findings have been supported by a number of studies in which telehealth has been used to help treat diabetes, where it has been noted that improvements in HbA1c correlated with patient reports of increased confidence in self-managing and understanding diabetes mellitus as a result of using telehealth technology. This also coincides with three patients who used an RPM device for CHF and credited that the device “literally saved their lives or significantly diminished the potentially negative outcomes of heart failure” for management of the disease. Furthermore, patients using one of the recognized telehealth platforms noted that having access to a device any time of the day gave them a sense of autonomy to the point where they felt they were no longer burdening their families, while allowing caregivers to more closely monitor them in regard to managing chronic health conditions. Finally, improvements in health outcomes as a result of using telehealth services have been cited in the literature.
Magnus et al.\textsuperscript{32} compared patient perceptions of health outcomes between baseline and follow up and reported significant improvements for treatment of end stage renal disease (ESRD) using RPM technology. Furthermore, Lawford et al.\textsuperscript{33} expanded patient perceptions to knee osteoarthritis and found that patients treated with telephone-delivered therapy perceived greater increases in muscle strength, which in turn improved knee pain and physical capabilities.

**Effect of telehealth on access to care.** The effect telehealth has on improving access to care has not gone unnoticed by patients.\textsuperscript{6,59} Using an RPM device for PPDM, Andrews et al.\textsuperscript{5} discovered that patients credited the device to increased access to diabetes care and supplies. While not all RPM devices allow for around-the-clock access to a health care professional, the convenience of monitoring devices is extended by the technology when data is sent electronically to the patient’s care team, who reviews the data and can make adjustments to treatment as needed.\textsuperscript{5,28} Similar results have been found with synchronous telehealth visits, as a 2007 study found 79\% of COPD and CHF patients reported that telehealth increased access to care and a second study conducted in 2013 found 95\% of patients undergoing treatment of dysphagia reported their telehealth consultations increased access to health care.\textsuperscript{22,44} This body of research indicates there is use for telehealth beyond the pandemic and can be useful for non-ambulatory patients as well.\textsuperscript{22,33,44} The use of a telephone to participate in telehealth services is particularly useful in treating underserved populations. Telephone-based care is versatile and can be used for synchronous and asynchronous telehealth. In particular, telephone-based care can be used to provide access to telehealth services for patients of low socioeconomic
status, with inability to access other forms of technology, or for those lacking technical proficiency required for other telehealth platforms.\textsuperscript{5,6,13,32,33}

Patients have also utilized telehealth to access specialty care. For example, a shortage of neurologists in the United States has been identified within the last ten years; when a patient experiences a neurological medical emergency such as a stroke, time is of the essence to ensure the highest chances of survival.\textsuperscript{60} Research has shown that stroke telemedicine consultations allow patients to receive specialty care in areas where needed expertise is not readily available.\textsuperscript{9,60} Patient perceptions of increased access to specialty care have been comparable to studies of knee osteoarthritis treatment, migraine management, preoperative anesthesia procedures, post-operative head and neck surgery, and dentistry.\textsuperscript{6,10,16,33,43} These patients reported telehealth as being beneficial for improving access to specialty care for themselves and particularly for those in remote locations or non-ambulatory. As a direct result of increased access to a health care provider, patients in two studies expressed that travel times were decreased, therefore saving resources and money.\textsuperscript{6,16} As evidence of the impact telehealth has on access to care continues to grow, monitoring patient recognition of such impacts will be pivotal to telehealth development.

Telehealth also has a significant capability to improve access to care, especially in health professional shortage areas (HPSAs).\textsuperscript{6,9,59,60} This was especially apparent during the COVID-19 global pandemic. Telehealth has enabled patients to experience accessibility to care during the pandemic without having to risk exposure or cancelling a doctor visit.\textsuperscript{16} This is significant, as there has not been a global pandemic to this magnitude since the introduction of modern approaches to telehealth.\textsuperscript{10,31} HPSA’s do not
exclusively impact rural areas, and improvements in access to care have been reported by patients in metropolitan areas as well, further demonstrating the versatility of telehealth.\textsuperscript{53,56}

While the previously mentioned benefits of telehealth apply to use during the pandemic, the sudden change in health care delivery has not been welcomed by all. Many patients who would not necessarily choose to see their provider in a virtual manner have now been forced to use technology in a way that may be foreign to them.\textsuperscript{31} Holtz\textsuperscript{31} reported that 39.2\% of adults had used telehealth after the onset of COVID-19 and generally responded with preference to see a provider in-person for subsequent visits, which supports the 2017 findings of Powell et al.\textsuperscript{1} that telehealth may be more beneficial if patients use it with an established primary care provider.

**Patient perceptions of telehealth platforms.** Although no single study has attempted to examine patient perceptions of telehealth using all four platforms to date, patients generally report a positive response to telehealth interventions regardless of what platform was offered, suggesting that one platform is not necessarily superior to another. Future studies should be conducted that observe comparisons between platforms, particularly in the field of dentistry where very limited research has been conducted.

Another serious limitation of the evidence is the primary use of self-reported data, contributing to a source of bias. It has been mentioned that health care surveys typically elicit positive results, even when confidentiality and anonymity are maintained.\textsuperscript{16} Future research should take this into consideration with the understanding that the nature of the subject of patient perceptions relies on self-reported data.
Patient-reported benefits on convenience. Telehealth can be accessed virtually anywhere there is an internet or phone connection available. While taking this into consideration, it is no surprise that the convenience of using telehealth to meet health needs has been identified as a benefit by patients. Telehealth convenience has also been traced to reducing costs to the patient, whether it comes in the form of saving money on transportation, parking costs, loss of wages from missed work, or a combination of these factors.\textsuperscript{1,16,46} Ease of use of the telehealth technology is often coupled with convenience. Laframboise et al.\textsuperscript{21} measured ease of use of the RPM for monitoring heart failure and found that participants unanimously determined that the device was “not intimidating or time-consuming”. These results coincide with findings from other studies, drawing the conclusion that adaptability and simplicity of the systems contributed to higher rates of compliance, therefore improving health outcomes.\textsuperscript{6,28,44,56}

Telehealth vs. in-person care. In addition to its numerous benefits, telehealth shows promise as an alternative or supplement to traditional in-person care. Several studies compared the delivery of health care using telehealth with in-person or home visit therapies and found that telehealth-supported care is at least comparable to in-person care, with some participants reporting superior care.\textsuperscript{28,43,44,60–62} Findings from two studies support the idea that when incorporated with primary care, telehealth has the capability to further enhance the benefits of convenience, comfort, and privacy which ultimately contributes to improved efficiency by allowing patients timely access to their typical sources of care.\textsuperscript{1,60} Comparisons between telehealth and in-office visits have also revealed surprising findings. Friedman et al.\textsuperscript{43} cited 92.7\% of patients who used telemedicine for management of migraines completed the number of visits required in the
randomized controlled trial compared to 87% of patients who had in-office visits, which in turn attributed to improved health outcomes.

Those who have used telehealth have also recognized the importance of utilizing these services during the COVID-19 pandemic. Participants from several studies have reported that telehealth is a positive addition to the provision of health care.\textsuperscript{46,56,63} In fact, in the case of surgical consultations, Wiadji et al.\textsuperscript{46} found that 75% of participants perceived the care received via asynchronous telehealth was to the same level as face-to-face encounters, with 41% reporting that telehealth visits would be preferred over face-to-face visits in the future. This has been mirrored by other studies, where patients have expressed a desire to participate in future telehealth appointments, in addition to in-person visits when necessary.\textsuperscript{56,63}

Patient Perceptions of Telehealth Barriers

While telehealth has several reported benefits, there are barriers to its successful uptake that must be addressed. Research studies and reviews have suggested that technology acceptance and lack of education are potential reasons for hindered telehealth adoption by both patients and health care providers.\textsuperscript{5,14,21,31,59} Patient-reported barriers include difficulties using technology for consultations and perceived changes in the patient and provider relationship.\textsuperscript{1,5,6,16,21,31,32,43,59,60} Research suggests that the barriers patients perceive can be managed and overcome with sufficient training and effective communication from both the patient and the provider.\textsuperscript{4,13,14,21} Identifying and acknowledging a comprehensive list of patient and provider-reported barriers will increase the chance for successful adoption of telehealth services across the health care sector, including dentistry.
Technology acceptance. While use of technology is an essential component of telehealth, it also has the potential to create a barrier when technological difficulties arise. Issues surrounding technology are amongst the highest reported barriers to telehealth acceptance by patients. Research investigating the patient perceptions of use of telehealth technology report that problems with connectivity, complexity, and visual and audio components were the most common responses of patients, regardless of which telehealth platform was used.5,21,31,59,64 Not only do users need some form of hardware (i.e. a computer, cellphone, or tablet) that is compatible with the telehealth software, but also adequate internet and mobile connectivity.14,64 Studies that identified technological challenges found that a small percentage of patients who experienced such challenges were less likely to be satisfied with the telehealth consultation, seek future care using telehealth, or adhere to use of an existing telehealth program.5,33,37,59

Lack of user acceptance continues to be one of the most critical barriers to telehealth implementation and growth; therefore, significant training and planning for patients and providers must be executed for health programs wishing to incorporate telehealth into practice.21 Fitzsimmons et al.28 confirmed this by finding when telehealth programs were planned and implemented with care, technology was not thought of as a potential hindrance to telehealth expansion.28

A correlation has been found between patients’ inability to adapt the telehealth interface into daily routines and a reported lack of willingness to engage with the interface.5,21 This barrier is most commonly reported by telephone and RPM users.5,21,58 Despite these issues with the use of technology for telehealth delivery expressed by patients, the technology alone did not deter patients from continuing with the telehealth
interface or intent to use telehealth in the future.\cite{21,58,59} Alternatively, Andrews et al.\cite{5} conducted a study using a telephone-based RPM system in which 27\% of patients reported that they would not be willing to use the same telehealth interface to report blood glucose. However, they were open to using a different interface or the same interface with a significant modification of the system.\cite{5} These reported findings highlight the value of end-user feedback for improving telehealth systems. Results of other studies using qualitative data have shown that end-users have generally viewed telehealth favorably, but technical issues continue to influence individual experiences.\cite{57,58,62}

Particularly amongst older adults, preferences for technology must be taken into consideration. Findings from several studies indicate that most, if not all, older adults are willing to use any of the telehealth platforms, but this population prefers to use familiar technology or devices already in the home, such as a computer, smartphone, or tablet.\cite{58} The need for access to support should a technical issue arise was identified in numerous studies exploring older adults’ perceptions of telehealth technology, regardless of the condition being treated.\cite{57,58} This further demonstrates that technology acceptance is a variable with psychological and emotional implications, especially for older adults.

