Spring 4-10-2023

Telehealth Impact on National Emergency Department Utilization Among Children with Type 1 Diabetes Mellitus

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TELEHEALTH IMPACT ON NATIONAL EMERGENCY DEPARTMENT UTILIZATION AMONG CHILDREN WITH TYPE 1 DIABETES MELLITUS

BY

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A doctoral project submitted to the faculty of the Medical University of South Carolina
in partial fulfillment of the requirements for the degree
Doctor of Health Administration
in the College of Health Professions

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Chair, Project Committee	Jiebing Wen, PhD	Date
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Acknowledgments

It would be impossible to list everyone I must thank for supporting me personally and professionally throughout my life which has led to the culmination of this degree and the completion of this project. This journey has been one of the most challenging yet rewarding experiences for me. I truly could not have reached this goal without you.

First, I would like to extend many thanks and gratitude to the Medical University of South Carolina, College of Health Professions- Doctor of Health Administration program professors and administrative staff for their unwavering support, expertise, and guidance. It is through your knowledge and willingness to share your experience that I have been successful in this journey. To my chair, Dr. Jiebing Wen, I am honored that you agreed to mentor me through this project. Your kindness and patience go unmatched and for you, I am dearly indebted. Dr. Annie Simpson and Dr. Daniel Brinton, thank you for agreeing to be on my committee and for your constructive criticism, while I was not sure how this project would evolve, I trusted you explicitly. To Dr. Jillian Harvey and Leslie Anderson, I am so thankful you were there each step of the way over the entirety of this program, answering each last-minute question and always having time for a chat or an email; your value cannot be overstated.

To my parents, I cannot begin to express my love and gratitude for the grit and faith that you have shown and instilled in me over my lifetime. Your examples of selflessness, determination, and strength through all that you do is my foundation. You continue to be my biggest fans and the ones who I look to for support and encouragement as it means everything. You never let me settle and always believed that I would one day change the world, so thank you. To my sister, my sidekick, my best of times and worst of times, thank you for never judging my words or actions; thank you for all the stress-relieving shopping trips and junk food binges, and for being there for me no matter what the circumstance (and there have been many). I truly could not imagine a day without you in it. To my grandmother, our prayer warrior, I could always count on you for your faith and love and for remembering me in your innumerable prayers, thank you. I do not doubt that those prayers provided the fuel and determination to continue my journey. To my husband who has been there through it all, thank you. You carried my burdens so many times when I could not, and your honesty, support, and assurance are something I always look for in every moment. You were the mom and dad to our children when needed and were understanding when my school commitments took time away from our family. To my children and niece, you have undoubtedly sacrificed the most; I could never tell you in words how thankful I am that you are mine. You have each taught me so much about myself and allowed me to grow, learn, fail, and succeed and your faith in me is what drives me to always be better, do better, and live better.

To all my friends who encouraged me to begin this program and believed in me, your friendship means everything. Your check-ins, phone calls, dinner dates, and love are things I hold so dear. Your willingness to be honest with me and push me when I thought I could not go on, speaks to your character as you invested in me as a human being and as your friend; please know I return the sentiment and think you all hung the moon.

Abstract of Dissertation Presented to the
Medical University of South Carolina
In Partial Fulfillment of the Requirements for the
Degree of Doctor of Health Administration

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Chairperson: Jiebing Wen, PhD
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Daniel Brinton, PhD

Abstract

Background: The COVID-19 pandemic brought challenges to patient care as healthcare entities and systems were forced to move care virtually in many instances. Some organizations were poised for this challenge while others struggled, however, most were concerned with how well patients were being managed as telehealth became a primary method in care delivery. This study aims to evaluate the impact of telehealth services on ED utilization rates for children ages 0-12 years with a new diagnosis of Type 1 diabetes mellitus.

Methods: Using linear regression analyses and individual and state fixed effects models, over 67000 emergency department (ED) and telehealth claims were reviewed as well as over 3000 total daily visits. The findings were displayed in line graphs for comparison and descriptive tables.

Conclusion: Data analysis showed that telehealth care may be an effective tool in reducing emergency department utilization for children within the defined cohort. Although ED and telehealth were rare events, through both models, telehealth was not shown to increase the probability of an ED claim/visit.

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CHAPTER I INTRODUCTION

1.1 Background and Need

Type 1 diabetes mellitus (DM) currently accounts for approximately 5-10% of the diabetes population; this disease can be incredibly difficult to manage, and prevalence has continued to rise over the last several years (cdc.gov, 2022). Because there are no proven preventive methods, the focus becomes treatment and prevention of complications. To further complicate disease management, research has shown that children are often misdiagnosed and/or treated for Type 1 or Type 2 DM incorrectly (Amed et al., 2016). Due to the prevalence of childhood obesity, Type 2 DM is becoming more common in a younger population, therefore, clinicians must evaluate risk factors and symptomatology to ensure a correct diagnosis, which will drive care practices (Amed et al., 2016). Dependent upon age and developmental levels, Type 1 DM becomes increasingly problematic to treat in children as they are not always able to identify or articulate symptoms of hypo or hyperglycemia in a meaningful manner, nor express how they are feeling (e.g., cold, clammy skin, dry mouth, thirst, fatigue, etc.). Streisand et al. (2014) outline barriers to adequate DM management in young children as they may not cognitively be able to detect and verbalize symptoms, they often have unpredictable behavior and eating patterns, and parents are responsible for picking up on verbal and non-verbal cues that may be indicating their child is experiencing high or low blood sugar levels. Halvorson et al. (2005) present considerations for managing children with diabetes from babies and toddlers through teen years and adolescence and underscores the importance of understanding the physiological changes as well as psychological maturity of a child under 18 years of age. With each adolescent phase, there are unique considerations regarding the management of symptoms, hormonal changes, and the increasing need for children to begin managing their condition autonomously. The level of parental involvement varies across cases.

Devastating side effects and negative health outcomes can be attributed to an uncontrolled disease state. Permanent organ damage and even death can result if signs and symptoms of low or high blood glucose levels are not recognized and addressed immediately; however, the risk becomes lower if blood glucose levels are adequately controlled (Mayo Clinic, 2022). The Mayo Clinic (2022) outlines complications from diabetes mellitus to include “heart and blood vessel disease, nerve damage, kidney damage, eye damage, and osteoporosis,” making disease management imperative to not only ensuring a healthy lifespan but also the quality of life for the individual.

1.2 Diabetes Mellitus Statistics

The National Diabetes Statistics Report for 2020 estimated that in 2018, 210,000 children, inclusive of adolescents (<20 years of age) had diabetes mellitus. Of those 210,000 individuals, 187,000 were diagnosed with Type 1 requiring insulin. 1.4 million adults (>20 years of age) reported having diabetes and requiring insulin administration (Centers for Disease Control and Prevention, 2020). The American Diabetes Association estimated the numbers to be even higher in 2019, with 244,000 children and adolescents accounting for the 1.9 million Americans with a Type 1 diabetes mellitus diagnosis. American Indians and Alaskan Natives account for the highest proportion of those afflicted with DM, followed by non-Hispanic blacks. Together, they account for over 35% of the population with any kind of DM diagnosis. The Centers for Disease Control and Prevention reported more black children dying from Type 1 DM than other races (Saydah et al., 2017).

1.3 Chronic Care Model

The Chronic Care Model was introduced in the 1990s which resulted in improved ambulatory care for chronic disease management by creating a multi-disciplinary care team approach, better/expanded education for primary care providers, patient education, and ensuring adequate support for individuals and families and evaluating the usefulness and improving upon registry-based information systems (Coleman, et al., 2009). The improvement of clinical information systems and the adoption of electronic health records and the health information exchange have improved the way in which providers collaborate and care for patients. When tracking systems improve and clinical information such as laboratory reports become more readily available, patients and clinicians gain a tool to identify trends and improve management and subsequent control of chronic conditions (Stellefson et al., 2013). In a systematic review by Stellefson et al. (2013), it was shown that the use of the Chronic Care Model was effective in improving clinical care outcomes for those diagnosed with DM. Willens et al. (2011) underscored the importance of an integrated clinical team approach when they evaluated patients enrolled in an advanced care model over 12 months who had a diagnosis of DM. They found these patients had an improvement in their hemoglobin A1C levels and had higher levels of adherence to preventive measures such as vaccinations and intermittent foot examinations (Willens et al., 2011).

1.4 Interdisciplinary Treatment Teams and Support Systems

Introducing interdisciplinary treatment teams to the clinical plan of care has been shown effective in lowering the incidence of or thwarting actual or potential negative health events or side effects attributed to diabetes mellitus. For example, in a child with DM, nutritional support becomes important as food must provide fuel for growth and energy and must be balanced based on insulin needs and schedules, thus the needed inclusion of the dietician in treatment teams (American Diabetes Association, 2002). Clinical support teams often appear the same for children with DM, compared to treatment teams for adults with DM. They include specialty providers, podiatry, dentists, ophthalmologists, dietetics, diabetes health educators, and pharmacists (cdc.gov, 2022). Psychosocial support for the individual and family becomes critical throughout the diabetes diagnosis and resultant care. Emotional and psychological support should be available for the family as well as the patient starting at the point of diagnosis. In a study involving parents of adolescents between the ages of 11 and 16 years, diagnosed with diabetes mellitus, Wysocki et al. (2005) found that the introduction and adherence to the behavioral family systems therapy for diabetes (BFST-D) amongst patients and families, resulted in better glycemic control, improved family cohesion, and increased treatment compliance. Patients with poor glycemic control saw a marked reduction in hemoglobin A1C levels.

Parents and guardians have a significant responsibility to manage the care of a child with diabetes in a holistic manner. One aspect of that care management becomes the insulin injections the child will require. McLenon, et al. (2018) conducted a meta-analysis looking at the fear of needles and found that a significant number of patients with Type 1 DM and their caregivers reported a fear of needles (whether directly related to the needle or physiological side effects of injection), which further adds to the complex management components of DM and potentially negative health outcomes if fear is keeping the child from receiving proper medication dosing. As a result of multiple components related to diabetes care, there is a need for families to feel supported throughout the journey as they often rely on schools, coaches, family, and hospital care teams to assist, educate, and remain mindful of the child's condition including how well the diabetes is controlled, in their absence. Young children including those children who are not able to express their symptoms well may face unique challenges outside of the home as they attend school where personnel will be expected to take on the task and responsibility of managing the condition (Halvorson et al., 2005). A complicating factor includes unstable family units or family units in conflict regarding diabetes management which may have a negative effect on Type 1 diabetes control among adolescence (Vaid et al., 2017). Vaid et al. (2017) looked at 93 teenagers with a mean age of 15.12 years and an average disease history of 6.15 years from the time of diagnosis, who were experiencing challenges in managing their diabetes. They found the teens who were experiencing difficulty managing their diabetes, had higher instances of poor self-regulation and above-target glycemic control if their family unit experienced conflict regarding diabetes management, highlighting the importance of an accessible and supportive clinical team for both patient and family (Vaid et al., 2017).

1.5 Acute Complications

Diabetes often responds differently for different people, therefore, anytime there is a clinical change in a child with DM, such as they become ill with a virus or develop an infection, parents will notice how difficult it may be to keep blood glucose levels within a normal range. One of the most serious complications of diabetes is a condition known as Diabetic Ketoacidosis or DKA. The American Diabetes Association refers to DKA as life-threatening and requiring immediate medical attention. DKA occurs when there are high levels of ketones in the body, which makes the blood very acidic, and too much acidity is not compatible with life (American Diabetes Association, 2022). Aside from DKA, potentially life-threatening acute complications are defined by Rewers (2018) as lactic acidosis, hyperglycemic hyperosmolar state (HHS), and hypoglycemia.

