VISION THERAPY DELIVERED THROUGH TELEMEDICINE:

EVALUATION OF PATIENT EXPERIENCE AND EFFICACY

A thesis presented to the graduate faculty of New England College of Optometry in partial fulfillment of the requirements for the degree of Master of Science.

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This manuscript has been read and accepted by the Thesis Committee in satisfaction of the thesis requirement for the degree of Master of Science

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Abstract:

VISION THERAPY DELIVERED THROUGH TELEMEDICINE: EVALUATION OF PATIENT EXPERIENCE AND EFFICACY

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Purpose

The COVID-19 pandemic has brought telemedicine to prominence. Previous studies on telemedicine in eye care have assessed the impact of telemedicine on screening for retinal pathologies and low vision rehabilitation. The goal of this study was to report patient perspectives on telemedicine and to assess the efficacy of vision therapy (VT) delivery through telemedicine during the COVID-19 pandemic.

Methods

This study was conducted at the New England College of Optometry's VT clinic from April 2020 to March 2022. Between April and December 2020, patient perspectives on telemedicine were collected through a telephone-based survey (16 questions) after completing at least three virtual VT sessions. The survey asked about access to technology, prior experience with telemedicine, the usability of the telemedicine platform, and overall satisfaction. Efficacy was evaluated by conducting a retrospective chart review of patients who completed a majority (≥ 50%) of VT sessions via telemedicine between April 2020 and March 2022. Predefined criteria were used to categorize patients with binocular vision anomalies and determine treatment efficacy based on success/improvement in post-treatment clinical measures.

Results

Of the 27 participants that were eligible to be contacted, 23 participants (mean 19.62 years, SD 11.06, range 9-52) completed the satisfaction survey. A majority of participants (82.6%,

n = 19) connected to their telemedicine sessions through cable internet and used a laptop (47.8%, n = 11), a tablet (21.7%, n = 5) or a smartphone (30.4%, n = 7). 56.5% (n = 13) and 43.5% (n = 10) of participants reported the audio/video quality to be "excellent" or "very good/good" respectively. Of the 54.6% (n = 12) of participants who reported experiencing a technical disruption, 69.2% (n = 9) reported that the disruption affected less than 5% of the telemedicine session. Patient satisfaction was high with 65.2% (n = 15) of patients reporting to be "very satisfied" and 34.8% (n = 8) reporting to be "satisfied". 18 patients (mean age 18.2 years, SD 11.15, range 8-51) completed ≥ 50% of VT via telemedicine, with a mean of 15.44 total VT sessions and a mean of 12.66 telemedicine VT sessions. Accommodative disorders were seen in 6 patients (31.5%), saccadic dysfunction in 7 patients (38.9%), and vergence disorders in 12 patients (66.6%) with convergence insufficiency being the most prevalent disorder of all conditions (55.6%, n = 10). . In those with accommodative disorders, 66.6% (n=4) were successful and 33% (n=2) improved and in those with vergence disorders, 83.3% (n =10) were successful and 16.6% improved (n =2). 5 of the 7 patients (71.4%) with saccadic dysfunction only met the improved criteria and two (28.6%) showed no improvement after the VT course.

Conclusion

This study showed that the use of telemedicine for the delivery of vision therapy was technologically viable and is met with high patient satisfaction. In addition, telemedicine was largely effective in treating non-strabismic oculomotor anomalies in this small sample. As the utilization of telemedicine continues, randomized clinical trials are needed to evaluate its effectiveness in delivering vision therapy.

Acknowledgments

I would like to express my deepest appreciation for Dr. Gayathri Srinivasan - first for agreeing to take on hours of work and responsibility as my thesis advisor and second for the many years of mentorship throughout my time at NECO. Over the entire duration of the program, and particularly over the last several months, her encouragement, expertise, and dedication to this project helped me reach the finish line. Her work in the field of pediatric optometry and binocular vision is inspiring and I am lucky to have had a chance to work with her.