Changes in patient-provider relationship. Concern surrounding the change in patient-provider relationships is a perceived barrier by patients receiving care through telehealth. Patients report missing the “physical touch” component to traditional care and are concerned a doctor will not be able to make a full diagnosis based on quality of photo, video, or information provided, particularly for synchronous and asynchronous platforms.\cite{1,16,31,63} This correlated with the findings of two studies using telephone services, where patients reported a lack of visual contact being a concern.\cite{6,33} In a
qualitative study conducted by Granberg et al.\textsuperscript{63} some patients felt as though the physician was “less thorough” and “more rushed” when conducting synchronous video visits to provide oncology care. It is worth noting that while the change in patient-provider dynamic was a concern of patients in several studies, this had little effect on the intentions to use telehealth for future health care needs.\textsuperscript{5,16,33,60,63} With the remote delivery of health information, coupling empathy and support is key to maximizing uptake of telehealth.\textsuperscript{21,60}

Patient Satisfaction

Despite reported barriers, patient satisfaction rates remained consistently high in studies that aimed to quantify patients who would use telehealth services again.\textsuperscript{1,9,10,16,22,36,46,65} While the definitions of end-user satisfaction have differed between studies, substantial personal benefit, high-quality care, quality patient-provider interactions, and quality of the technology used have been commonly cited as a basis for satisfaction.\textsuperscript{9,62} Studies that used either synchronous or asynchronous methods conveyed that patients reported high satisfaction rates and an openness to use telehealth again, depending on the situation.\textsuperscript{1,16,22,44,46,62} Conversely, Robinson et al.\textsuperscript{9} used technical quality as a measure of patient satisfaction and found 90\% of study participants reported no technical problems at all while using a synchronous telehealth system. Several studies report similar findings that patients were satisfied with using either a synchronous video visit or a telephone consultation and claim they would use telehealth again, particularly in light of COVID-19.\textsuperscript{10,46,56}

Patient perceptions of provider empathy. Studies have highlighted the counterintuitive nature of patients who reported high levels of empathy received by their providers, even
while separated by physical distance.\(^5,28,32,33\) What is perhaps more surprising is that these high levels of perceived empathy and support were reported by patients who either used the telephone or RPM devices, where there was no visual contact made.\(^5,28,32,33\) Cheshire et al.\(^60\) found that use of technology to deliver health care did not interfere with patient perceptions of empathy expressed by their physician while Morland et al.\(^61\) reported that older veterans preferred receiving care for post-traumatic stress disorder (PTSD) through telehealth services compared to office-based delivery. These findings broke through common misconceptions that telehealth providers lack empathy and elderly patients would not show interest in using services via telehealth and disproved both hypotheses of the respective studies.\(^60,61\) This suggests that patients and providers can be removed from the traditional in-office setting and still achieve desirable interpersonal communication. However, Sharma et al.\(^22\) made it a point that patient concerns revolving around telehealth assessments or consultations should be addressed prior to the appointment by the provider, especially if a patient will be using telehealth for the first time in order to obtain higher patient satisfaction.

Implications for Use in Dentistry

While telehealth is a practical option for management and treatment of a wide range of medical concerns across health care, a proportion of patients remain who may be unwilling to seek telehealth services or have a condition that telehealth may not be useful for.\(^22\) This argument has particularly been used in the case of dental care, which relies heavily on both visual and tactile assessment.\(^10,66\) With the exception of the reported findings of Rahman et al.,\(^10\) positive attitudes toward teledentistry are consistent in the literature. However, studies that used quantitative data alone were less likely to find
statistically significant results and found less positive perceptions of telehealth.\textsuperscript{31,59–61,67} Nevertheless, teledentistry has the capability to be used between dentists and patients for risk assessment, triage services, and remote management for dental care delivery as well as between dentists and specialists for treatment planning purposes.\textsuperscript{10,68} Additionally, teledentistry has been evaluated for effectiveness in caries detection, detection of enamel erosion in patients with eating disorders, radiographic interpretation of jaw pathologies, post-operative maxillofacial surgery, cleft lip and palate management, and geriatric prosthodontic emergencies; however, perceptions of services rendered were not reported in these studies.\textsuperscript{69–76} These practical implications indicate that teledentistry can be used in everyday treatment, emergency care, and in conjunction with mobile dental programs.

Studies revealing end-user perceptions in general dentistry, orthodontic treatment, and dental public health demonstrate a high percentage of favorable responses to the use of teledentistry.\textsuperscript{53,77–80} According to an important cross-sectional survey conducted by a study team in London, dentists and dental students expressed higher confidence and competence following a synchronous consultation and found the platform to be helpful and easy to use while over 70% of patients reported that the technology ran smoothly and use of the system was convenient, with about 80% ultimately reporting that they would recommend use of the synchronous consultation.\textsuperscript{80} While this study shows acceptance by both patients and dental providers and that teledentistry may be a valid option to providing oral care across five different areas of dentistry, it is one of the only studies of its kind.

Future research should be expanded to exploring end-user perceptions of telehealth services used in dentistry, where there are known dental HPSAs around the
United States tracked by state health departments. In Minnesota alone, 62.1% of counties were designated as either partial or full-country dental workforce shortage areas, according to 2018 data.\textsuperscript{15} Using teledentistry to reduce geographic variabilities between patients and providers as well as reducing delays to accessing specialty care has shown to be a promising solution to oral health care provision in areas of dental professional shortages.\textsuperscript{13,17} It should be noted that HPSAs are not specific to rural areas and apply to urban and suburban populations, further demonstrating the relevance of teledentistry as shortages of dentists are identified across the United States.\textsuperscript{17,45} Furthermore, perceptions of teledentistry utilization research should be investigated in all specialties and those using any telehealth platform.

Theoretical Framework

The rapid advancement of information technology impacts numerous industries, including health care. Development of such technology is a critical piece to improving the quality of health care including enhancements in communication, efficiency, and patient safety.\textsuperscript{19} While significant uptake of telehealth services has occurred in medicine and other fields of health care, it has been noted that acceptance and adoption of teledentistry services has been considerably slow in the United States, even when compared to other countries.\textsuperscript{20} In the wake of the COVID-19 pandemic, awareness of all telehealth services, including teledentistry, dramatically increased when many elective procedures such as nonemergent dental care were put on hold. However, other challenges in the uptake of these services, particularly within dentistry, still exist and have been noted. From a technological standpoint, patients may face challenges accessing the required technology needed for teledentistry and may have financial concerns, especially
with a potential lack of reimbursement from third-party payors.\textsuperscript{81} Perhaps an even greater barrier is an overall lack of awareness of teledentistry, its benefits, and how it can be applied to standard practice.\textsuperscript{34} Successful adoption of telehealth requires that both providers and patients accept the technology used for providing this type of care regardless of the platform used. Identifying patient perceptions and intentions to use telehealth services is part of an important first step to address any barriers that may hinder its adoption.

In 2003, Venkatesh\textsuperscript{82} presented the Unified Theory of Acceptance and Use of Technology (UTAUT), an extension of the Technology Acceptance Model (TAM). UTAUT is an integrative method using a combination of eight theories, including human behavior theory, to explain variance of technology acceptance and intentions to use technology.\textsuperscript{18–20} This model has been broadly used to measure the adoption of information technology and findings can be applied to both providers and patients.\textsuperscript{18–20} According to the UTAUT, four factors influence intentions to use telehealth include: performance expectancy (PE), effort expectancy (EE), social influence (SI), and facilitating conditions (FC).\textsuperscript{18–20} The UTAUT posits that moderating factors such as age, gender, experience with technology, and degree of voluntarily adopting the technology can influence the four constructs of the model to varying extents.\textsuperscript{83} Several studies have used the UTAUT model in the health care context to successfully predict provider acceptance of technology, but a relatively small number of studies have applied this model to the acceptance of and behavioral intent to use teledentistry. However, three systematic reviews of the literature conclude that the UTAUT model can successfully predict both patient and provider perceptions and intent to use telehealth services.\textsuperscript{38,83,84}
According to Khatun et al.,\textsuperscript{18} “low-usage rate, resistance, and abandonment of use of new technology occurs when end-user reactions are not thoroughly considered” (2017). Therefore, this study explores patient perceptions surrounding telehealth, including telemedicine and teledentistry, and ultimately the intent of patients to use teledentistry within the context of the UTAUT.
SECTION 3
Introduction and Literature Review

Telehealth is the communication between a provider and a patient or patient’s caregiver through use of one or more technological platforms to provide patient-centered care. This technology has played an increasing role in health care delivery since the mid-20th century.\textsuperscript{1,3} While its roots are in medicine and radiology, telehealth is an umbrella term that also includes services provided in diverse specialties of health care such as nursing, pharmacology, dentistry, and others.\textsuperscript{1} When COVID-19 reached pandemic status, health care systems were challenged on a global level and were forced to re-evaluate practices and create innovative solutions for providing care.\textsuperscript{4,11,16,55} This triggered an unprecedented expansion of telehealth services across the health care sector, including the growth of services provided through telemedicine and teledentistry.\textsuperscript{4,11,16,55} Telehealth delivery has evolved as technology has advanced, with four platforms currently recognized: synchronous, asynchronous, remote patient monitoring (RPM), and mobile health (mHealth).