Due to the seriousness of the disease and the complex care required to prevent acute and long-term complications of DM, many institutions are relying on supplementary care models such as the Patient-Centered Medical Home (PCMH) and the addition of telehealth services to augment care team practices and communication with the families to improve care and health outcomes. Bojadzievski et al. (2011) emphasize that a Medical Home model that is working optimally, consists of sound communication and coordination and highlights the importance of 'Team' as the main concept. They go on to list the components of PCMH to include the following, noting that the use of integrated care teams, again becomes one of the most important elements of chronic disease care delivery, which is paramount to diabetes management:

- Coordination and integration of care
- Quality and safety
- Whole person orientation
- Personal physician
- Physician-directed medical practice
- Enhanced access
- Payment

1.6 COVID-19 Pandemic

In March 2020, the World Health Organization declared COVID-19, a pandemic, noting a sharp increase in diagnosed cases globally and expressing concern regarding how quickly the spread was happening and how the response was inadequate (Cucinotta et al., 2020). Quickly following this announcement, precautions were put in place to attempt to stop the spread and manage those infected. The ramifications of nationwide lockdowns affected the way in which healthcare was delivered and above all, access to care for patients. For some, the consequences of less, or even no in-person care were a much different season of healthcare than what they were accustomed to, inclusive of both patients and the care teams. Healthcare providers had to quickly become adept at managing patients remotely and there was a need for effective communication and better communication methods, especially for those populations considered vulnerable. In 2020, Reddy et al. highlighted the need for effective communication and went on to provide sample scripts that explained the importance of clear, concise information when discussing medical issues with patients and families. They further stressed the need to include cultural considerations, potential generational gaps, and language barriers. With conditions such as DM, the task of managing patients to prevent complications and maintain health would be a challenge, but those patients who had a difficult time controlling their condition were considered especially high risk. This required care teams and healthcare systems to pivot and leave the mindset of traditional care and realize that the pandemic era was forcing a new way to manage care, whether the healthcare system was ready or lagging. Alromaihi et al. (2020) conducted a study looking at the efficacy of transitioning diabetes care to telemedicine versus in-person care and found that patients could be successfully managed using this framework during the active and post-pandemic phases.

1.7 Care Delivery Systems to Include Telehealth Services

Marcin et al. (2016) evaluated the usefulness of telehealth services for a variety of conditions such as asthma, diabetes, and obesity in adolescents, specifically focusing on those children who may not have readily accessible healthcare resources due to geographical constraints and found that by managing children with diabetes through a telehealth program, there were fewer instances of acute complications as well as fewer calls to the school nurse and improved hemoglobin A1C levels. Divers et al. (2020) reported amongst youths, defined as those individuals 20 years old and younger, the prevalence of Type 1 Diabetes Mellitus had an annual percentage change of 1.9% comparing rates in 2002-2003 as 19.5 per 100,000 to 22.5 per 100,000 from 2014-2015. In 2015, 18,200 children were diagnosed with Type 1 DM (ADA, 2022). Telehealth efforts have expanded exponentially during and after the pandemic, and the way in which care is delivered has evolved. For example, in a Letter to the Editor of the Clinical Transplantation journal, Santos-Parker et al. (2020) explained that due to expansion efforts for telehealth services via the Centers for Medicare and Medicaid Services during the pandemic, which included the ability to charge the same rate for telehealth services as in-person visits, this provided an opportunity to evaluate how telehealth could be leveraged within transplant services as static practice. Patients are opting into telehealth programs for convenience, timely access, traditionally lower costs for service to include copays, and even to avoid transportation challenges and barriers to parking (Reed et al., 2020). It stands to reason that if telemedicine efforts to manage complex disease processes in vulnerable populations are proven successful, the positive impact on health outcomes and the healthcare system will be widely quantifiable. For example, Garg et al. (2020) outline a pediatric case of newly diagnosed Type 1 diabetes mellitus in a 12-month-old. The child was discharged to home on an insulin pump and the parents were instructed to upload the insulin pump data through their home computer using vendor software. The result was successful patient management using remote patient monitoring methods, specifically leading to a marked improvement in in-between-meal and overnight glycemic profiles. By utilizing artificial intelligence to augment telehealth services for those suffering chronic conditions, there is potential to reach an even broader patient base and potentially find solutions or at a minimum, help for an ailing healthcare system facing clinician shortages (Tejaswi et al., 2021).

1.8 Problem Statement

Managing Type 1 DM requires a holistic approach which includes considerations for not only physical well-being but emotional and psychological support as all become important to maintaining glucose homeostasis (Juanamasta et al., 2021). Interdisciplinary treatment teams

(IDTs) have been proven successful in preventing complications and helping patients achieve glycemic goals, however, the COVID-19 pandemic forced the model of care to move away from an in-person design and to begin exploring ways in which technology could assist in managing even complex disease states. Telemedicine became the norm instead of the exception, but the execution of effective telemedicine strategies would require understanding patient and community vulnerabilities, cultural considerations, and potential barriers and challenges for patients and providers who may not be well-versed in technology. Type 1 diabetes management presents separate challenges as most children are required to rely on parental/guardian support as they navigate their healthcare journey and may not be able to articulate their signs and symptoms of complications well. We know that acute complications become especially dangerous for this population and can escalate to life-threatening quickly. With the COVID-19 pandemic presenting a new set of barriers to access to care, the goal quickly focused on decreasing emergency department (ED) utilization and inpatient admissions. The issue of ED over utilization was not a new problem, it was known to be one of the six major sources of healthcare waste as outlined by the New England Healthcare Institute in their report *Waste and Inefficiency in the Health Care System- Clinical Care: A Comprehensive Analysis of in Support of System-wide Improvements* (NEHI-us.org, 2010).

1.9 Research Questions

The primary focus of this paper will be to attempt to answer, “Is the use of telehealth services associated with changes in emergency department utilization for acute complications in children diagnosed with Type 1 diabetes mellitus?”

2 CHAPTER II SCOPING LITERATURE REVIEW

This literature review will further explore how the COVID-19 pandemic accelerated the use of telehealth care as well as delve into the advantages and disadvantages of telehealth. This review will outline the characteristics of children with Type 1 diabetes mellitus and explore the use of telehealth services for managing Type 1 DM in the pediatric population. It will outline potential challenges contributing to the underutilization of telehealth, and obstacles for use of telehealth services specific to those diagnosed with Type 1 diabetes mellitus.

2.1 The Evolution of Telehealth Care through the COVID-19 Pandemic

The use of telehealth became mainstream as the world fell into the grips of the COVID-19 pandemic. Wosik et al. (2020) explained the transformation of telehealth through the pandemic, covering all phases, starting with the initial shut down through reopening and attempts to normalize. It was no surprise that the need for telehealth services grew exponentially as people were encouraged to stay home, yet still required medical care, but how the healthcare community responded varied, and it became apparent that some were just not ready. Wosik and colleagues published their work as the first surge was easing (May 2020) but foreshadowed the need to maintain a state of preparedness, especially as many subject matter experts predicted additional surges and potential shutdowns. They highlighted the need to develop infrastructures that would continue to support telehealth growth and to remain mindful of what good, quality care means in terms of telehealth, as well as emphasizing the importance of revenue streams in this new care continuum (Wosik et al., 2020).

While healthcare systems were grappling with their challenges with increasing the ability to provide telehealth, the patient perspective could not be lost. Hospitals could invest millions in improving existing infrastructure or developing infrastructure for the purpose of telehealth care delivery, however, questions remained as to whether patients would accept this as a primary care modality and whether it would be sustainable beyond the pandemic. New York University Langone Health (NYULH) is an example of a health system that had invested in telehealth infrastructure prior to the pandemic, which allowed them to be adequately positioned for the surge in telehealth demand during the pandemic (Bakken, 2020). NYULH saw virtual visits rise from around 100 per day to around 800 per day within less than 60 days and interestingly found that patient satisfaction scores remained relatively steady through the uptick (Bakken, 2020). Bakken (2020) highlighted the efforts of Vanderbilt University Medical Center to manage COVID-19 patients within their pediatric population by focusing on patient portal enrollment which resulted in increased enrollments per week for children and adolescents. By increasing patient portal enrollment, they were able to meet the demand for telehealth care for their pediatric patient population, which was not realized prior to the pandemic.

Prior to the COVID-19 pandemic, the need to understand telehealth and its efficacy was well-stated. In 2015, The National Institutes of Health funded the research initiative known as SPROUT, Supporting Pediatric Research on Outcomes and Utilization of Telehealth (aap.org). The purpose of SPROUT is to develop an evidence base related to the utilization of telehealth for the pediatric population. Olson et al. (2018) emphasized the importance of the SPROUT initiative and gave a general overview of telehealth amongst the pediatric population, pointing out the large growth that pediatric telehealth has seen over the last decade, but also reminding the healthcare community that barriers continue to exist such as reimbursement, provider time to dedicate to telehealth practice and licensing concerns (Olson et al., 2018).

Medicare responded to the pandemic by expanding benefits so that virtual care would be reimbursed at the same rate as in-person visits, however, some specialty services such as care rendered by Registered Dieticians, remained noncovered (Mehta et al., 2020). The COVID-19 public health emergency allows for this expanded coverage, however, once lifted, there is uncertainty as to whether coverage will remain the same or revert to previous pay schedules (aha.org).

2.2 Advantages of Telehealth

Not only has the use of telehealth increased over the years, but the modalities have evolved to include synchronous telehealth via the use of video cameras that allows providers and patients to interact in real-time as though they were in-person. Providers have the ability to interact with a patient in much of the same manner they were accustomed to in the clinic. With the advances in technology related to cellular and hand-held devices such as video tablets and phones; the video quality is stable, and patients are able to interact with their clinical team in the comfort of their own homes and environments (Technological advances are facilitating telehealth, 2018). Cloud technology has further advanced telehealth by allowing asynchronous telehealth to mature which permits patients to upload media to an application and providers may view those submissions at their leisure. These data transfers are secure and timely, most often, immediately once the patient uploads (Linthicum, 2020).

As COVID-19 ravaged the nation, those who were already struggling with access to healthcare and/or complicated medical processes, saw that struggle only amplify. Medical beds were full, and hospitals were often reluctant to take patients for various reasons. Before the pandemic and only worse as time has gone on, the medical field has realized the lack of providers, caregivers, and support staff at an accelerated pace. This has left families reeling and patients at risk for complications, especially those who rely on case managers, nurses, and care navigators to help with the education and management of chronic diseases, such as diabetes mellitus (Jacobs, 2021). The pandemic has reinforced a familiar narrative that equates telehealth and telemedicine to the same quality of care as in-person treatment and evaluation. The issue of provider shortages and lack of physician capacity has been a topic since before the pandemic, therefore it is reasonable to assume that the pandemic has only emboldened this concern. To increase clinic capacity, one must evaluate inefficiencies in care practices. One study looked at the use of telemedicine to increase clinic/provider efficiency and found that telehealth made the practice more efficient by employing strategies such as remote patient monitoring to reach and treat vulnerable populations, thus, increasing the capacity of clinic slots (Marcin, et al., 2015).

Individuals in underserved areas may have higher rates of complications due to inadequate access to healthcare for prevention purposes. Research has shown that poverty, race, and ethnicity have placed vulnerable populations at a greater disadvantage than those of their counterparts as it relates to health outcomes (e.g., blood pressure control, and target hemoglobin A1C levels) (Hill-Briggs et al., 2021). Leyser et al. (2021) explained that the advances in telehealth are promising in terms of reaching patients who do not reside in metropolitan areas and who struggle with transportation issues. Government policies that have been relaxed as part of the pandemic have made reaching those in rural areas easier as most people own some sort of smart device that allows them to connect to telehealth and see a provider (Leyser et al., 2021).

Gleghorn at al. (2022) evaluated the California Children's Services' (CCS) use of telehealth in managing the child with care team needs (i.e., children who required interdisciplinary care) and found that incorporating telehealth elevated continuity of care as an assigned care team was required to schedule the appointment versus an in-person visit where a random care provider who had schedule availability would see the patient. Patient feedback was positive, and the quality of care was perceived as improved.

Ray et al. (2022) discussed the adoption of telehealth modalities in rural treatment areas, specifically focusing on access to pediatric subspecialties, and found that access to specialty services was improved with telehealth and hypothesized through the feedback of provider participants, that more providers may be inclined to practice in rural areas if they have access to and a collaborative relationship with subspecialists.

One study looked at the use of telemedicine in Type 1 DM care and highlighted the way in which this condition may benefit from telemedicine such as the remote monitoring aspect (Lee et al., 2021). Patients with Type 1 DM often have insulin pumps that store data that can be easily uploaded to the computer and use glucometers to frequently measure blood glucose levels, where data can also be uploaded to the computer and sent for provider or care team evaluation. Insulin adjustments can be made remotely as can many treatment plan aspects (Lee et al., 2021).

2.3 Disadvantages of Telehealth

While the advantages of telehealth care are well-documented, it should be discussed that there are known limitations to the use of telehealth in certain instances. Breton, at al. (2021) discusses how the pandemic moved care delivery via telehealth modalities from a more policy-driven, coverage for care, acceptance by patients and caregivers' discussion, to one of necessity and especially access to care consideration as patients simply needed to be seen. Brenton went on to explain that patients who needed psychological support were not as suitable for telehealth care while outlining a host of other barriers such as age and the ability to navigate technology, access to technology and infrastructure, patients with language barriers, rural populations, low-income individuals, and the inability to perform an in-person physical exam, all making telehealth more difficult.

A study completed by Singh et al. (2021) evaluating the patient perspective regarding telehealth visits in a cardiology clinic during COVID-19 found that in-person visits were still the preferred method by patients when seeing their provider, and interestingly, no-show rates were approximately the same for telehealth scheduled visits versus in-person care. Of note, many of those patients who did not show up for their appointments reported not knowing they were scheduled, which should be a consideration when evaluating no-show data.

A topic that is being explored further is the issue of provider training to perform telehealth. This goes beyond the use of telehealth equipment and dives into the issue of clinical assessment skills via synchronous or asynchronous means. Health Resources and Services Administration (HRSA) has outlined the need for ongoing provider education and training in relation to operating telehealth equipment and learning the fundamentals of clinical assessment via telehealth modalities (HHS.gov, 2022). HRSA promotes the use of telementoring, which is the use of mentorship to assist the provider as they learn ways in which they may better serve and care for their patients during telehealth care (HHS.gov, 2022). The inability to physically assess a patient is often a challenge for even seasoned providers who may not have received training specific to virtual care during their academic preparation. Mahoney (2020) explained in the wound/ostomy specialty, the inability to physically assess a patient presented challenges. Assessing a wound often requires the use of sight, smell, and touch, therefore, patients would need to describe how a wound may smell or feel, which may present a challenge for some patients (Salcido, 2005).

One area of particular interest and begs consideration is many insurance providers are no longer reimbursing for telephone visits, despite policy extensions by CMS, therefore, this may prevent care using these telehealth services. (Lee et al., 2021).

The Social Determinants of Health brings about specific considerations to the use of telehealth for care delivery. While technology is not yet considered a social determinant of health (Clare, 2021), it certainly has implications for accessing healthcare which can be related to the places whereby people reside. Holpuch (2020) wrote a piece highlighting the gaps that exist with the digital divide (access to technology) and how those gaps exacerbated care disparities during the pandemic. According to Holpuch (2020), 62% of counties within the United States, did not have proper broadband which is defined by minimum download speeds set by the federal government. If these counties do not have proper broadband speeds, the use of telehealth could be limited or non-existent. Conley et al. (2020) looked at the advantages of high-speed internet in rural locations and went as far as to explain the need for it. Having internet that is capable of streaming, video conferencing, etc. is no longer considered a luxury, but a necessity for everyday life. It is plausible that there will be groupings of children throughout the United States that saw worse health outcomes related to their diabetes mellitus than others, dependent upon the social determinants of health.

2.4 Characteristics of Children with Type 1 Diabetes Mellitus

Children defined in this project will be those under 12 years of age. Research has shown that children as young as 2 months old have been diagnosed with Type 1 DM, therefore, characteristics of children will vary by age group. For example, infants and toddlers do not always present with obvious signs of DM, therefore, watching for symptoms such as grunting, irritability, fruity breath, wetting more diapers than normal, increased appetite, and diaper rash that will not subside, is imperative (webmd.com, 2022). Toddlers and children may present with many of the already mentioned symptoms, in addition to behavior changes that could be perceived as mood swings, frequent urination in the toilet-trained child, complaints of thirst, and even weight loss despite an increased appetite (Mayoclinic.org).

Children enrolled in Medicaid services are shown to be higher users of Emergency Departments than non-Medicaid, insured children, and amongst this cohort, the children are shown to have a higher instance of chronic illness or illnesses (Peltz et al., 2017). Medicaid.gov reports over 72.5 million Americans are covered under Medicaid services with the largest group being children and pregnant women (Medicaid.gov, 2022). Statista reports in 2019, the highest group of Medicaid users by race was White (38.3%), while the lowest was Asian (4.9%). Other categories included Black at 21.3%, Hispanic at 30.4%, and Other at 5%. It should be noted that these numbers may not reflect the whole picture, the Medicaid and CHIP Payment and Access Commission (MACPAC) report in March 2022 stated that while states are required to report the demographics of their population of Medicaid recipients, this information can be incomplete since recipients have the option to not disclose that information if they choose.

2.5 Use of Telehealth Care for the Management of Diabetes Mellitus in Pediatrics

The use of telehealthcare in the management of DM in pediatrics has shown efficacy in many aspects of care such as reducing or eliminating the need to miss school for in-person provider visits, an increase in adherence to care plans, improved glycemic control, improved quality of care, an increase in the utilization of technology as a tool for disease management, and improved family education and participation in care planning (Fogel et al., 2020). Wood et al. (2016) looked at a telemedicine clinic in Aurora, Colorado, where pediatric patients were treated for DM and found that there was an increase in the number of clinic visits via virtual methods which allowed for more adherence to the American Diabetes Association recommended screening guidelines and resulted in fewer complications related to the disease process. Patton et al. (2019) studied the effects of telehealth on reducing hypoglycemic fears in parents of children with diabetes, however, only 42 parents were selected for this study, representing a relatively small sample size. Another study looked at telehealth in patients with Type 1 Diabetes and its adoption since the pandemic and found that telehealth was useful in supporting the mental health of the patients as well as the parents who feared negative complications related to the disease, however, this study gives an overall opinion and does not go in-depth into the statistical outcomes of actual use of telehealth or telemedicine to manage symptoms and care (Kompala et al., 2020).

There should be a distinction made between those children newly diagnosed and those with previous diagnoses of DM and the use of telehealth services. For those who are newly diagnosed, in-person care may be especially useful as a thorough clinical assessment is required to determine the extent of the disease process and then switch to maintenance therapy as able (Umano et al., 2021). Oftentimes new-onset DM is diagnosed when the child is in an acute crisis requiring hospital admission, therefore this is an ideal time for initial education; however, COVID-19 did require an adaptation to some of these care models as even for those newly diagnosed, who could be managed from home or were in lesser crisis, hospital admission was heavily scrutinized as beds were sparse and providers were pulled to work COVID units (Shawar at al., 2021).

The use of telehealth services in pediatrics with DM who are immunocompromised has been shown to protect them from communicable viruses and diseases which they may be exposed to in healthcare environments such as clinics and hospitals, especially during times of high influenza and respiratory illnesses (Aberer et al., 2021). Aberer et al. (2021) express the importance of ensuring this population is not socially isolated. Those socially isolated have poorer outcomes than those who are in close contact with their care teams (Aberer et al., 2021).

2.6 Factors Contributing to Telehealth Underutilization

Simply stated, there are providers and care teams that may not be comfortable using telehealth to treat their patients, especially those who are more vulnerable, such as the pediatric population. Reeves et al. (2021) developed guidelines to assist the provider and care team in assessing if telehealth is appropriate for a patient (Figure 1). For example, a patient appropriate for telehealth would be one with a follow-up visit for a known condition, who has a sound social or family support system, with a technologically savvy family member (Reeves et al., 2021). As one may deduce, the perfect scenario for offering telehealth may be debatable and the provider may choose to err on the side of caution and keep care in-person.

Hosseini et al. (2019) explained that Pennsylvania schools were one example of a state where the school system, although technically capable, has chosen not to participate in any telehealth programs, thus thwarting any school-based telehealth option for parents and children. They underscored the importance of the school system committing to understanding the web resources and monitoring the student's level of engagement in the programs. Some have described the implementation of school-based telehealth as disruptive to in-place clinical teams and day-to-day work, however, to gain a better understanding, more thorough research is recommended to explore these concerns (Love et al., 2019).

The use of telehealth technology and the wariness of the staff and even the client can be contributing factors to low utilization or adoption of telehealth. Patients and providers have differing levels of experience and comfort using telehealth equipment, which is a major contributing factor when evaluating the usefulness of the service. Thorough education and ongoing support can alleviate some of these concerns, but in instances where support or knowledge may be lacking, the likelihood of telehealth use is far lower than with those who are more comfortable or willing to learn how to use the equipment (Pammer et al., 2001).

Table 1. Characteristics to Consider for Determining the Appropriateness of Telehealth

Table 1. Characteristics to consider for determining the appropriateness of telehealth.

Characteristic	Appropriate for telehealth
Visit type	Follow-up visit for known/diagnosed disease state or patient condition
	Follow-up postprocedure visit with no patient complaints
	Recurring medication or chronic medical condition review
	Initial or follow-up visit for mental health conditions
Patient characteristics	Existing, trusting, personal connection with the provider
	High health literacy
	Robust social support system
	Anxious in health care settings
	Lives remotely or has inadequate transportation
	Prefers telehealth
Chief complaint or disease state characteristics	Physical examination unlikely to be diagnostic
	N/A[a]
	Focused physical examination can be performed virtually (ie, visual examination)
	Chief complaint with standardized initial workup and management
Other considerations	English as a second language (interpreter required)
	Patient or close family member technologically savvy
	Patient with multiple family members at home who can join telehealth visit

[a]N/A: not applicable.

Patient perception, including reports of discrimination, has been reported as potential barriers to utilizing telehealth. For example, a survey of adolescents in one heavily diverse facility found that those between the ages 12-21 years who were Latino, Black, or Black identifying as Somali, reported reluctance to utilize telehealth as they had experienced racism and/or discrimination in the past, lacked a private area to participate, had difficulty with internet connectivity or technology, harbored apprehension regarding the quality of the physical exam and/or had concerns surrounding the potential disclosure of private information from provider to parent(s) (Gerwitz et al., 2022).

2.7 Similar Studies

This study's data analysis compared the number of emergency department visits for complications related to diabetes in children with Type 1 DM, enrolled in telehealth services to those who are not (inclusive only of those privately insured). Rui et al. (2019) looked at the number of emergency department visits per 10,000 persons for a defined age group throughout the US over several years which yielded a logical way to display and represent their data, therefore, this methodology was applied to this project and data is reflective of statistics per 1000 claims and per 1000 visits, allowing a clear trend to emerge. Shehab et al. (2016), also took a similar approach with their study that reviewed the number of outpatient adverse drug events in the United States for a 12-month reporting period. Utilizing public health surveillance data, they were able to obtain the number of ED visits that were directly related to adverse drug events in an outpatient setting and reported in X number of events per 1000 individuals, similar to what was seen in the prior study.