While telehealth shows valuable potential to improve health outcomes by reducing health inequities and providing greater access to timely and cost-effective care, it does not come without barriers, regardless of the platform used.\textsuperscript{5,11,21,22} Technology use is a key barrier to wide acceptance of telehealth.\textsuperscript{2,13} Issues with the technology interfaces, sound and audio limitations, and complexity have been cited as technological concerns that patients have experienced.\textsuperscript{5,21} For telehealth to be successful and sustainable, its users must believe in its efficacy.\textsuperscript{5} While technology acceptance of telehealth has been
measured amongst current and future health care providers in several studies to date, a relatively small body of literature exists that is concerned with patient perceptions and intentions to use telehealth, with even less literature surrounding teledentistry. Therefore, understanding patient perceptions, both prior to and after the first experiences with teledentistry is essential to identify any additional barriers to employing effective services.

The Unified Theory of Acceptance and Use of Technology (UTAUT) model explains variance of technology acceptance and behavioral intent (BI) to use technology through four constructs: performance expectancy (PE), effort expectancy (EE), social influence (SI), and facilitating conditions (FC). The UTAUT posits that moderating factors such as age, gender, experience with technology, and degree of voluntarily adopting the technology can influence the four constructs of the model to varying extents and can be applied to both health care providers and patients. Applied to teledentistry, the UTAUT reveals end-user (i.e. patient or provider) variance in technology acceptance and explains intentions to use by integrating human behavior theory methods.

Several benefits of telehealth have been identified by the literature from a provider and patient perspective, including improvements in access to care, improvements in health outcomes, and convenience. Specifically, teledentistry has the capability to be used between dentists and patients for risk assessment, triage services, and remote management for dental care delivery as well as between dentists and specialists for treatment planning purposes. These practical
implications indicate that teledentistry can be used in everyday treatment, emergency care, and in conjunction with mobile dental programs.

For telehealth to have a maximum effect on the health of adults, these perceptions must be considered moving forward. To achieve this, the first step is to identify telehealth and teledentistry usage amongst United States adults and explore individual experiences and perceptions using each construct to determine intentions to use teledentistry in the future. Teledentistry ultimately has the ability to improve access to oral health care and influence the adoption of innovative health promotion and education programs. The results of this study will inform the medical and dental communities of patient perceptions surrounding telehealth and teledentistry use as well as the intent of U.S. adults to use teledentistry services in the future. These findings will aid in discovering potential barriers hindering the uptake of teledentistry and provide patient perspectives necessary for addressing these barriers and proposing solutions.

Methods and Materials

This mixed-methods, cross-sectional study was conducted via electronic survey and approved by the University of Minnesota Institutional Review Board (STUDY00012797).

Sample. Participants were recruited from a convenience sample of 484 2021 Minnesota State Fair adult attendees, locally and 416 participants from ResearchMatch, nationally. The sample size was derived from a power analysis using Cohen’s $F^2$ with an effect size calculated at 80% power. Participants were eligible for inclusion if they met the following criteria: 18 years of age or older at the time of survey completion, able to provide consent, and able to complete the survey in English. Exclusion criteria include
under 18 years of age at the time of survey completion and those incapable of providing consent.

Data was collected online, beginning August 2021 for participants recruited through the university-approved ResearchMatch tool and during three six-hour research sessions in the Driven to Discover (D2D) building at the Minnesota State Fair in August 2021. Participants from each sample self-identified.

ResearchMatch Participation. U.S. adult participants were initially contacted through ResearchMatch by a member of the research team and had to first respond with interest in participation before informed consent and data collection procedures begun. In order to obtain informed consent through ResearchMatch, participants were provided a document to view electronically, which outlined the study purpose, procedures, eligibility, and participant rights. Once participants read inclusion criteria and were deemed eligible, a signature was obtained in REDCap for each participant to ensure consent. Electronic survey distribution and data collection was accomplished using REDCap, a secure, university-approved platform. A link to the electronic survey was sent to participants, which was estimated to take 5-10 minutes to complete. ResearchMatch participants had the option to enter an incentive drawing for one of three $50 internet gift cards as a token of appreciation for participation and to maximize response rates. Patient identification information was stored separately from survey data in the university-approved Box secure storage system, which uses duo-authentication to ensure anonymity and confidentiality. The link to the electronic survey was closed on September 30th, 2021 at 11:59pm for ResearchMatch participants.
Driven to Discover (D2D) Participation. Electronic survey administration also occurred in-person at the 2021 Minnesota State Fair at the Driven to Discover (D2D) research facility. Study team members were trained and calibrated to administer the survey prior to each D2D session. Recruitment took place outside the D2D building by a member of the research team. Study eligibility criteria was written on a large chalkboard at the D2D booth. After participants self-identified, participants were provided an iPad containing the study overview document. Informed consent was obtained, and participants were required to provide a signature in REDCap before gaining access to the electronic survey. The survey took approximately 5-10 minutes to complete. State Fair participants were given a backpack including a toothbrush, toothpaste, and floss as a token of appreciation for participation and to maximize response rates. The link to the electronic survey was closed at the conclusion of the third D2D session for State Fair participants.

Variables and operational definitions. The dependent variable tested was the behavioral intent (BI) of participants to utilize teledentistry technology. The independent variables included performance expectancy (PE), effort expectancy (EE), social influence (SI), and facilitating conditions (FC). For each of the 17 UTAUT items, an ordinal 5-point Likert scale ranging from “strongly disagree” = 1 to “strongly agree” = 5 was used. Moderating factors included age in years, gender, and education level.

The following operational definitions were used to define the constructs: PE is the degree to which a participant believes that using the teledentistry system will help the individual attain gains in job performance; EE is the degree to which a participant believes that ease is associated with use of a teledentistry system; SI is the degree to
which a participant perceives that others (e.g., physician, dentist, specialist) believe he/she should use the teledentistry system; FC is the degree to which a participant believes that the organizational and technical infrastructures exist to support using a teledentistry system; BI is the degree to which a participant intends to use a teledentistry system; and teledentistry was defined as the use of telecommunication devices (e.g., video calls on a cell phone or computer) to facilitate dental exams and services when the patient is in one location and the dentist is in another location.1,18

Instrument. Exploring end-user perceptions of technology use and acceptance, particularly in the delivery of health care, has historically been demonstrated through UTAUT-based survey methods and can easily be applied to the technology involved in teledentistry.18–20,87–90 For this reason, it was considered appropriate to use a survey design for this study. A survey was adapted to measure each construct of the UTAUT, including perceptions of performance and effort expectancies, social influences, and facilitating conditions regarding telehealth and teledentistry.

The first nine survey items were newly constructed in addition to the UTAUT-based items to measure participant knowledge and experience of telehealth and teledentistry. The survey was piloted among a representative sample of 10 participants, including two University of Minnesota School of Dentistry faculty members and several individuals who are representative of the population of interest. The pilot test was performed for face validity and modifications were made where necessary, before finalizing the survey for dissemination.

Internal reliability for the original instrument showed acceptable levels of internal consistency using Cronbach’s alpha and construct composite reliability.18 Convergent and
discriminant validity were also at acceptable levels and tested using average variance extracted (AVE) and cross-loading matrix and square root of all AVEs, respectively. To ensure the validity of this survey, all items were adopted with minimum adaptation from the original instrument. To reduce selection bias, UTAUT survey items were modified to use future tense verbiage which maximized the eligibility of potential participants. Modifications to the UTAUT construct items were made to reflect the methodology of the UTAUT questionnaire as suggested by Khatun et al. (2017) and to address telehealth and teledentistry as a whole, rather than on any specific telehealth platform(s).

The final instrument included 33 items. The first three items asked participants about their dental experience in the past year, reason for not visiting a dentist, and how many miles the participant travels to see a dentist. A definition of telehealth was provided to participants, followed by four items, which asked the familiarity with telehealth and teledentistry. A definition of teledentistry was provided and whether the participant utilized these services in the past twelve months was asked next. If the participant had used teledentistry services in the last twelve months, there were two additional follow-up questions: the first asking whether participants would use the services again and the second asking participants to rate their experience graded on a 5-point Likert scale, with Strongly Negative=1 to Strongly Positive=5. The survey then proceeded to the UTAUT items, with 14 items addressing the four constructs in relation to teledentistry: four items asking about predicted perceptions of performance expectancy (PE), three items for effort expectancy (EE), three items for social influence (SI), and four items for facilitating conditions (FC). The dependent variable was then determined from the three items asking about predicted behavioral intent to use teledentistry, which followed the construct items.
For each of the 17 UTAUT items, possible answers were based on a 5-point Likert scale, ranging from “strongly disagree” = 1 to “strongly agree” = 5. Following the UTAUT items, two questions asked the patient to identify perceived benefits and barriers of using teledentistry, using forced-choice responses as well as an opportunity for open-response if “Other” was selected.

Four demographic items included were: age in years, gender, education level, and zip code. One qualitative question at the end of the survey prompted participants to “provide any comments regarding your experience and/or concerns in using any form of telehealth or teledentistry for the delivery of your health care.” An optional incentive for a gift card drawing was available immediately upon survey submission for ResearchMatch participants. Names and email addresses were collected and stored separately from survey responses, if the participant chose to enter the drawing.

Data Analysis

All data were collected through REDCap, with analyses and data management conducted using R version 4.1.1. All analyses were conducted with both descriptive and inferential analysis for each sample independently and totaled. Descriptive data were summarized using counts and proportions for categorical variables and means and standard deviations for continuous variables. To address the primary aim of the study, outcome measures of participant behavior intention (BI) to use teledentistry services were compared to each of the four UTAUT constructs of performance expectancy (PE), effort expectancy (EE), social influence (SI), and facilitating conditions (FC) using univariate analysis. The relationships between the behavioral intention outcome and the UTAUT construct scores for PE, EE, SI, and FC were examined using multiple linear regression,
which also controlled for modifying factors. Missing values were imputed, when possible, to validate findings. Results were summarized using standardized regression coefficients with 95% confidence intervals. A two-sided p-value less than 0.05 were regarded as statistically significant.