While it is important to consider the challenges that may be unique to children who receive Medicaid services, these same challenges may skew the results of this project topic. For example, in an issue brief published by the Kaiser Family Foundation (2019), Musumeci et al. explained that children receiving Medicaid services tend to have poorer health, multiple comorbidities, and chronic health conditions compared to children who are privately insured. They emphasized that children who are insured by Medicaid are more likely to require more medical services throughout the course of a year as opposed to children privately insured. To this point, this research project focused on children who were privately insured to account for any potential for data to become skewed or difficult to evaluate due to a multitude of chronic healthcare conditions experienced by children under Medicaid services. The objective of this research review was to examine children who were newly diagnosed with Type 1 diabetes mellitus and attempt to show the use of telehealth services did not increase the probability of the child developing diabetes-related acute complications as evidenced by an increase in emergency department claims/visits within the index period. Acute complications are defined as hypoglycemia (to include coma), hyperglycemia (to include coma), diabetic ketoacidosis (DKA), and acute kidney injury (to include diabetes mellitus as a diagnosis code and contributing factor). Also included were diagnoses for emergency department care if directly attributable to diabetes mellitus (e.g., influenza, pneumonia, gastroenteritis, infection). A full list of ICD-10 codes included in this review is in Appendix A. We hypothesized that during the COVID-19 pandemic, the use of telehealth services had a positive impact on disease management for patients diagnosed with Type 1 diabetes mellitus which would be evidenced by stable ED utilization rates.

Maniatis et al. (2005) studied the incidence and severity of diabetic ketoacidosis (DKA) in children who were newly diagnosed with Type 1 diabetes mellitus and were insured by Medicaid. While their study includes one of the complications this project discusses (DKA), it is very focused on one medical treating facility, which was more limited than the study sample that this research paper used. This was taken into consideration during the data collection phase of this study. The use of a statistical sampling tool was not necessary as the data pull was able to be represented by using data reflected as proportions (per 1,000 claims/visits).

3 CHAPTER III METHODOLOGY

3.1 Research Design and Method

This study employed a retrospective descriptive cohort design to examine the trend of telehealth uses between March 2020 and December 2020 (the outbreak of COVID-19) by children ages 0-12 years newly diagnosed with Type 1 diabetes mellitus continuously enrolled in the 2019-2020 IBM Watson Health MarketScan® Commercial Claims and Encounters (CCAE) databases. We are the first, to our knowledge, to examine the impact of telehealth use by children with Type 1 diabetes mellitus on subsequent ED visits since the outbreak of the COVID-19 pandemic in the United States. We chose this study period because we were able to identify sizable telehealth uses by children ages 0-12 years newly diagnosed with Type 1 diabetes mellitus (DM) with continuous enrollment (Figure 3.1).

Figure 3. 1 Telehealth Visit Claims per 1,000 Claims by Children Newly Diagnosed with Type 1 DM

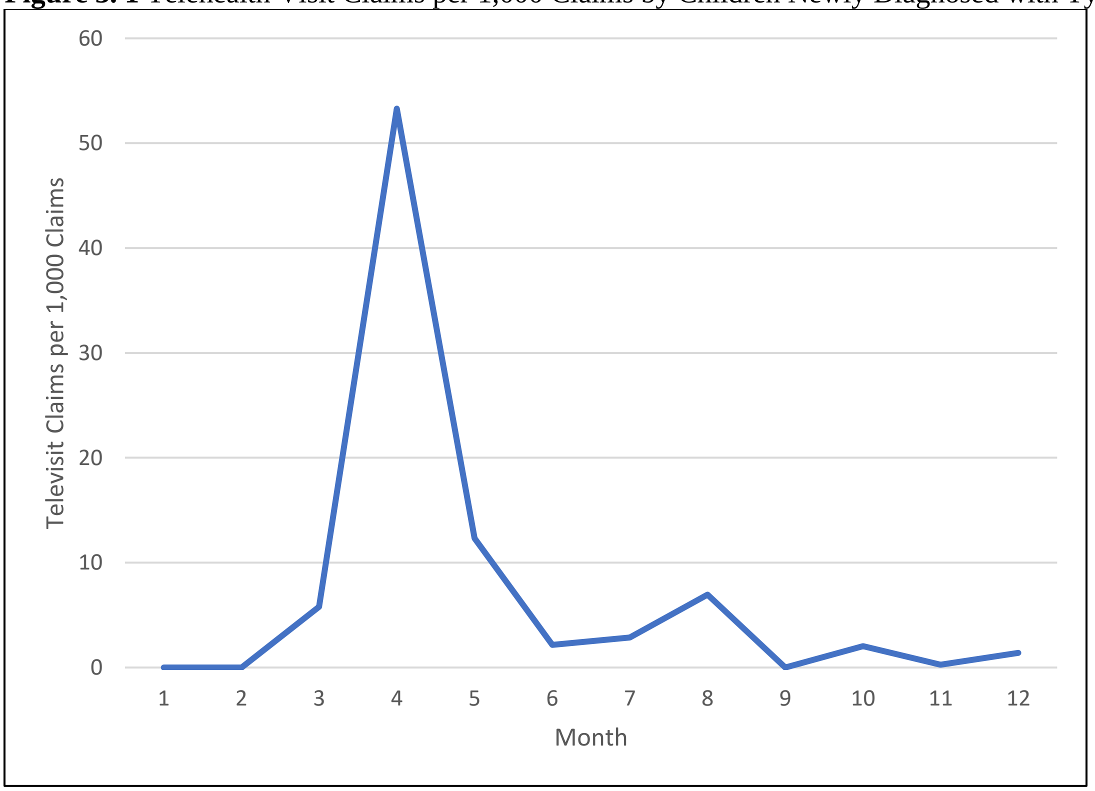


Figure 3.1. Increase in rates of telehealth visit claims by children newly diagnosed with Type 1 DM (ages 0-12) since March 2020, from authors' analyses of data from 2020 IBM Watson Health MarketScan® Commercial Claims and Encounters (CCAE) databases, N=67,049.

Given that telehealth uses among children with Type 1 diabetes mellitus started to increase significantly in March 2020, our study period allowed us to examine the joint impact of the COVID-19 measures and changes in both providers' and patients' behaviors on telehealth uses.

3.2 Sample Selection

This study included children ages 0-12 years: 1) with continuous enrollment between 2019 and 2020; 2) without any Type 1 diabetes mellitus-related diagnoses between January 2019 and June 2019 (pre-index period); and 3) with a new Type 1 diabetes mellitus related diagnosis between July 2019 and February 2020 (index period). Type 1 DM-related diagnoses were identified using ICD-10-CM codes (Appendix A). The claims from telehealth visits were identified using the Current Procedural Terminology (CPT) codes.

Children who were chosen for this study were relatively early in their diagnosis as this cohort of patients can be especially difficult to treat due to the "honeymoon" phase that many newly diagnosed individuals with Type 1 DM experience. This is characterized by a period of remission in which the body's need for exogenous insulin drastically decreases and rarely, however not impossible, ceases (Abdul-Rasoul et al., 2006). This honeymoon phase can last from as little as a month to over a year. Because of this phenomenon, patients often present to the ED or their provider in distress as insulin administration has been decreased or discontinued and blood glucose levels may not be monitored closely; signs of hyperglycemia can be subtle until a crisis, making this a critical medical event. In addition, the establishment of an interdisciplinary care team is crucial to positive patient outcomes but relies heavily on patient and parent/guardian involvement within this age group as well as the timeframe to diagnosis. Because this age group is vulnerable defined by a decreased ability to communicate signs and symptoms timely and accurately, and the reliance on others for everyday care and disease management, they become a crucial group to study as the pandemic changed the way in which care was delivered for most healthcare institutions.

3.3 Instrumentation

This project utilized the 2019-2020 IBM Watson Health MarketScan® Commercial Claims and Encounters (CCAE) databases, specifically, the Outpatient Services Tables and the Annual Enrollment Summary Tables. This data tool was selected for the vast amount of claims data it includes for over 245 million unique patients since 1995 (IBM Watson Health, 2018). The goal was to evaluate the ED utilization rates of those using telehealth compared to those who used in-person services. The IBM Marketscan Database has been featured in numerous peer-reviewed publications since 1990, solidifying its place as one of the most widely used databases for life science research (IBM Watson, 2018). IBM Watson Health (2018) outlined limitations of their data including potential biases due to the non-randomization of samples, and underrepresentation of small or medium size employers, and accessing the data requires special software and at times program support.

3.4 Data Set Description

In 2016, the IBM Watson Health MarketScan® Commercial Claims and Encounters (CCAE) databases contained greater than 43.6-million-person years of data (CDC.gov, 2021). These data contain a convenience sample of claims for commercial insurers to include point of service and indemnity plans as well as health maintenance organizations (HMOs), fee for service and full capitation, etc. (CDC.gov, 2021). The databases allow end users to review care level encounter specifics including diagnoses, procedure codes, insurance payments, and patient demographics and characteristics per claim. While demographic data is dependent upon enrollment forms, it should be noted that this could be a limitation of the dataset and full representation of patient characteristics (CDC.gov, 2021).

3.5 Data Collection/Procedure

Utilizing the IBM Watson Health MarketScan® Commercial Claims and Encounters (CCAE) databases, we identified 2883550 and 2336192 children ages 0-12 years with continuous enrollment in 2019 and 2020, respectively. Using ICD-10 codes, children were excluded from this study if the period of DM diagnosis was within the pre-index period (Jan 2019-June 2019), subsequently, revealing new diagnoses occurring within the index period (July 2019-Feb 2020). The number of children in our final sample between March 2019 and March 2020 is 653 (throughout the United States).

The data was collected nationally as this study's goal was to evaluate the effect of telehealth visits on subsequent ED utilization during the pandemic.

3.6 Independent and Dependent Variables

The first outcome variable was the probability of an ED claim. The second outcome variable is the probability of a daily ED visit. The independent variable of interest is a binary indicator for time since a telehealth visit (since a telehealth visit=1; 0 otherwise). Covariates include gender, age, metropolitan statistical area (MSA), and state residence.

3.7 Data Analysis

This study employed two linear regression models to study the effect of a telehealth visit on each outcome: 1) a two-way fixed effect model controlling for individual and month fixed effects; and 2) a fixed effect model controlling for the effects of demographics and, state and month fixed effects. Robust standard errors were estimated for all models to account for the heteroskedasticity in the probability distribution.

1. Model specifications to examine the effect of telehealth visits on the probability of subsequent ED claims:

    I. Two-way fixed effects model:

$$y_{ct} = \alpha + \beta Televisit_{ct} + \delta_i + \eta_m + \varepsilon_{ct},$$

Where

y_{ct}: a binary variable with “0” indicating a non-ED claim and “1” indicating an ED claim for an individual’s claim *c* on day *t*.

$Televisit_{ct}$: a binary variable with “1” indicating the period since a telehealth visit for an individual’s claim *c* on day *t* and “0” otherwise.

δ_i: individual fixed effects.

η_m: month fixed effects.

    II. State and month fixed effects model

$$y_{ct} = \alpha + \beta Televisit_{ct} + \gamma Dem_{ct} + \delta_s + \eta_m + \varepsilon_{ct},$$

Where

y_{ct}: a binary variable with “0” indicating a non-ED claim and “1” indicating an ED claim for an individual’s claim *c* on day *t*.