The inclusion of qualitative data was used to explore participant opinions, questions, and perceptions of telehealth and teledentistry. Using the UTAUT as a framework, two members of the research team calibrated and independently coded qualitative data obtained from items 27-29 of the survey as representative of one of the UTAUT constructs: PE, EE, SI, FC, or BI. Once a construct code was assigned to each comment, the comment was further divided by whether it was perceived as “positive” or “negative”. Comments that did not fit into the UTAUT constructs but that expressed concerns with scope of practice or general questions were coded as “Lack of Knowledge”. Comments were initially assigned a primary and secondary code but were further reviewed based on the definitions provided by the UTAUT until a consensus was reached for only a primary code to be used in data analysis.

Results

In the D2D population, 484 participants were invited and completed the survey (100%). Of those contacted through ResearchMatch, a total of 14,994 potential volunteers were invited to participate, and 432 (2.9%) completed the survey. Following data cleaning, 483 D2D participants and 416 (98.1%) ResearchMatch responses were used for analysis. Table 1 shows participant demographics, separated by each sample individually and for the total sample.
The mean age of the D2D sample was 49.1 years (SD 17.9). Similarly, the mean age of the ResearchMatch sample was 47.2 (SD 17.5). The majority of participants identified as female in both samples, with 64.4% in the D2D sample and 77.9% in the ResearchMatch sample. The highest completed level of education was also similar between the two samples, with the majority of participants responding, “college degree or technical school graduation”. The second highest frequency for sample participants was “advanced or doctorate degree”, with 25.7% and 38.7%, respectively. Zip codes of all participants were mapped to indicate residence by state and county (Figures 1 and 2). All but six states were represented in the U.S. between the two samples, with the majority of participants residing in Minnesota. Further analysis of Minnesotan participants was mapped by county, with the majority of respondents residing within the seven-county Twin Cities metropolitan area (Figure 3).

The frequencies of the UTAUT item responses from the survey instrument are expressed in Table 2. Within the four UTAUT construct items for PE, EE, SI, and FC, similar response trends were noted between the two samples. In general, the least frequent responses were found in the “strongly disagree” category of each item. A large percentage of “neutral” responses were also noted for nearly all items between the two samples and were approximately within a 5-10% range in similarity between the two samples. The SI construct items showed the greatest distribution between responses in both samples and where there were significantly fewer “strongly agree” responses compared to other construct survey items. The number of participants in each sample who did not choose a response for each of the UTAUT items was between 0.0% and 2.3%, and therefore not included in Table 2.
The three items measuring participant BI showed similar outcomes in the percentages of “neutral” responses compared to the four construct item responses. However, the fewest number of participants in each sample responded “Strongly Agree” on intending, predicting, and planning to use teledentistry in the next six months. The ResearchMatch sample showed a significant difference in the “Strongly Disagree” response compared to the D2D sample responses for the same category in all three BI items.

The behavioral intent of participants to use teledentistry in the next six months differed between the two samples (Table 2). The majority of D2D participants responded to the three BI items with “neutral” (36.2%-40.4%), while a majority of ResearchMatch participants responded to these items with “strongly disagree” (37.7%-38.2%).

Univariate analysis found that each UTAUT construct was statistically significant (<0.0001) with the dependent variable, BI (Table 3).

Multiple regression correcting for age, gender, and highest level of education was conducted for each of the two samples independently and for the total sample (Table 4). There were statistically significant differences found between BI and both PE and SI using the multivariate regression model for all samples.

As the survey instrument was altered for this study, Cronbach’s alpha was calculated to measure internal consistency for each construct, or how closely items are related as a group (Table 5). Alpha values greater than 0.70 were considered to be acceptable levels supporting the internal consistency of the survey instrument. PE was found to be good (0.9>α≥0.8) in all three analyses, EE was excellent (α≥0.9) for the D2D sample and good in the RM and totaled samples, SI was good in all three analyses, FC
was acceptable \((0.8 > \alpha \geq 0.7)\) in the D2D sample, but questionable \((0.7 > \alpha \geq 0.6)\) in the RM and pooled samples, and BI was excellent in all three analyses.

**Hypotheses testing.** Coefficients and \(P\) values were used to test the association between the dependent and independent variables using multiple regression to correct for the modifying effects (Table 4). The results indicate that the relationships between PE and BI \((0.39, P < 0.0001)\) as well as SI and BI \((0.42, P < 0.0001)\) were significant in the combined sample. Therefore, H1o and H3o were rejected. However, the relationship between EE and BI \((-0.06, P = 0.1611)\) as well as FC and BI \((-0.01, P = 0.8131)\) were not found to be statistically significant, therefore H2o and H4o failed to be rejected.

**Qualitative data**

Thematic analyses of all comments from both samples were used to add depth to the research question of, “What is the association between behavioral intent of United States adults and the Unified Theory of Acceptance and Use of Technology constructs of performance expectancy, effort expectancy, social influence, and facilitating conditions?” Item 29 on the survey asked participants an open-ended question: “Provide any comments regarding your experience and/or concerns in using any form of telehealth or teledentistry for the delivery of your health care.” Items 27 and 28 included forced-choice responses, but participants also had the option of choosing “Other” and describing responses to “What benefits do you believe teledentistry services provide?” and “What reason(s) impact why you might not use teledentistry services?”, respectively.

In the D2D sample, 59 participants provided a total of 76 responses to the open-response questions: 6 participants responded to two of the three questions, and 3 participants provided answers to all three questions. In the RM sample, 137 participants
provided a total of 205 responses: 32 of the participants provided responses to two of the questions and 3 participants provided responses to all three questions. Six main themes were identified using the UTAUT constructs as an initial framework: Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Behavioral Intent, and Lack of Knowledge. Responses outside this framework were given new codes based on commonalities of like responses. Figure 1 provides representative quotes for each identified theme.

**Performance Expectancy.** Of the UTAUT constructs, performance expectancy was found to be the most prominent theme. Responses demonstrated how participants believed that the use of a teledentistry service could assist in consultations and communication with a dentist. Subthemes of PE included positive and negative responses. Several participants recognized the role teledentistry plays in consultations and providing triage services. Representative quotes include, “teledentistry would be helpful for consultation of future care” and “triage prior to visit or to determine if a visit is necessary” (Table 6). Conversely, several responses were concerned with missed dental findings and not as effective as in person associated with teledentistry use.

**Effort Expectancy.** Participants also provided comments with the degree to which they believed a teledentistry system is associated with ease of use. Subthemes of positive and negative comments also emerged. Convenience of using teledentistry was a common trend amongst those who commented on EE. Representative quotes included, “Making appointments and/or talking about procedures” and “I don’t have to leave my home usually” (Table 6). Participants with hearing impairments expressed similar perceptions
of previous telehealth visits being “difficult to understand the conversation” from a technology platform standpoint.

Social Influence. Of the four UTAUT constructs, comments surrounding social influence, or the perceptions of participants that providers such as physicians, dentists, and specialists believe that a teledentistry system should be used were the least commonly reported. Positive comments related to the SI subtheme primarily involved teledentistry being particularly useful for “those in assisted living and long-term care” (Table 6). One participant discussed how teledentistry could be beneficial as a caretaker in getting “my sister appropriate and necessary health care – which I am responsible for – and it is a major effort…and getting harder for me and her”. Negative comments related to this subtheme included, “my dentist already provides me the care I need” and is “already easily accessible” as justification for not using teledentistry.

Facilitating Conditions. Organizational and technical infrastructure, necessary for any teledentistry platform to exist and sustain, did not go unnoticed. Comments ranged from “there are possibilities that the internet might be down, incompatible, signal interruption, slow speed, etc.” to “not understanding the process” (Table 6). Despite this feedback, there were also participants who recognized the potential of teledentistry in underserved populations: “I believe it could be a low barrier opportunity for rural communities if the resources and infrastructure is in place.”

Behavioral Intent. Several comments emerged where participants expressed their intentions to use teledentistry in the future. The majority of participants who expressed interest in using teledentistry demonstrated enthusiasm with the idea of using any platform. Representative comments included, “I would use teledentistry if my dentist
offered it”, “I cannot imagine how teledentistry works, but I’m interested and will give it a try” (Table 6). Several participants also commented that cost and insurance coverage would impact their decision to use teledentistry for future care. There were also those who responded with negative behavioral intent: “I don’t see myself using teledentistry ever”, and “I go to the dentist twice a year. I would never use teledentistry”.

Lack of Knowledge. An overall lack of knowledge surrounding the scope of teledentistry played a significant role in respondents’ perceptions of and intentions to use teledentistry in the future. It was revealed that most of these comments were grounded on the basis that participants associated dentistry with treatment, such as dental prophylaxis and restorative procedures. Examples of quotes included, “I don’t think teledentistry has any advantage for teeth cleaning, filling cavities, or anything else”, “I just need my teeth cleaned, and that’s not an option virtually”, and “I only go to the dentist if something is wrong and I need a crown or filling” were all common responses demonstrating this association (Table 6). Additionally, several responses also expressed uncertainty about whether teledentistry programs are currently operating, or if their dental providers were offering any teledentistry services. “Don’t know of any dental televisits at this time”, “Not sure my dentist provides this service”.

In summary, the majority of open-ended comments fell within the existing UTAUT framework. The additional theme outside the framework was a general lack of knowledge regarding teledentistry. The qualitative comments reinforced the quantitative findings in that lack of knowledge appeared to coincide with the high proportion of UTAUT items where participants were neutral. While the qualitative data was minimal, the information gathered corroborated with the quantitative results.
Discussion

To the authors’ knowledge, this study is the first to report U.S. adults’ perceptions of teledentistry technology and behavioral intentions to utilize teledentistry. The results of this study indicate that performance expectancy (PE) and social influence (SI) were statistically significantly associated with the behavioral intent (BI) to use teledentistry within the next six months. Using a coinciding triangulation strategy verified the findings that the intention to utilize teledentistry is associated with the theoretical constructs postulated by the UTAUT. Perceived benefits and barriers, a general lack of knowledge surrounding the scope of teledentistry and access to care were also revealed.

This study found that between the two samples, participants heavily responded to the three UTAUT BI items (I intend to use…, I predict I will use…, I plan to use…teledentistry in the next 6 months) with “strongly disagree”, “disagree”, or “neutral”. This was not surprising with the general lack of knowledge identified within the comments provided by the open-ended questions. Other explanations for these findings could be that participants were not excluded based on inexperience with teledentistry or possibly the limitation of a six-month time frame in which teledentistry would be used.

The results of this study found varying results compared to other quantitative survey studies used to explore patient perceptions and intentions to use telehealth and teledentistry.\textsuperscript{10,22} Sharma et al.\textsuperscript{22} used a pre- and post- survey approach for patients who underwent dysphasia assessment and synchronous telerehabilitation and found that reported perceptions of future telehealth use increased from 80-85\% at the pre-assessment to 92-98\% at the time of the post-assessment. Findings from a teledentistry
survey conducted by Rahman et al.\textsuperscript{10} revealed that 96% of participants who had used either a virtual clinic or telephone clinic visit in the U.K. would use teledentistry services again in the future. While this study and the present study measured intentions to use teledentistry in the future, a key difference between the two studies is that Rahman et al.\textsuperscript{10} measured participant perceptions following a teledentistry encounter with a provider, which produced a much greater positive response than what the present study found. It should also be noted that this study, like the present study, was conducted during the COVID-19 pandemic, which may have increased interest as many elective procedures were postponed, those with childcare responsibilities had to work remotely, and the concern for disease transmission kept many in self-isolation.\textsuperscript{10}

Mixed methods and qualitative surveys have also provided insight into participant perceptions of and intentions to use telehealth.\textsuperscript{1,16} The findings of Triantafillou et al. supported the present study: while approximately half of the 56 patients who had used synchronous telemedicine visits for otolaryngology surgery consults offered insights of future use of telemedicine, this potential use did not come without concerns. Participants identified that telehealth could be beneficial for triage and communication with providers, but expressed concern with the appropriateness of telehealth and unsure about the effectiveness of telehealth for a new patient visit, which aligned with the qualitative data provided by the current study.\textsuperscript{16} Surprisingly, oral surgery patients who used synchronous teledentistry for consultations reported high satisfaction rates with being able to fully discuss and express their concerns (95.1%).\textsuperscript{93} Despite the 43.5% rate of these patients experiencing technical difficulties during the consultation, 93.5% reported that they would use a video consultation again.\textsuperscript{93} While these results have not yet been commonly
reported in teledentistry research, one explanation for this is the application of teledentistry in consultation services, where in-person examination is not necessarily required. In the present study, a large number of qualitative responses associated dentistry with hands-on procedures (e.g. fillings, crowns, dental cleanings) where teledentistry was not seen to have value. However, a small number of qualitative comments did highlight the use of telehealth and teledentistry for consultation purposes, which is supported by Crummey et al.¹⁹

There were statistically significant differences found between BI and both PE and SI using the multivariate regression model for all samples using age, gender, and education level as modifying factors. This finding varies slightly from other UTAUT-based survey research.¹⁸,²⁰ Khatun et al. found that PE, EE, and SI did not have a significant effect on BI, yet FC did for participants in Australia who had used a cloud-based mHealth service for primary care.¹⁸ Participants in this study were included if they had used the mHealth service in the last 28 days and were 18 years or older, whereas participants in the present study did not need any previous teledentistry usage in order to participate. Interestingly, Khatun et al. found a disproportionate rate of male compared to female participants, which was credited as being a limited evaluation of gender effects on BI, while this study found a larger proportion of female participants than male.¹⁸

Alabdullah et al. discovered that PE and EE were the strongest predictors of BI, but SI and FC also showed to be positive significant predictors of dental students’ BI to use teledentistry.²⁶ Alabdullah et al. also used a cross-sectional electronic survey, which specifically targeted 4th-year dental school students in the U.S. to explore their intentions to use teledentistry after completing dental school.²⁰ Moreover, the dental students who
participated were not required to have previous clinical experience with teledentistry, which like the current study, may have allowed for a more diverse collection of responses. Alabdullah et al. did not explore moderating effects of age, gender, or experience on BI, and used a convenience sample of future clinicians rather than patients, which differs from the current study.

Despite differences in which of the UTAUT constructs effect BI found in the literature, BI has been a good representation of actual behavior. Technology use and acceptance will continue to be at the forefront of telehealth and teledentistry utilization and sustainability. Synchronous visits require patients to have the knowledge and ability to access the internet, operate and troubleshoot audiovisual components, and communicated effectively without being prompted. While older adults have experienced technology-related issues due to disabilities or inexperience in previous telehealth research, it has also been noted that the more telehealth technology was utilized, the more positive perceptions the patients had of it, which could be applied to any age group.\textsuperscript{26,58} The findings of this study support this ideology and as it relates to the UTAUT, as a relatively wide age range was represented in each sample.

Although the UTAUT items in this study were slightly modified from a previously validated instrument created by Khatun et al.,\textsuperscript{18} the same constructs were used. When comparing Cronbach’s alpha values, this study found all constructs except FC met acceptable levels of internal validity. One difference to note between this study and Khatun et al. is the sample, which was taken from one sample with a total of 167 participants. Furthermore, the survey items in the Khatun et al. study used past tense verbiage to measure an existing telehealth platform that the participants had already used,
where this study was written with future tense verbiage and was purposefully kept broad to allow participants the opportunity to include perceptions and utilization of any teledentistry platform, whether synchronous or asynchronous.

While face-to-face visits will never be fully replaced in dentistry, teledentistry offers a unique opportunity to patients who may be unable or unwilling to see a dentist or other health care provider in a traditional setting. Whether these inabilities or unwillingness stem from issues surrounding limited access to care or COVID-19, health care should never be neglected, and telehealth provides a viable alternative for patients to receive quality care and can be achieved by any teledentistry platform.

Limitations

Several limitations should be considered in the discussion of the results from this study. Selection bias was identified as a potential threat to internal validity, as both samples used were convenience samples. Further replication of this study at the national level using randomization could increase generalizability of findings to a larger population. Current sample sizes of nearly all research surrounding teledentistry are relatively small. Although this can be a potential limitation, sample size also corresponds with the fact that telehealth and teledentistry have been used globally to target small, rural, underserved communities in order to address access to health care. For this study, the use of the two sample groups in addition to not having a representative sample from all 50 states limits the generalizability to a larger population of United States adults. As evidence continues to emerge, results coming from a diverse population and across teledentistry platforms will hopefully shed light on closing gaps in access to care.
The potential for an increased threat to external validity through reactivity is common in survey research, and particularly in self-reported health care research, where participants tend to respond positively.\textsuperscript{10,16,31,63,94} While the survey instrument used was found to have acceptable construct validity, it was adapted from an existing instrument and has not been validated. Therefore, results should be viewed accordingly. The UTAUT model was not originally developed in a health care context, but was used in this study and others to help explain end-user acceptance and utilization of telehealth platforms, including teledentistry.\textsuperscript{18–20}

This study provides new directions for further investigation into the relationship between the Unified Theory of Acceptance and Use of Technology constructs and the intention of U.S. adults to use teledentistry services in the future. Since PE and SI were the strongest predictors of a participant’s intention to use teledentistry in the future, this data can be used to further develop teledentistry platforms. With the lack of knowledge identified in this study population, educational initiatives could be developed to enhance the general public’s knowledge.

Conclusion

This study found a strong association between the Unified Theory of Acceptance and Use of Technology’s (UTAUT) constructs of performance expectancy (PE) and social influence (SI) with end-user behavioral intent (BI) to utilize teledentistry services amongst both individual and total samples. Qualitative analysis using the UTAUT constructs corroborated the associations resulting from quantitative analysis, as well as revealed a general lack of knowledge regarding the scope of teledentistry and access to care through teledentistry services. Application of these results suggest intervention
designs that build on the constructs of PE and SI for developing educational or marketing strategies for teledentistry.
SECTION 4
### TABLES

Table I: Demographic characteristics of participants from State Fair (D2D) and ResearchMatch (RM) samples