$Televisit_{ct}$: a binary variable with “1” indicating the period since a telehealth visit for an individual’s claim *c* on day *t* and “0” otherwise.

Dem_{ct}: a vector of demographic covariates: gender, age, MSA, and state residence.

δ_s: state fixed effects.

η_m: month fixed effects.

2. Model specifications to examine the effect of telehealth visits on the probability of subsequent daily ED visits:

I. Two-way fixed effects model:

$$y_{it} = \alpha + \beta Televisit_{it} + \delta_i + \eta_m + \varepsilon_{it},$$

Where

y_{it}: a binary variable with "0" indicating a non-ED visit and "1" indicating an ED visit by an individual *i* on day *t*.

$Televisit_{it}$: a binary variable with "1" indicating the period since a telehealth visit by an individual *i* on day *t* and "0" otherwise.

δ_i: individual fixed effects.

η_m: month fixed effects.

II. State and month fixed effects model

$$y_{it} = \alpha + \beta Televisit_{it} + \gamma Dem_{it} + \delta_s + \eta_m + \varepsilon_{it},$$

Where

y_{it}: a binary variable with "0" indicating a non-ED visit and "1" indicating an ED visit by an individual *i* on day *t*.

$Televisit_{it}$: a binary variable "1" indicating the period since a telehealth visit by an individual *i* on day *t* and "0" otherwise.

Dem_{it}: a vector of demographic covariates: gender, age, MSA, and state residence.

δ_s: state fixed effects.

η_m: month fixed effects.

4 CHAPTER IV RESULTS

4.1 Results/Findings

4.1.1Results at the Claim Level

653 children were included in the final sample for the review period and were considered newly diagnosed with Type 1 DM per screening criteria. There were 67499 total claims from March 2020 through December 2020 (Table 2).

Table 2. Total ED Claims and Telehealth Claims from March 2020 through December 2020

	N	Proportion
Total ED Claims	1,158	0.01715581
Total Telehealth Claims	450	0.006666765
Total Claims	67,499	

This data was further analyzed to show the proportion of ED claims and Telehealth claims per 1,000 total claims (Figure 4.1) over time. The total number of ED claims was highest in March 2020 at 31 per 1,000 claims; however, the highest number of telehealth claims was seen in April 2020 at 53 per 1,000 claims.

Figure 4. 1 Total ED and Telehealth Claims per 1,000 Claims by Children Newly Diagnosed with Type 1 DM

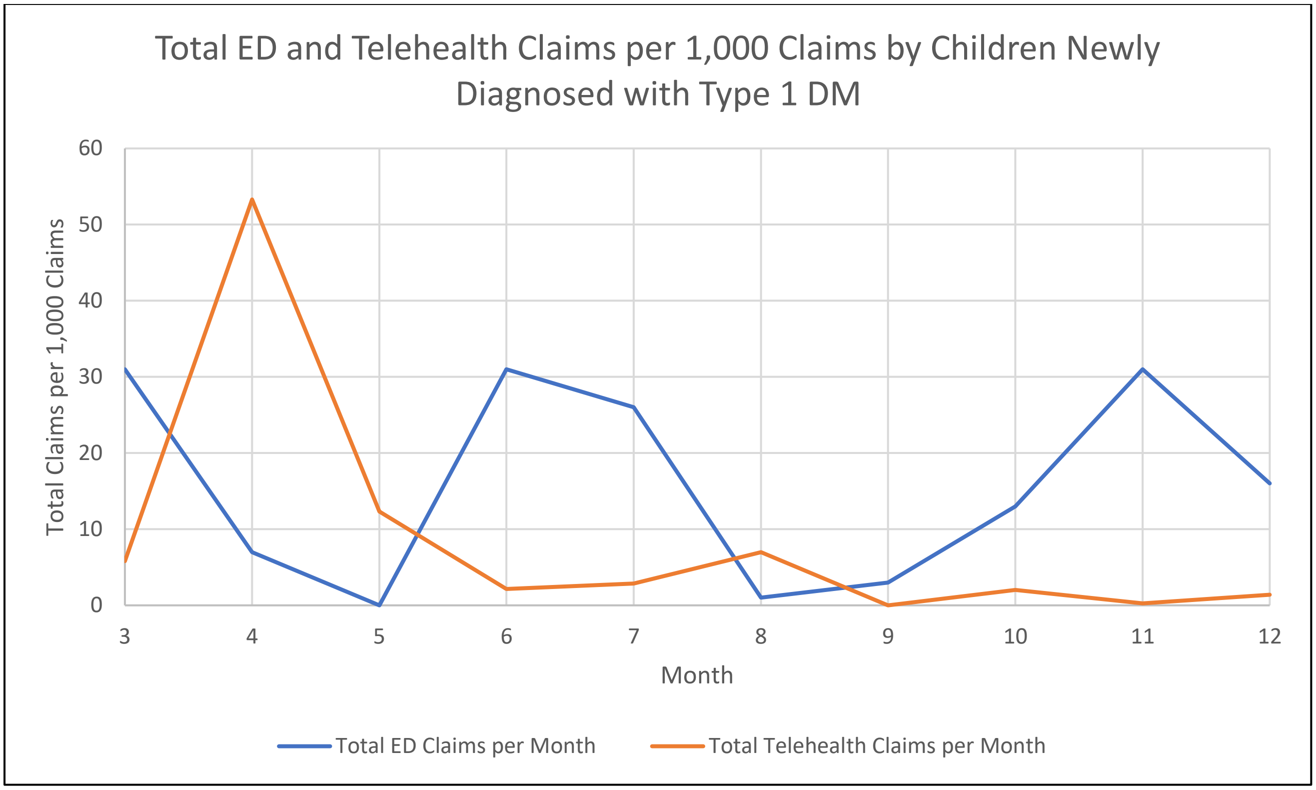


Figure 4.1. Total ED and telehealth claims per 1,000 claims by children newly diagnosed with Type 1 DM (ages 0-12) since March 2020, from authors' analyses of data from 2020 IBM Watson Health MarketScan® Commercial Claims and Encounters (CCAE) databases, N=67,499.

A comparison review was completed to look at ED claims since a telehealth visit versus ED claims without a previous telehealth visit. For ED claims since a telehealth visit, 0 claims per 1,000 claims were identified for 9 out of 10 months from March 2020 through December 2020, except September when there were 6. Upon reviewing ED claims without a previous telehealth visit, we can see the largest number of claims occurring in March, June, and November, each with over 30 claims per 1,000 claims (Figure 4.2).

Figure 4. 2 Comparison of Total ED Claims per 1,000 Claims with and without a Previous Telehealth Visit

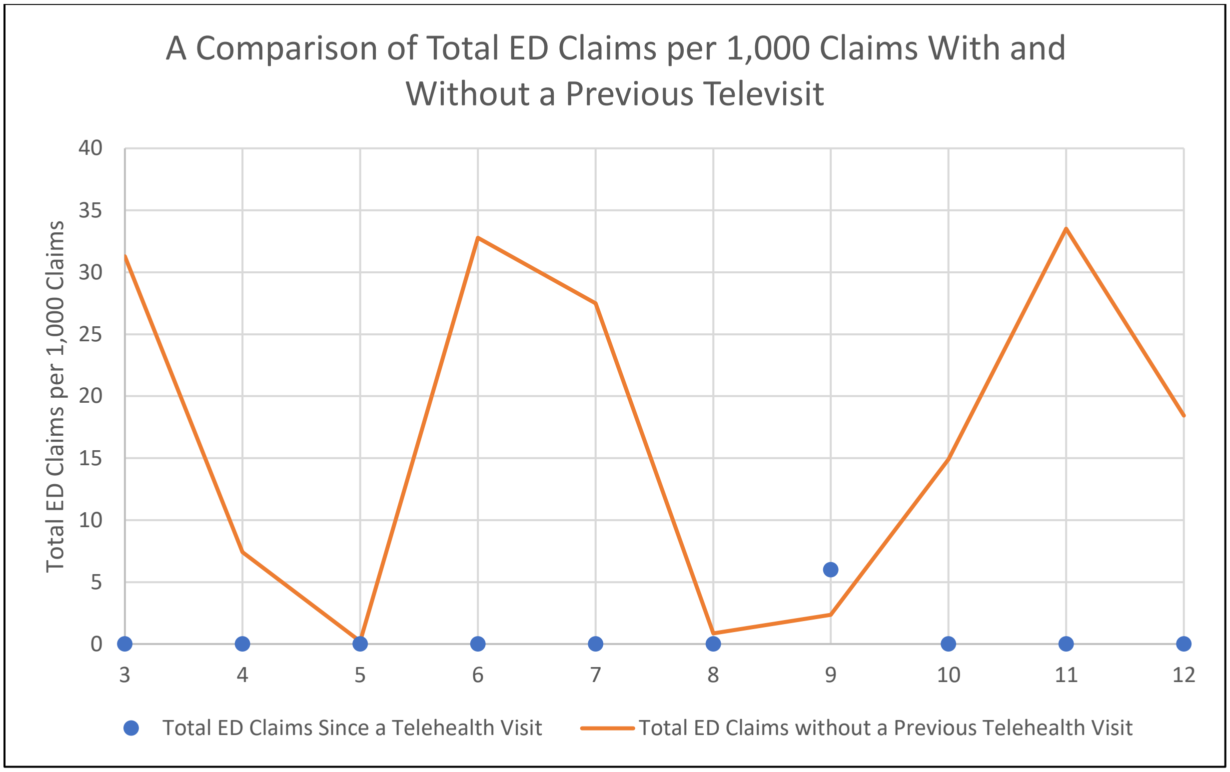


Figure 4.2. A comparison of the total ED per 1,000 claims with and without a previous telehealth visit by children newly diagnosed with Type 1 DM (ages 0-12) since March 2020, from authors' analyses of data from 2020 IBM Watson Health MarketScan® Commercial Claims and Encounters (CCAE) databases, N=67,499.

This analysis shows that telehealth visits may be effective in preventing ED claims.

4.1.1.1 The Effect of Telehealth Visits on the Probability of Subsequent ED claims (two-way fixed effects model).

On average, telehealth visits were associated with a 2.7% (*P*<0.001; 95% CI [-3.5%, -1.8%]) reduction in the probability of subsequent ED claims from the baseline probability of 1.9%, which is the probability of having ED claims without a prior telehealth visit (Table 3). The linear probability model is unbounded; therefore, the small negative value of the probability of ED claims with a prior telehealth visit indicating the probability of ED claims with a prior telehealth visit is close to 0.

Table 3. Individual Fixed Effects Model for ED Treatment Since a Telehealth Visit

	Coefficient	P>t	95% Confidence Interval	
Period since a telehealth visit	-0.02674	0	-0.0354555	-0.01803
Baseline predicted probabilities: Without a prior telehealth visit With a prior telehealth visit	 0.0190143 -0.0077276			
Month- Baseline March				
4	-0.01509	0	-0.0185617	-0.01162
5	-0.01447	0	-0.0174285	-0.01151
6	0.01241	0	0.0091649	0.015655
7	0.00214	0.333	-0.0021948	0.006486
8	-0.01276	0	-0.0155321	-0.00999
9	-0.01192	0	-0.014844	-0.00899
10	-0.00005	0.692	-0.0032337	0.002148
11	0.00405	0.036	0.0002724	0.007841
12	-0.01055	0	-0.0147772	-0.00633
N=67,499				
R-squared=0.30				

Note: Individual fixed effects not reported

4.1.1.2 The Effect of Telehealth Visits on the Probability of Subsequent ED claims (state and month fixed model with demographic controls).