<table>
<thead>
<tr>
<th>Variables</th>
<th>State Fair/D2D Participants (n=483)</th>
<th>ResearchMatch Participants (n=416)</th>
<th>Total Sample (n=899)</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>mean (SD)</td>
<td>mean (SD)</td>
<td>mean (SD)</td>
</tr>
<tr>
<td></td>
<td>no. (%)</td>
<td>no. (%)</td>
<td>no. (%)</td>
</tr>
<tr>
<td><strong>Age (in years)</strong></td>
<td>49.1 (17.9)</td>
<td>47.2 (17.5)</td>
<td>48.2 (17.8)</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>163 (33.7)</td>
<td>80 (19.2)</td>
<td>243 (27.0)</td>
</tr>
<tr>
<td>Female</td>
<td>311 (64.4)</td>
<td>324 (77.9)</td>
<td>635 (70.6)</td>
</tr>
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<td>2 (0.5)</td>
<td>4 (0.4)</td>
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<tr>
<td><strong>Education Level</strong></td>
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</tr>
<tr>
<td>Less than high school/GED</td>
<td>9 (1.9)</td>
<td>2 (0.5)</td>
<td>11 (1.2)</td>
</tr>
<tr>
<td>High school diploma/GED</td>
<td>59 (12.2)</td>
<td>23 (5.5)</td>
<td>82 (9.1)</td>
</tr>
<tr>
<td>Some college or technical school</td>
<td>77 (15.9)</td>
<td>52 (12.5)</td>
<td>129 (14.3)</td>
</tr>
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<td>College degree or technical school graduation</td>
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<td>178 (42.8)</td>
<td>390 (43.4)</td>
</tr>
<tr>
<td>Advanced or doctorate degree</td>
<td>124 (25.7)</td>
<td>161 (38.7)</td>
<td>285 (31.7)</td>
</tr>
<tr>
<td>UTAUT Constructs and Items</td>
<td>D2D</td>
<td>RM</td>
<td>TOTAL</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------------------------</td>
<td>---------</td>
<td>--------</td>
<td>--------</td>
</tr>
<tr>
<td></td>
<td>no (%)</td>
<td>no (%)</td>
<td>no (%)</td>
</tr>
<tr>
<td><strong>PE</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>I would find teledentistry useful for consulting with a dentist</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strongly Disagree</td>
<td>9 (1.9)</td>
<td>40 (9.6)</td>
<td>49 (5.5)</td>
</tr>
<tr>
<td>Disagree</td>
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<td>84 (20.2)</td>
<td>133 (14.8)</td>
</tr>
<tr>
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<td>100 (24.0)</td>
<td>240 (26.7)</td>
</tr>
<tr>
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<td>225 (46.6)</td>
<td>144 (34.6)</td>
<td>369 (41.0)</td>
</tr>
<tr>
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<td>58 (12.0)</td>
<td>47 (11.3)</td>
<td>105 (11.7)</td>
</tr>
<tr>
<td>Using teledentistry will allow me to have faster communication with a dentist</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>7 (1.4)</td>
<td>15 (3.6)</td>
<td>22 (2.4)</td>
</tr>
<tr>
<td>Disagree</td>
<td>25 (5.2)</td>
<td>43 (10.3)</td>
<td>68 (7.6)</td>
</tr>
<tr>
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<td>68 (16.3)</td>
<td>158 (17.6)</td>
</tr>
<tr>
<td>Agree</td>
<td>273 (56.5)</td>
<td>218 (52.4)</td>
<td>491 (54.6)</td>
</tr>
<tr>
<td>Strongly Agree</td>
<td>82 (17.0)</td>
<td>68 (16.3)</td>
<td>150 (16.7)</td>
</tr>
<tr>
<td>Using teledentistry will improve communication with a dentist</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strongly Disagree</td>
<td>11 (2.3)</td>
<td>22 (5.3)</td>
<td>33 (3.7)</td>
</tr>
<tr>
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<td>39 (8.1)</td>
<td>74 (17.8)</td>
<td>113 (12.6)</td>
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<td>120 (24.8)</td>
<td>115 (27.6)</td>
<td>235 (26.1)</td>
</tr>
<tr>
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<td>245 (50.7)</td>
<td>160 (38.5)</td>
<td>405 (45.1)</td>
</tr>
<tr>
<td>Strongly Agree</td>
<td>66 (13.7)</td>
<td>43 (10.3)</td>
<td>109 (12.1)</td>
</tr>
<tr>
<td>If I use teledentistry, it will make it easier for me to communicate with a dentist</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>11 (2.3)</td>
<td>21 (5.0)</td>
<td>32 (3.6)</td>
</tr>
<tr>
<td>Disagree</td>
<td>40 (8.3)</td>
<td>68 (16.3)</td>
<td>108 (12.0)</td>
</tr>
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<td>101 (24.3)</td>
<td>199 (22.1)</td>
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</tr>
<tr>
<td><strong>EE</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>If I use teledentistry, the technology used would be clear and understandable for me</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Strongly Disagree</td>
<td>6 (1.2)</td>
<td>11 (2.6)</td>
<td>17 (1.9)</td>
</tr>
<tr>
<td>Disagree</td>
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<td>32 (7.7)</td>
<td>61 (6.8)</td>
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<td>250 (27.8)</td>
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<td>192 (46.2)</td>
<td>436 (48.5)</td>
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<td>57 (11.8)</td>
<td>75 (18.0)</td>
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<td>It would be easy for me to become skillful at using teledentistry</td>
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<td></td>
</tr>
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<td>Strongly Disagree</td>
<td>9 (1.9)</td>
<td>8 (1.9)</td>
<td>17 (1.9)</td>
</tr>
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<td>188 (45.2)</td>
<td>424 (47.2)</td>
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<td>78 (18.8)</td>
<td>144 (16.0)</td>
</tr>
<tr>
<td>I would find teledentistry easy to use</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Strongly Disagree</td>
<td>10 (2.1)</td>
<td>8 (1.9)</td>
<td>18 (2.0)</td>
</tr>
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<td>Disagree</td>
<td>32 (6.6)</td>
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<td>67 (7.5)</td>
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<td>264 (29.4)</td>
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<td>183 (44.0)</td>
<td>399 (44.4)</td>
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<td>67 (13.9)</td>
<td>76 (18.3)</td>
<td>143 (15.9)</td>
</tr>
<tr>
<td>SI</td>
<td>People who influence my behavior would think that I should use teledentistry</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
</tr>
<tr>
<td>----</td>
<td>--------------------------------------------------------------------------</td>
<td>-----------------</td>
<td>---------</td>
</tr>
<tr>
<td></td>
<td>Strongly Disagree</td>
<td>16 (3.3)</td>
<td>76 (15.7)</td>
</tr>
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<td>Disagree</td>
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<td>Agree</td>
<td>50 (10.2)</td>
<td>103 (24.8)</td>
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<tr>
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<td>Strongly Agree</td>
<td>15 (3.1)</td>
<td>49 (10.1)</td>
</tr>
<tr>
<td></td>
<td>I have the resources necessary to use teledentistry (internet connection, computer/tablet/smartphone, family support)</td>
<td></td>
<td></td>
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<tr>
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<td>8 (1.7)</td>
<td>16 (3.3)</td>
</tr>
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<td>49 (10.1)</td>
<td>158 (32.7)</td>
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<td></td>
<td>Agree</td>
<td>50 (10.2)</td>
<td>103 (24.8)</td>
</tr>
<tr>
<td></td>
<td>Strongly Agree</td>
<td>15 (3.1)</td>
<td>49 (10.1)</td>
</tr>
<tr>
<td></td>
<td>I think teledentistry fits well with my lifestyle</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Strongly Disagree</td>
<td>15 (3.1)</td>
<td>49 (10.1)</td>
</tr>
<tr>
<td></td>
<td>Disagree</td>
<td>49 (10.1)</td>
<td>158 (32.7)</td>
</tr>
<tr>
<td></td>
<td>Neutral</td>
<td>50 (10.2)</td>
<td>103 (24.8)</td>
</tr>
<tr>
<td></td>
<td>Agree</td>
<td>50 (10.2)</td>
<td>103 (24.8)</td>
</tr>
<tr>
<td></td>
<td>Strongly Agree</td>
<td>15 (3.1)</td>
<td>49 (10.1)</td>
</tr>
<tr>
<td></td>
<td>A specific person (or group) is available for help if I experience teledentistry difficulties</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Strongly Disagree</td>
<td>10 (2.1)</td>
<td>47 (9.7)</td>
</tr>
<tr>
<td></td>
<td>Disagree</td>
<td>15 (3.1)</td>
<td>49 (10.1)</td>
</tr>
<tr>
<td></td>
<td>Neutral</td>
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<td>158 (32.7)</td>
</tr>
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<td></td>
<td>Agree</td>
<td>50 (10.2)</td>
<td>103 (24.8)</td>
</tr>
<tr>
<td></td>
<td>Strongly Agree</td>
<td>10 (2.1)</td>
<td>47 (9.7)</td>
</tr>
<tr>
<td></td>
<td>BI I intend to use teledentistry in the next 6 months</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Strongly Disagree</td>
<td>83 (17.2)</td>
<td>155 (32.1)</td>
</tr>
<tr>
<td></td>
<td>Disagree</td>
<td>158 (38.0)</td>
<td>123 (26.9)</td>
</tr>
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<td>123 (26.9)</td>
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<td></td>
<td>Agree</td>
<td>158 (38.0)</td>
<td>123 (26.9)</td>
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<tr>
<td></td>
<td>Strongly Agree</td>
<td>158 (38.0)</td>
<td>123 (26.9)</td>
</tr>
<tr>
<td></td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Neutral</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-------------------</td>
<td>----------</td>
<td>---------</td>
</tr>
<tr>
<td>I predict I will use teledentistry in the next 6 months</td>
<td>85 (17.6)</td>
<td>151 (31.3)</td>
<td>175 (36.2)</td>
</tr>
<tr>
<td>I plan to use teledentistry in the next 6 months</td>
<td>92 (19.0)</td>
<td>150 (31.1)</td>
<td>179 (37.1)</td>
</tr>
<tr>
<td></td>
<td>157 (37.7)</td>
<td>121 (29.1)</td>
<td>99 (23.8)</td>
</tr>
<tr>
<td></td>
<td>159 (38.2)</td>
<td>119 (28.6)</td>
<td>99 (23.8)</td>
</tr>
<tr>
<td></td>
<td>242 (26.9)</td>
<td>272 (30.3)</td>
<td>274 (30.5)</td>
</tr>
<tr>
<td></td>
<td>251 (27.9)</td>
<td>269 (29.9)</td>
<td>278 (30.9)</td>
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</table>
Table III: Univariate analysis of UTAUT constructs (PE, EE, SI, FC) with BI for D2D and RM samples

<table>
<thead>
<tr>
<th>UTAUT Construct</th>
<th>D2D Sample</th>
<th>RM Sample</th>
<th>Total Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient (CI)</td>
<td>p-value</td>
<td>Coefficient (CI)</td>
</tr>
<tr>
<td>PE</td>
<td>0.55 (0.45, 0.65)</td>
<td>&lt;0.0001</td>
<td>0.66 (0.58, 0.74)</td>
</tr>
<tr>
<td>EE</td>
<td>0.36 (0.25, 0.46)</td>
<td>&lt;0.0001</td>
<td>0.34 (0.23, 0.45)</td>
</tr>
<tr>
<td>SI</td>
<td>0.57 (0.47, 0.67)</td>
<td>&lt;0.0001</td>
<td>0.69 (0.60, 0.78)</td>
</tr>
<tr>
<td>FC</td>
<td>0.39 (0.27, 0.50)</td>
<td>&lt;0.0001</td>
<td>0.61 (0.46, 0.75)</td>
</tr>
</tbody>
</table>
Table IV: Multiple regression analysis of UTAUT constructs (PE, EE, SI, FC) with BI for D2D and RM samples

<table>
<thead>
<tr>
<th>UTAUT Construct</th>
<th>D2D Sample</th>
<th>RM Sample</th>
<th>Total Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient (CI)</td>
<td>p-value</td>
<td>Coefficient (CI)</td>
</tr>
<tr>
<td>PE</td>
<td>0.55 (0.45, 0.65)</td>
<td>&lt;0.0001</td>
<td>0.41 (0.29, 0.53)</td>
</tr>
<tr>
<td>EE</td>
<td>0.36 (0.25, 0.46)</td>
<td>0.7918</td>
<td>-0.07 (-0.18, 0.05)</td>
</tr>
<tr>
<td>SI</td>
<td>0.57 (0.47, 0.67)</td>
<td>&lt;0.0001</td>
<td>0.39 (0.27, 0.52)</td>
</tr>
<tr>
<td>FC</td>
<td>0.39 (0.27, 0.50)</td>
<td>0.7352</td>
<td>0.05 (-0.11, 0.21)</td>
</tr>
</tbody>
</table>
### Table V: Cronbach’s alpha for UTAUT construct items (PE, EE, SI, FC, BI) by sample

<table>
<thead>
<tr>
<th>UTAUT Construct</th>
<th>D2D Sample</th>
<th>RM Sample</th>
<th>Total Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>PE</td>
<td>0.89</td>
<td>0.88</td>
<td>0.89</td>
</tr>
<tr>
<td>EE</td>
<td>0.90</td>
<td>0.87</td>
<td>0.89</td>
</tr>
<tr>
<td>SI</td>
<td>0.84</td>
<td>0.86</td>
<td>0.86</td>
</tr>
<tr>
<td>FC</td>
<td>0.78</td>
<td>0.57</td>
<td>0.67</td>
</tr>
<tr>
<td>BI</td>
<td>0.97</td>
<td>0.98</td>
<td>0.98</td>
</tr>
<tr>
<td>Themes</td>
<td>Sub Themes</td>
<td>Quotes</td>
<td></td>
</tr>
<tr>
<td>--------------------</td>
<td>----------------------</td>
<td>----------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Performance</td>
<td>Positive Responses</td>
<td>“Teledentistry would be helpful for consultation of future care.”</td>
<td></td>
</tr>
<tr>
<td>Expectancy</td>
<td></td>
<td>“[…] saves traveling and time for simple follow-up care”</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Negative Responses</td>
<td>“[…] Inability to do full exam meant less worth.”</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>“[…] not as beneficial as in person.”</td>
<td></td>
</tr>
<tr>
<td>Effort</td>
<td>Positive Responses</td>
<td>“[…] makes appointments a million times easier”</td>
<td></td>
</tr>
<tr>
<td>Expectancy</td>
<td></td>
<td>“…”</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Negative Responses</td>
<td>“[…] It was often difficult to understand the conversation.”</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>“[…] more indirect and difficult way to get the proper needed care.”</td>
<td></td>
</tr>
<tr>
<td>Social</td>
<td>Positive Responses</td>
<td>“[…] more people should use”</td>
<td></td>
</tr>
<tr>
<td>Influence</td>
<td></td>
<td>“[…] beneficial for those in assisted living and long-term care.”</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Negative Responses</td>
<td>“Not sure my dentist provides this service.”</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>“My dentist is easily available to my family.”</td>
<td></td>
</tr>
<tr>
<td>Facilitating</td>
<td>Positive Responses</td>
<td>“Internet quality would dictate how well the dentist could assess.”</td>
<td></td>
</tr>
<tr>
<td>Conditions</td>
<td></td>
<td>“[…] much more effective with video than without”</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Negative Responses</td>
<td>“[…] I have been lost in systems for months and there has been no follow up”</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>“Internet connectivity issues, like dropped calls […]”</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>“Not available in rural MN.”</td>
<td></td>
</tr>
<tr>
<td>Behavioral</td>
<td>Positive Responses</td>
<td>“[…] would do it if someone offered it to me!”</td>
<td></td>
</tr>
<tr>
<td>Intent</td>
<td></td>
<td>“[…] I’m interested and will give it a try”</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Negative Responses</td>
<td>“[…] only go to the dentist when I need to. I would not use teledentistry.”</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>“I don’t see myself using teledentistry ever.”</td>
<td></td>
</tr>
<tr>
<td>Lack of Knowledge</td>
<td>Associate dentistry with treatment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>----------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“Dental work is very hands-on, so not sure how well this could work.”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>“How can a dentist obtain x-rays and a close visual of my mouth or teeth in question?”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>“[…] just need my teeth cleaned, which can’t be done virtually!”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>“[…] am unfamiliar with any services offered”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>“I don’t know if it is available with my provider”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>“Not sure current dentist offers this an as option”</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
FIGURES

Figure I: Number of participants by state for the total sample
Figure II: Number of participants by U.S. county for the total sample
Figure III: Number of participants by Minnesota county for the total sample
SECTION 5
BIBLIOGRAPHY

Comprehensive list of references:


83. Connolly SL, Miller CJ, Lindsay JA, Bauer MS. A systematic review of providers’


SECTION 6
Appendix A: Practical Applications

Teledentistry has been an innovative form of oral health care delivery. While its applications serve many benefits, research has identified technology use as a noteworthy barrier to its widespread uptake. The Unified Theory of Acceptance and Use of Technology (UTAUT) was used in this study to explore the perceptions and behavioral intent (BI) of U.S. adults in teledentistry utilization.

The results of this study found that performance expectancy (PE) and social influence (SI) most predicted a participant’s BI to use teledentistry in the next six months. Furthermore, the qualitative data collected revealed a general lack of knowledge about the scope of teledentistry and where access to these services can be found. Based on these findings, PE and SI may serve as a framework on which to build educational and marketing strategies for teledentistry. Educational initiatives in dental and medical curricula and professional education courses for licensed practitioners could help increase teledentistry awareness and competence amongst providers, who would then be able to educate their patients on the benefits of teledentistry applications.\textsuperscript{11} Manufacturers of do-it-yourself orthodontic aligners have already implemented online and social media advertisements, information sharing, and consent procedures, which could be a platform for teledentistry marketing. However, regulation and quality assurance would be needed to ensure that accurate and evidence-based information is being provided.\textsuperscript{11}

Stakeholder involvement is critical to teledentistry’s uptake and sustainability. More research is needed to determine whether building on PE and SI factors will sustain a user’s BI and facilitate the adoption of teledentistry into standard dental practice in the United States.
Appendix B: IRB Exemption Letter:

UNIVERSITY OF MINNESOTA

EXEMPTION DETERMINATION

June 18, 2021

Priscilla Flynn
507-459-0420
flynn125@umn.edu

Dear Priscilla Flynn:

On 6/18/2021, the IRB reviewed the following submission:

<table>
<thead>
<tr>
<th>Type of Review:</th>
<th>Initial Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title of Study:</td>
<td>D2D: Evaluating perceptions and intentions of adult teledentistry utilization: A survey study</td>
</tr>
<tr>
<td>Investigator:</td>
<td>Priscilla Flynn</td>
</tr>
<tr>
<td>IRB ID:</td>
<td>STUDY00012797</td>
</tr>
<tr>
<td>Sponsored Funding:</td>
<td>None</td>
</tr>
<tr>
<td>Grant ID/Con Number:</td>
<td>None</td>
</tr>
<tr>
<td>Internal UMN Funding:</td>
<td>Internal grant program (e.g. OVPR, Cancer Center, Provost, AHC, GPS Alliance, IonE, LAS, or other) : Grant in Aid</td>
</tr>
<tr>
<td>Fund Management Outside University:</td>
<td>None</td>
</tr>
<tr>
<td>IND, IDE, or HDE:</td>
<td>None</td>
</tr>
<tr>
<td>Documents Reviewed with this Submission:</td>
<td>CTI training for Dr. Susan Buck-Wischnieter, Category: Other; HRP-587 - TEMPLATE - Information Sheet for Exempt Research.docx, Category: Consent Form; HIPCO Survey.pdf, Category: HIPAA Authorization; Teledentistry Electronic Survey.docx, Category: Other; D2D Recruitment Poster.docx, Category:</td>
</tr>
</tbody>
</table>

Driven to Discover™
The IRB determined that this study meets the criteria for exemption from IRB review. To arrive at this determination, the IRB used “WORKSHEET: Exemption (HRP-312).” If you have any questions about this determination, please review that Worksheet in the HRPP Toolkit Library and contact the IRB office if needed.

This study met the following category(ies) for exemption:

1. (2) Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) if at least one of the following criteria is met: (ii) Any disclosure of the human subjects’ responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects’ financial standing, employability, educational advancement, or reputation.

Ongoing IRB review and approval for this study is not required; however, this determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these activities impact the exempt determination, please submit a Modification to the IRB for a determination.

For the 2021 state fair, any follow-on submissions, such as modifications to the study protocol or the addition of new study team members, must be submitted to the IRB by July 24, 2021.

In conducting this study, you are required to follow the requirements listed in the Investigator Manual (HRP-103), which can be found by navigating to the HRPP Toolkit Library on the IRB website.

For grant certification purposes, you will need these dates and the Assurance of Compliance number which is FWA00000312 (Fairview Health Systems: Research FWA00000325, Gillette Children's Specialty Healthcare FWA00004063).

Sincerely,

Clinton Dietrich, MA, CIP
Senior IRB Analyst

We strive to provide clear, consistent, and timely service to maintain a culture of respect, beneficence, and justice in research. **Complete a brief survey** about your experience.
Appendix C: ResearchMatch Contact Message

Hello,

Researchers at the University of Minnesota are surveying the perceptions and intentions of adults around the country to use teledentistry services. The information gained will help us overcome barriers to accessing oral health care related to use of technology.

You are eligible for this study if:
- You are 18 years or older
- You are able to complete this survey in English

Briefly, participation is voluntary and involves spending approximately 10-15 minutes completing an electronic survey. If you decide to participate, you are free to discontinue participation at any time without prejudice or penalty. Should you choose to complete this survey, you have the option to enter a random drawing for a $50 online gift card.