The descriptive analysis lists total claims, claims since a telehealth visit, and covariates to include gender, metropolitan area, and age. The number of associated ED claims was 1158 (1.7%), and the total associated telehealth claims were 450 (0.6%). 67499 total claims were included in this review. The total claims since a telehealth visit were 4,691 (7.0%). Gender was controlled with 1 denoting male and 2 denoting female. For males, there were 39289 total claims (58.21%), and for females, 28210 (41.79%). Those residing in metropolitan areas are denoted by 1, compared to those not residing in metropolitan areas denoted by 0. For MSA, there were 52989 total claims (78.5% of total claims), and for not MSA, there were 14510 total claims (21.5% of total claims). The majority of the total claims for this study included individuals residing in metropolitan areas. Age was reported as a continuous variable with a mean of 8.5 years and a standard deviation of 2.9; max years remained at 12 (Table 4).

Table 4. Descriptive Table for States Fixed Effects Model

		Total Claims N= 67,499	Proportion	Mean (SD)	Min	Max
Total ED Claims		1,158	1.7%			
Total Telehealth Claims		450	0.6%			
Claims since a Telehealth Visit						
	0	62,808	93.0%			
	1	4,691	7.0%			
Gender of Patient						
	Male	39,289	58.2%			
	Female	28,210	41.8%			
MSA						
	0	14.510	21.5%			
	1	52,989	78.5%			
Age		67,499		8.5 (2.9)	1	12

Table 4. Total claims data since March 2020, from authors' analyses of data from 2020 IBM Watson Health MarketScan® Commercial Claims and Encounters (CCAE) databases, N=67,499; 653 total children.

Here, we replaced individual fixed effects with demographic controls (Table 5) and the results are consistent with the two-way fixed effects model. On average, telehealth visits were associated with a 1.1% (P<0.001; 95% CI [-1.4%, -0.9%]) reduction in the probability of subsequent ED claims from the baseline probability of 1.8%, which is the probability of having ED claims without a prior telehealth visit. The R-square (0.07) is smaller than that of the two-way fixed effect model (0.30), indicating that individual fixed effects explained most of the variability in ED visits.

Table 5. State and Month Fixed Effects Model for ED Treatment Since a Telehealth Visit

	Coefficient	P>t	95% Confidence Interval	
Period since a telehealth visit	-0.01127	0	-0.01367	-0.00887
Baseline predicted probabilities: Without a prior telehealth visit With a prior telehealth visit	0.017939- 0.006668			
Month- Baseline March				
4	-0.02478	0	-0.02897	-0.02059
5	-0.02651	0	-0.02987	-0.02316
6	0.003799	0.111	-0.00088	0.008478
7	-0.01218	0	-0.01638	-0.00797
8	-0.02468	0	-0.02817	-0.02119
9	-0.02667	0	-0.03018	-0.02316

Table 5. Continued

10	-0.00931	0	-0.01351	-0.00511
11	0.005674	0.025	0.000716	0.010632
12	-0.01866	0	-0.02297	-0.01435
2.Sex	-0.02133	0	-0.02349	-0.01918
1.MSA	-0.01532	0	-0.01982	-0.01082
Age	0.001009	0	0.000719	0.001299
N=67,499				
R-squared= 0.07				

Note: state fixed effects not reported

4.1.2 Results at Day Visit Level

Here, we looked at individual ED day visits as well as individual telehealth days and then broke this data down to look at individual day visits per month (both ED and telehealth) beginning in March 2020 and ending in December 2020 to identify trends. The total number of day visits was 3,937. ED day visits were a rare event at 48 or 1.22% per 1,000 visits and total individual telehealth days were slightly more at 81 or 2.06% per 1,000 visits, but given the pandemic, this was expected (Table 6).

Table 6. Total ED and Telehealth Day Visits for March 2020 through December 2020

	N	Proportion
Total ED Daily Visits	48	1.22
Total Telehealth Daily Visits	81	2.06
Total Daily Visits	3,937	

The month-by-month analysis began in March 2020 and extended through December 2020 and allowed for the identification of trends if they existed. The highest number of individual ED day visits was seen in March with a total of 12 (26.49% per 1,000 visits) with 453 total day visits for the month and the lowest in May, with just 1 ED day visit (2.64% per 1,000 visits) compared to 379 total day visits for the month. There was a spike in telehealth visits in April and then began to level out from May to December 2020. ED day visits dipped after the declaration of the COVID-19 pandemic and then also began to level out in the following months (figure 4.3).

Figure 4. 3 Total Day Visits by Children Newly Diagnosed with Type 1 DM

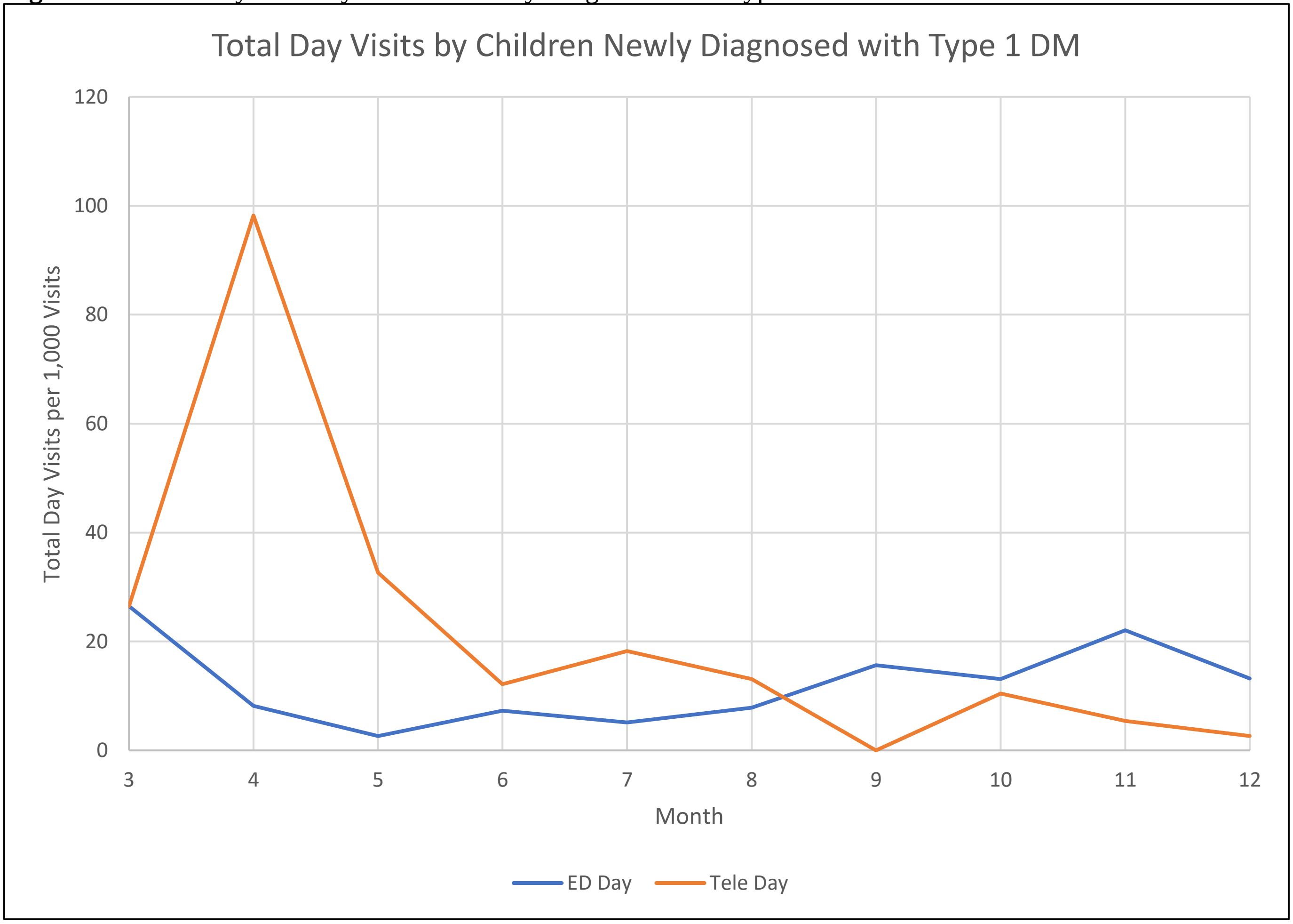


Figure 4.3. The total day visits (ED and Tele) by children newly diagnosed with Type 1 DM (ages 0-12) since March 2020, from authors' analyses of data from 2020 IBM Watson Health MarketScan® Commercial Claims and Encounters (CCAE) databases, N=3937.

Individual ED day visits since a telehealth visit compared to individual ED day visits without a telehealth visit were graphed to show a comparison of this data. As in the first level review, the number of ED day visits was 0 for all months (March 2020 through December 2020) with the exception of September which had 1. September had 28 total day visits, therefore, the proportion of ED day visits since a telehealth visit was 35.71%. ED day visits without a telehealth visit also showed a similar trend to the total claims analysis with slightly more ED day visits when there was no identified telehealth visit. March 2020 had the highest number at 12 (27.21%) ED day visits out of 441 total day visits, while May 2020 saw the lowest with 1 (2.86%) ED day visit for the 350 total day visits (Figure 4.4).

Figure 4. 4 Total Day Visits by Children Newly Diagnosed with Type 1 DM since a Telehealth Visit versus ED Days without a Telehealth Visit

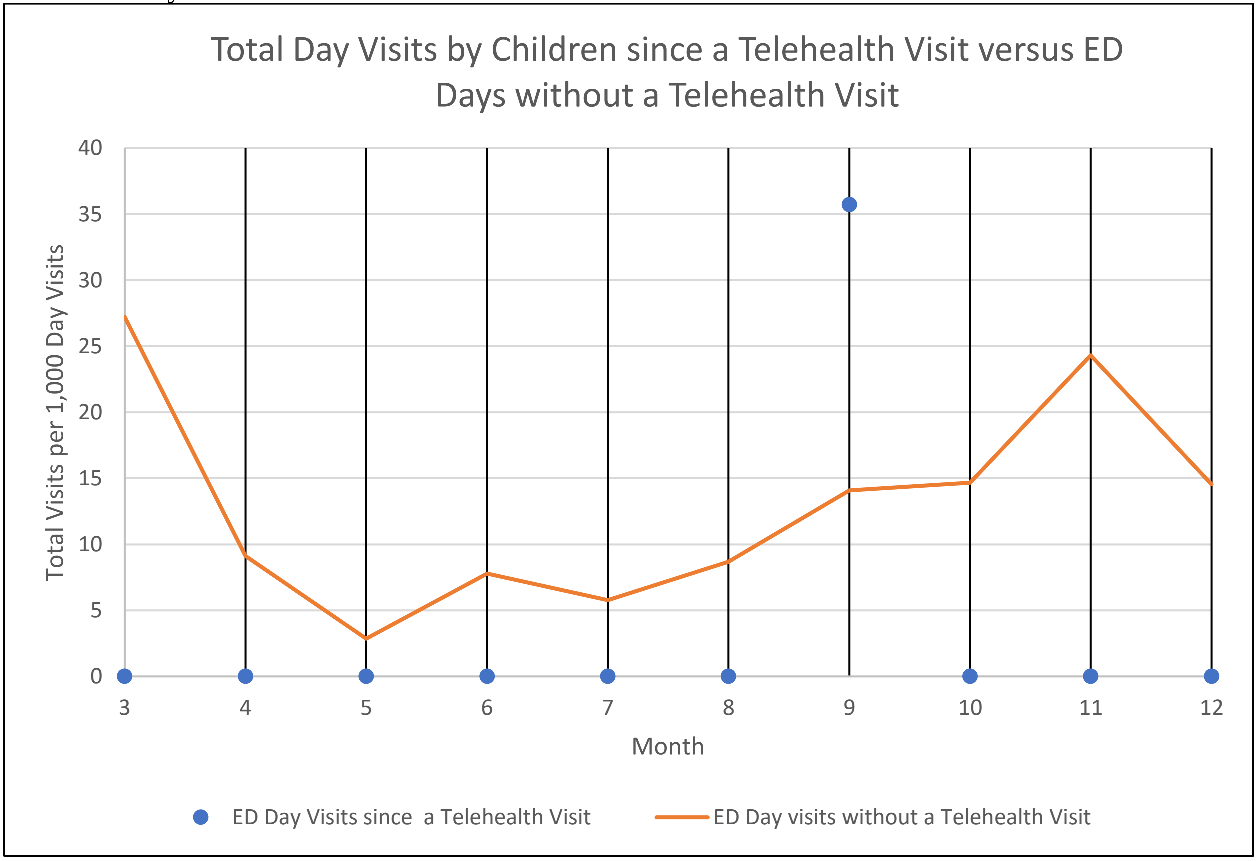


Figure 4.4. A comparison of the total ED day visits (ED day visits since a telehealth visit and ED day visits without a telehealth visit) by children newly diagnosed with Type 1 DM (ages 0-12) since March 2020, from authors' analyses of data from 2020 IBM Watson Health MarketScan® Commercial Claims and Encounters (CCAE) databases, N=3937.