If you are interested in learning more about this study, please click “yes” so that a study team member may contact you. Thank you for your time and consideration.
Appendix D: Informed consent for D2D sample participants

Dear Participant,

You are invited to participate in a research project. The purpose of this survey is to assess your perceptions of teledentistry and your intentions to use these services in the future. Results will help us design and adopt innovative oral health promotion programs across the country. After providing consent, you will be asked to complete an electronic survey containing 34 questions surrounding telehealth and teledentistry perceptions and experiences.

This survey should take no longer than 15 minutes to complete. You must be at least 18 years old to participate. Your participation is voluntary. Your decision whether or not to participate will not be held against you. If you decide to participate, you are free to discontinue participation at any time without prejudice or penalty. You are free to ask any and all questions you have before you agree to participate. There will be no risks, discomforts, or hazards associated with this research. If you agree to take part in this research study, you will be given a backpack containing a toothbrush, floss, and toothpaste in appreciation for your time and effort.

The records of this study will be kept confidential. No identifying information will be collected from you. The code number on the survey is used for tracking purposes only. When the results are published, only combined data will be reported. This study has been approved by the University of Minnesota Institutional Review Board (STUDY00012797). This research is supported by the University of Minnesota Division of Dental Hygiene.

By completing this survey, you are indicating that you are at least 18 years old, have read this document, have had all your questions answered, and voluntarily agree to take part in this research study.

Thank you in advance for your cooperation. Please feel free to contact Dr. Angela Hastings with any questions or comments you may have at 763-221-5934 or hasti070@umn.edu or the University of Minnesota Institutional Review Board Research Participants’ Advocate Line at 612-624-4490 or go to www.irb.umn.edu/report.html.

Sincerely,

Angela Hastings, DMD  Mercedes VanDeWiele, BSDH  Priscilla Flynn, DrPH, RDH
Clinical Assistant Professor  Student Investigator  Associate Professor

Department of Primary Dental Care
University of Minnesota School of Dentistry
515 Delaware St SE
Minneapolis, MN 55455
Appendix E: Informed consent for ResearchMatch sample participants

Dear Participant,

You are invited to participate in a research project. The purpose of this survey is to assess your current intentions to use teledentistry services in the future. Results will help us design and adopt innovative oral health promotion programs across the country. After providing consent, you will be asked to complete an electronic survey containing 34 questions surrounding telehealth and teledentistry perceptions and experiences.

This survey should take no longer than 15 minutes to complete. You must be at least 18 years old to participate. Your participation is voluntary. Your decision whether or not to participate will not be held against you. If you decide to participate, you are free to discontinue participation at any time without prejudice or penalty. There will be no risks, discomforts, or hazards associated with this research. Once the survey is completed, if you would like to enter a random drawing for ONE of three $50 online gift cards, you will be asked to provide your email address, separate from the survey questionnaire.

The records of this study will be kept confidential. Any identifying information collected will be collected separately and securely, and be destroyed upon study completion. The code number on the survey is used for tracking purposes only. When the results are published, only combined data will be reported. This study has been approved by the University of Minnesota Institutional Review Board (STUDY00012797). This research is supported by the University of Minnesota Division of Dental Hygiene.

By completing this survey, you are indicating that you are at least 18 years old, have read this document, have had all your questions answered, and voluntarily agree to take part in this research study.

Thank you in advance for your cooperation. Please feel free to contact Dr. Angela Hastings with any questions or comments you may have at 763-221-5934 or hasti070@umn.edu or the University of Minnesota Institutional Review Board Research Participants’ Advocate Line at 612-624-4490 or go to www.irb.umn.edu/report.html.

Sincerely,

Angela Hastings, DMD
Clinical Assistant Professor

Mercedes VanDeWiele, BSDH
Student Investigator

Priscilla Flynn, DrPH, RDH
Associate Professor

Department of Primary Dental Care
University of Minnesota School of Dentistry
515 Delaware St SE
Minneapolis, MN 55455
Appendix F: UTAUT-based teledentistry questionnaire

Instructions: Please read each question carefully and choose one response.

1. Did you visit a dentist in the past year?
   1. Yes
   2. No
   3. Not sure

2. If you did not visit a dentist in the past year, what was the main reason?
   1. Cost
   2. Transportation issues
   3. Dentist office too far from me
   4. Inconvenient office hours
   5. Dental anxiety/fear
   6. COVID-19 restrictions
   7. No need
   8. Other (please describe)

3. How far do you travel to see your dentist?
   1. 10 miles or less
   2. 11-30 miles
   3. 31-59 miles
   4. 60 miles or more
   5. I don’t have a dentist
   6. Other: ______________

Telehealth is defined as communication between a provider and a patient or caregiver through one or more modes of technology (such as video calls on cell phones or computers) to deliver health care. Telehealth is an umbrella term that covers telemedicine as well as a number of nonphysician services, such as telenursing or telepharmacy.

4. Have you ever heard of telehealth?
   1. Yes
   2. No
   3. Not sure

5. Have you ever used telehealth?
   1. Yes
   2. No
   3. Not sure

6. Have you ever heard of teledentistry?
   1. Yes
   2. No
3. Not sure

Teledentistry is defined as the use of telecommunication devices (such as video calls on cell phones or computers) to facilitate dental exams and services when the patient is in one location and the dentist is in another location.

7. Have you used teledentistry services in the past year?
   1. Yes (set up e-survey to add Q #8 & #9)
   2. No
   3. Not sure

8. If YES to Question #7, would you use teledentistry services again in the future?
   1. Yes
   2. No
   3. Not sure

9. If YES to Question #7, how would you rate your experience with your teledentistry visit?
   1. Strongly Negative
   2. Negative
   3. Neutral
   4. Positive
   5. Strongly Positive

Please answer the following questions about using telehealth in the future. Read each statement and respond whether you strongly disagree, disagree, are neutral, agree, or strongly agree. If you do not have a dentist or your dentist currently does not offer teledentistry services (e.g., video visits, telephone calls, image forwarding, etc.), respond as if these services were offered using any technology platform(s). If you feel that a statement does not apply to you, you may respond with “Neutral”. You may only choose one answer for each question.

10. I would find teledentistry useful for consulting with a dentist
    1. Strongly Disagree
    2. Disagree
    3. Neutral
    4. Agree
    5. Strongly Agree

11. Using teledentistry will allow me to have faster communication with a dentist
    1. Strongly Disagree
    2. Disagree
    3. Neutral
4. Agree
5. Strongly Agree

12. Using teledentistry will improve communication with a dentist
   1. Strongly Disagree
   2. Disagree
   3. Neutral
   4. Agree
   5. Strongly Agree

13. If I use teledentistry, it will make it easier for me to communicate with a dentist
   1. Strongly Disagree
   2. Disagree
   3. Neutral
   4. Agree
   5. Strongly Agree

14. If I use teledentistry, the technology used would be clear and understandable for me
   1. Strongly Disagree
   2. Disagree
   3. Neutral
   4. Agree
   5. Strongly Agree

15. It would be easy for me to become skillful at using teledentistry
   1. Strongly Disagree
   2. Disagree
   3. Neutral
   4. Agree
   5. Strongly Agree

16. I would find teledentistry easy to use
   1. Strongly Disagree
   2. Disagree
   3. Neutral
   4. Agree
   5. Strongly Agree

17. People who influence my behavior would think that I should use teledentistry
   1. Strongly Disagree
   2. Disagree
   3. Neutral
   4. Agree
5. Strongly Agree

18. People who are important to me would think I should use teledentistry as it would help me consult a dentist
   1. Strongly Disagree
   2. Disagree
   3. Neutral
   4. Agree
   5. Strongly Agree

19. In general, I would be supported in my use of teledentistry
   1. Strongly Disagree
   2. Disagree
   3. Neutral
   4. Agree
   5. Strongly Agree

20. I have the resources necessary to use teledentistry (internet connection, computer/tablet/smartphone, family support)
   1. Strongly Disagree
   2. Disagree
   3. Neutral
   4. Agree
   5. Strongly Agree

21. I have the knowledge necessary to use teledentistry (basic computer knowledge)
   1. Strongly Disagree
   2. Disagree
   3. Neutral
   4. Agree
   5. Strongly Agree

22. I think teledentistry fits well with my lifestyle
   1. Strongly Disagree
   2. Disagree
   3. Neutral
   4. Agree
   5. Strongly Agree

23. A specific person (or group) is available for help if I experience teledentistry difficulties
   1. Strongly Disagree
   2. Disagree
   3. Neutral
24. I intend to use teledentistry in the next 6 months
   1. Strongly Disagree
   2. Disagree
   3. Neutral
   4. Agree
   5. Strongly Agree

25. I predict I will use teledentistry in the next 6 months
   1. Strongly Disagree
   2. Disagree
   3. Neutral
   4. Agree
   5. Strongly Agree

26. I plan to use teledentistry in the next 6 months
   1. Strongly Disagree
   2. Disagree
   3. Neutral
   4. Agree
   5. Strongly Agree

Please read the following two questions and check all that apply.

27. What benefits do you believe teledentistry services provide? Check all that apply.
   1. Lowering costs of dental services
   2. Providing more opportunities for prevention and education
   3. Convenient appointment times
   4. Decreasing dental anxiety
   5. Increasing access to dental care
   6. I do not believe there are any benefits
   7. Other (please describe): _____

28. What reason(s) impact why you might not use teledentistry services? Check all that apply.
   1. I do not own a cell phone or computer with video capabilities
   2. I live in a rural area with limited cell phone service
   3. Lack of internet connection in my area
   4. I do not feel comfortable with video technology
   5. I would rather see my dentist in person for all visits
   6. Other (please describe): _____
29. Optional: Provide any comments regarding your experience and/or concerns in using any form of telehealth or teledentistry for the delivery of your health care.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

Demographic Questions:

30. What is your current age, in years? _____

31. How do you describe your gender?
   1. Male
   2. Female
   3. Non-binary
   4. Prefer not to report

32. What is your highest level of education?
   1. Less than high school/GED
   2. High school diploma/GED
   3. Some college or technical school
   4. College degree or technical school graduation
   5. Advanced or doctorate degree

33. Please provide your zip code: _____