Following this analysis, we can conclude that telehealth visits may be effective in preventing individual ED day visits.

4.1.2.1 The Effect of Telehealth Visits on the Probability of Subsequent ED Day Visits (two-way fixed effects model).

Telehealth visits were not associated with a significant change in the probability of subsequent ED day visits. Therefore, telehealth visits were comparable to in-person visits in terms of the association between non-emergency day visits and the subsequent probability of ED day visits.

Table 7. Individual Fixed Effects Model for ED Day Visits Since a Telehealth Visit

	Coefficient	P>t	95% Confidence Interval	
Period since a telehealth visit	-0.01887	0.241	-0.0504503	0.012708
Baseline predicted probabilities: Without a prior telehealth visit With a prior telehealth visit	 0.01374 -0.00513			
Month- Baseline March				
4	-0.01099	0.221	-0.0285768	0.006601
5	-0.01809	0.026	-0.0340019	-0.00218
6	-0.01599	0.036	-0.0309073	-0.00107
7	-0.01366	0.084	-0.0291651	0.00184
8	-0.01095	0.177	-0.0268318	0.004932
9	-0.00837	0.348	-0.0258522	0.009107
10	-0.0074	0.362	-0.0233253	0.008528
11	-0.00095	0.928	-0.0216199	0.019716
12	-0.00947	0.293	-0.0271119	0.008169
N=3,937				
R-squared= 0.21				

Note: individual fixed effects are not reported.

4.1.2.2 The effect of telehealth visits on the probability of subsequent ED days (state and month fixed model with demographic controls).

Again, telehealth visits were not associated with a significant change in the probability of subsequent ED day visits. Therefore, telehealth visits were comparable to in-person visits in terms of the association between non-emergency day visits and subsequent probability of day ED visits.

A total of 3937 daily ED visits were included in this review. The number of days since a telehealth visit is 323, number of days without a telehealth visit is 3,614. Gender was also included with 1 denoting male and 2 denoting female. For males, there were 2062 daily visits (52.37%), and for females, 1875 (47.63%). Also, displayed is the percentage of those residing in metropolitan areas denoted by 1, compared to those not residing in metropolitan areas denoted by 0. For MSA, there were 2,992 daily visits (76% of total daily visits), and for not MSA, there were 945 daily visits (24% of total daily visits). The majority of the daily visits for this study included individuals residing in metropolitan areas. Age was reported as a continuous variable with a mean of 8.64 years and a standard deviation of 2.73; max years remained 12.

Table 8. Descriptive Table for Total Daily ED visits for States Fixed Effects Model

		Total Daily ED Visits N = 3,937	Proportion	Mean (SD)	Min	Max
Total Days without a Telehealth Visit		3,614	91.8%			
Total Days with a Telehealth Visit		323	8.2%			

Table 8. Continued

Gender of Patient						
	Male	2,062	52.37%			
	Female	1,875	47.63%			
MSA						
	0	945	24%			
	1	2,992	76%			
Age		3,937		8.64 (2.74)	1	12

A predictive probability analysis was completed for ED daily visits with an associated telehealth visit and without an associated telehealth visit. ED daily visits without a telehealth visit had a predictive margin of 0.012729, a p-value of 0, and a 95% confidence interval of 0.009116- 0.016343. The predictive probability of an ED daily visit with a telehealth visit is 0.00618, with a p-value of 0.126 and a 95% confidence interval of -0.00174- 0.014103. This shows that the probability of an ED daily visit is higher without a telehealth visit compared to a telehealth visit (0.012729 vs 0.00618) (Table 9). Demographic variables also controlled for included: female, not metropolitan area, and age, all not statistically significant with p-values >0.05.

Table 9. State Fixed Effects Model for ED Daily Visits Since a Telehealth Visit

	Coefficient	P>t	95% Confidence Interval	
Period since a telehealth visit	-0.00655	0.133	-0.0151	0.002004
Baseline predicted probabilities: Without a prior telehealth visit With a prior telehealth visit	 0.012729- 0.00618			

Table 9. Continued

Month- Baseline March				
4	-0.01709	0.044	-0.03373	-0.00045
5	-0.02187	0.004	-0.03667	-0.00707
6	-0.0185	0.026	-0.03481	-0.00219
7	-0.02024	0.009	-0.0354	-0.00508
8	-0.01673	0.045	-0.03307	-0.00039
9	-0.0099	0.29	-0.02821	0.008424
10	-0.01306	0.155	-0.03105	0.004937
11	-0.00263	0.8	-0.02294	0.017678
12	-0.01319	0.147	-0.03102	0.004641
2.Sex	0.003421	0.133	-0.0151	0.002004
1.MSA	0.002193	0.577	-0.00552	0.009905
Age	0.000347	0.496	-0.00065	0.001345
N=3,937				
R-squared= 0.03				

Note: State-fixed effects not reported

A heat map showing daily ED visits per 1,000 patients and daily telehealth visits per 1,000 patients provides a depiction of the minimal overlap that was seen when analyzing the relationship between daily ED visits and daily telehealth visits. While there may be individual reasons as to why an individual state or region saw a larger number of ED or telehealth visits, statistically, there was not a large overlap and again, we can state that from this analysis, it does not appear that a telehealth visit increased the probability of an ED visit over time (Figures 4.5 and 4.6).

Figure 4. 5 Daily ED Visits per 1,000 Patients

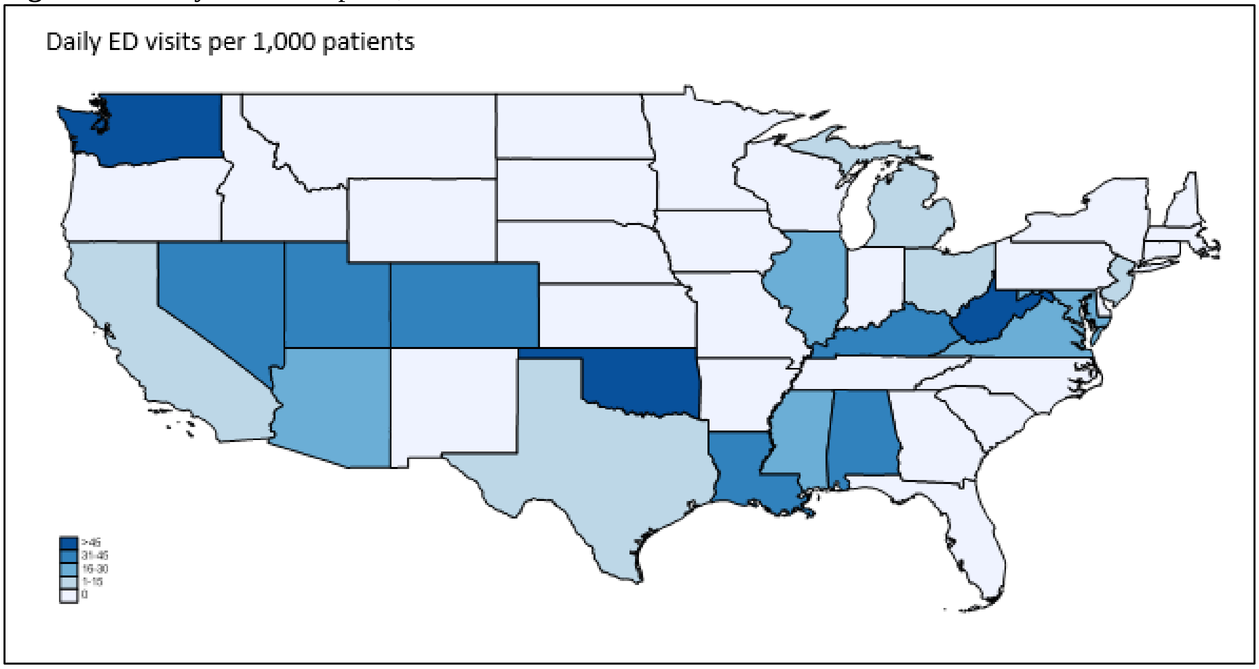
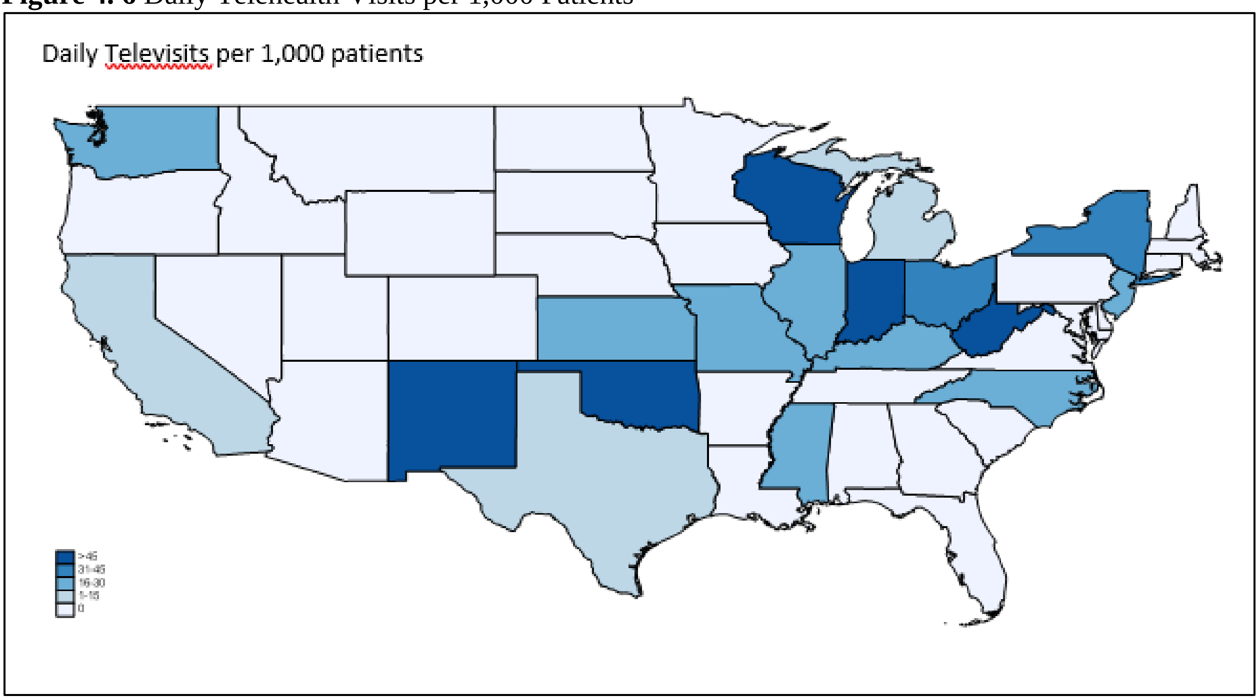


Figure 4. 6 Daily Telehealth Visits per 1,000 Patients



5 CHAPTER V DISCUSSION

5.1 Discussion of Results

The COVID-19 pandemic brought many challenges to the healthcare space, from how patients would seek care to how healthcare systems and practices would deliver care. For most organizations, the answer was virtual health. While many were poised for the quick expansion of telehealth care, others were not, however, the uncertainties abounded for everyone. Legislation was quickly erected to amend prior policies governing telehealth reimbursement and allowed for telehealth services to be covered beyond those residing in rural and underserved areas and permitted telehealth care to be delivered to the patient's home. Services were also expanded to include rehabilitation-related care, expansion of remote patient monitoring, end-stage renal disease services, and mental healthcare to include group visits.

While policymakers were quickly reacting to ensure patients could seek telehealth modalities and healthcare entities were evaluating infrastructure and resources, there remained a concern regarding the quality of care that was being delivered if virtual health became the first line of care delivery versus in-person care. There were questions regarding provider competencies and how well-versed they were in assessing a patient remotely, in addition to when the right time was to bring a patient in for treatment. As somewhat of a foreshadowing, in 2016, the American Medical Association released new ethical guidelines regarding telehealth and the responsibilities of the physician to uphold these guidelines when interacting with patients via virtual care as well as the expectation that the provider would partner with their organization to develop and improve policy (AMA, 2023). The AMA reinforced these guiding principles in the wake of the pandemic. These guidelines outline the expectation that the physician remains up to date in their knowledge regarding telehealth policy, advocate for their patients if remote care was the most feasible, appropriate, and practical means by which the patient would seek services, uphold expectations of patient privacy, practice sound medication prescribing practices, and always gain skills and remain proficient in the use of telehealth equipment and care delivery technologies.

Post-pandemic, the question remains, how well did our patients fare? More specifically, how well did the most vulnerable progress or cope in terms of health maintenance during a time when health inequities were certain to be exacerbated? Healthcare saw mass retirements, increases in work-related burnout rates, and a society politically divided which led to many leaving their place of employment if they disagreed with policy practices regarding COVID-19 vaccinations.

While still recovering, we have started to look at healthcare quality during the pandemic timeframe as more data becomes available. This study sought to evaluate emergency department utilization rates for acute complications related to Type 1 diabetes in newly diagnosed children ages 0-12 years as an indicator of the quality of care related to telehealthcare enrollment. It is important to begin to understand if telehealth contributed to higher ED utilization for complications related to disease processes for those not able to obtain in-person appointments, which was a large shift from what was the norm pre-pandemic.

Using the IBM Watson Health MarketScan® Commercial Claims and Encounters (CCAE) databases, over 67,000 claims were analyzed for ED and telehealth-related services specific to Type 1 diabetes care for children privately insured, 0-12 years in age and newly diagnosed throughout the United States. A total of 1158 ED claims and 450 telehealth claims were gleaned from this analysis. When the pandemic was declared in March 2020, there were 279 ED claims logged for this sample, while April 2020 saw just 29 and then only one in May. Yale Medicine created a timeline of the pandemic for 2020 and reported that May efforts to slowly reopen the economy and "normalize," led to an uptick in COVID-19 cases in June (Katella, 2021), which does correlate with the data for ED utilization, as we saw an increase in ED related claims in June at 227. As ED claims would increase and decrease over the study year, we were able to correlate that data with telehealth-related claims. Most dramatically noting that April saw 224 telehealth claims while only 29 ED visits. We can associate the rise of telehealth claims to be in relation to efforts to keep patients out of the hospital and managed at home.

Through the ED claims analysis (identified using CPT codes), we found that ED claims associated with those patients who were enrolled in a telehealth program were lower than those who were not enrolled in a telehealth program. In total, there were 2 ED claims since having a telehealth visit and 1156 ED claims with no previous telehealth visit related to Type 1 DM care. To further evaluate treatment since a telehealth visit, in relation to ED claims, the regression analysis using an individual fixed effects model showed a telehealth claim led to a 2.6% reduction in the probability of an ED claim. Gutovitz et al. (2021) discussed the decrease in ED utilization rates during the COVID-19 pandemic and presented two possibilities for the decline, with one of those being the increase in telehealth usage which may have had a direct impact on ED utilization as the typical urgent care visit would be handled via telemedicine versus a trip to the emergency room.

Using descriptive variables for the total ED claims review for the state fixed effects model, this study controlled for age, gender, and metropolitan area of residence (Section 4.1.1.2 *The Effect of Telehealth Visits on the Probability of Subsequent ED Claims*, Table 5). There was a statistical significance between the probability of ED claims for males as opposed to females, with being female showing a 2.1% reduction in the probability of a subsequent ED claim. Also, those residing in a metropolitan area had a 1.5% reduction in the probability of a subsequent ED claim as opposed to those not living in a non-metropolitan area. The mean age was 8.5 years. As widely discussed, challenges face rural populations in terms of access to broadband services, eHealth literacy, and education level (Chesser et al., 2016) which could help to explain the higher probability of ED claims for those in non-metropolitan areas as they may have limitations and barriers to enrollment in a telehealth program. More research is needed to understand if gender has a true impact on higher ED utilization rates for this study cohort.

Perhaps a better indicator of the impact of telehealth visits in relation to ED utilization for these children is the analysis of individual ED day visits and individual telehealth day visits linked to treatment for Type 1 DM care. Because claims data may have multiple claims within one visit (i.e., multiple claims may be submitted within one visit due to repetitive services), it is imperative to review individual day visits in addition to total claims data to garner both perspectives (Tyree et al., 2006). A strength of this study was the use of both models (total claims and total visits). Alternative models increase confidence that the data analysis is sound. Total individual day visits for March 2020 through December 2020 were 3,937, however, 48 of those were ED visits. Individual telehealth days were 81 for the same study period. While the events for both are rare, we can make the same correlation as seen with the total claims data in that, for April, there were 33 individual telehealth days compared to just 3 individual ED day visits congruent with the increase in telehealth services as in-person care quickly declined. ED day visits since having a telehealth visit and ED day visits without a telehealth visit also revealed a similar trend in that those that had a telehealth visit were less likely to have an ED visit. The regression analyses for both the individual fixed effects model and the state fixed effects model showed a decrease in the probability of an ED day visit with a telehealth visit as opposed to no telehealth visit, albeit not significant.

5.2 Limitations

This study used data from privately insured individuals, therefore, it may not be generalized to the Medicaid population. In addition, emergency department visits and telehealth visits overall were rare events in this study.

5.3 Future Research

Future work should focus on the use and efficacy of telehealth services to improve access to care and inform virtual health policy that may revert to pre-pandemic legislation in May 2023 when the Public Health Emergency Declaration ends. Much work has been done surrounding the burgeoning healthcare system as the price of care increases, supply chains have yet to return to pre-pandemic status, and healthcare staffing shortages are projected to increase by the year 2030 with more than 270,000 nurses needed. Telehealth may have solidified its place as a tool to help decrease emergency department utilization rates, improve healthcare access, and still allow the healthcare team to deliver high-quality care. Sieck et al. (2021) explained that access to technology and digital literacy has been referred to as the “super social determinants of health” as access to the internet, broadband connectivity, etc., allows for the individual or family unit to address all other social determinants of health. Further research should support this assertion that the inclusion of technology as a social determinant of health, elevates the use of virtual care as a way to address access to care barriers in not only rural but metropolitan areas as well.

Another recommendation for future work is to further analyze the correlations between region and telehealth usage compared to ED utilization. What we saw in the heat maps (Figures 4.5 and 4.6) is that the number of ED visits per 1,000 patients can at times be inversely proportionate to the number of Telehealth daily visits per 1,000 patients and the overlap was not significant. It should be noted that this is based on commercial data, therefore, further analysis is recommended for Medicaid recipients. For rural areas, we may see this data change as they may have larger numbers of children receiving state assistance and not utilizing telehealth services to the degree of those privately insured as internet access can present a challenge.

5.4 Conclusions

Evidence suggests that telehealth services may enable greater and quicker access to the patient's healthcare team and do not require traveling to a medical center for treatment. From a preventative care aspect, the thought is that symptoms will be identified and managed when they are first identified, thus leading to a decrease in acute diabetes-related complications, improving health outcomes, and the decreased need to seek care in the emergency department. The results from this study support this theory as telehealth visits may be effective in preventing ED utilization for children ages 0-12 years newly diagnosed with Type 1 DM as evidenced by a decrease in ED claims and ED day visits when there is an associated telehealth claim or visit.

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Appendix A

LIST OF ICD-10 CODES

E10.1 Type 1 diabetes mellitus with ketoacidosis

E10.10 Type 1 diabetes mellitus with ketoacidosis without coma

E10.11 Type 1 diabetes mellitus with ketoacidosis with coma

E10.2 Type 1 diabetes mellitus with kidney complications

E10.21 Type 1 diabetes mellitus with diabetic nephropathy

E10.22 Type 1 diabetes mellitus with diabetic chronic kidney disease

E10.29 Type 1 diabetes mellitus with other diabetic kidney complication

E10.3 Type 1 diabetes mellitus with ophthalmic complications

E10.31 Type 1 diabetes mellitus with unspecified diabetic retinopathy

E10.32 Type 1 diabetes mellitus with mild nonproliferative diabetic retinopathy

E10.33 Type 1 diabetes mellitus with moderate nonproliferative diabetic retinopathy

E10.34 Type 1 diabetes mellitus with severe nonproliferative diabetic retinopathy

E10.35 Type 1 diabetes mellitus with proliferative diabetic retinopathy

E10.36 Type 1 diabetes mellitus with diabetic cataract

E10.39 Type 1 diabetes mellitus with other diabetic ophthalmic complication

E10.4 Type 1 diabetes mellitus with neurological complications

E10.40 Type 1 diabetes mellitus with diabetic neuropathy, unspecified

E10.41 Type 1 diabetes mellitus with diabetic mononeuropathy

E10.42 Type 1 diabetes mellitus with diabetic polyneuropathy

E10.43 Type 1 diabetes mellitus with diabetic autonomic (poly)neuropathy

E10.44 Type 1 diabetes mellitus with diabetic amyotrophy

E10.49 Type 1 diabetes mellitus with other diabetic neurological complication

E10.5 Type 1 diabetes mellitus with circulatory complications

E10.51 Type 1 diabetes mellitus with diabetic peripheral angiopathy without gangrene

E10.52 Type 1 diabetes mellitus with diabetic peripheral angiopathy with gangrene

E10.59 Type 1 diabetes mellitus with other circulatory complications

E10.6 Type 1 diabetes mellitus with other specified complications

E10.61 Type 1 diabetes mellitus with diabetic arthropathy

E10.62 Type 1 diabetes mellitus with skin complications

E10.63 Type 1 diabetes mellitus with oral complications

E10.64 Type 1 diabetes mellitus with hypoglycemia

E10.65 Type 1 diabetes mellitus with hyperglycemia

E10.69 Type 1 diabetes mellitus with other specified complication

E10.8 Type 1 diabetes mellitus with unspecified complications

E10.9 Type 1 diabetes mellitus without complications