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1.0 General Introduction

1.1. Telemedicine

The World Health Organization (WHO) defines telemedicine as, "the delivery of health care services by health care professionals using technology entailing the exchange of medical information for the diagnosis, treatment, and prevention of diseases and injuries" (Organization, 2010). The history of telemedicine dates back to the 19^{th} century, with the use of telegraphs, and telephones to provide medical care during war times. Modern-day telemedicine evolved with the advancement of analog and digital communication techniques. Since the 1950s, the development of closed-circuit television, video communications, mobile, and satellite technologies have allowed medical personnel to interact with patients and deliver care.

The two main methods of information transfer via telemedicine are "synchronous" and "asynchronous" communication. The Centers for Medicare and Medicaid Services defines telemedicine as the exchange of medical information from one site to another using electronic communication to improve a patient's health (Medicare & Services, 2020). In synchronous telemedicine, live, two-way, audio and/or video communication is used to gather medical information in real-time without time delay. Examples of synchronous telemedicine include phone calls, and web-based or phone-based applications to establish information exchange. In asynchronous telemedicine, information is gathered and stored in some format and sent for expert interpretation later. Examples of asynchronous telemedicine include voice/text/email messages, with email communication being the most common method of store-forward communication (Craig & Patterson, 2005).

Over the past twenty years, telemedicine has been utilized across various medical specialties. A 2018 survey of physicians in the US (Kane & Gillis, 2018) found that radiology (39.5%), psychiatry (27.8%), and cardiology (24.1%) were the most common specialties to use telemedicine for patient interactions. The same study also found that store and forward data interpretation (42.7%) and video conferencing (31.6%) were the most frequently utilized modalities used in radiology and emergency medicine respectively. Across the globe, telemedicine services are utilized within (Pozzani et al., 2017) and across borders (Saliba et al., 2012) in various medical specialties.

Telemedicine has advantages and limitations. Important benefits of telemedicine include an increase in access to services and care in remote areas (Arora et al., 2013), improved access to information for patients and healthcare personnel, and a reduction in healthcare costs (Hjelm, 2005). Limitations of telemedicine include technological difficulties impeding the quality of care [(Clegg et al., 2011), (Yenikomshian et al., 2019), (Bloemen et al., 2016), (Wiseman et al., 2016)], concerns regarding privacy protection (Wiseman et al., 2015), reimbursement limitations [(Kim & Falcone Jr, 2017), (Sood et al., 2016), (Medicare & Services, 2020)] and malpractice concerns (Kim & Falcone Jr, 2017).

1.1.1. Utilization of Telemedicine in the US

Telemedicine has been used in many health care specialties such as emergency medicine (Deslich & Coustasse, 2014), (Young et al., 2011), radiology (Dimmick, 2006), oncology (Lewis et al., 2020), and ophthalmology (Mansberger et al., 2015). In the US, the telemedicine utilization rate has been on the rise. In the first survey of telemedicine programs, Grigsby reported that between 1994 to 1999, the number of telemedicine programs increased seven-fold and the number of telemedicine consultations increased by 35% (Grigsby & Rigby, 2002).

A recent report to the US Congress found that between 2006 to 2016, among fee-for-service Medicare enrollees, telemedicine utilization increased from 0.6 visits to 9.5 visits per 1,000 beneficiaries (Services, 2010). This report also found that among Medicare and commercial plan beneficiaries, basic physician visits and mental health services were the most utilized service types.

A 2018 study (Yu et al., 2018) on telemedicine usage in Minnesota, based on coverage type (public versus private payers), visit type (provider-initiated, patient-initiated). Provider type found that between 2010-2015, in metropolitan areas, the rate of telemedicine usage was the highest among commercially insured. In contrast, in non-metropolitan areas, the rate of telemedicine usage was the highest among people with Medicare and Medicaid.

When considering the impact of practice setting on telemedicine usage, Kane and Gillis (Kane & Gillis, 2018) found that hospitals, multi-specialty centers, and practices with fifty or more physicians had a greater likelihood of incorporating telemedicine. In support, a survey by Jain et al. (Jain et al., 2020) found that about half of the hospitals in the US reported providing telemedicine services.

The COVID-19 pandemic has brought telemedicine to prominence. During the pandemic, clinicians adopted telemedicine to continue patient care while minimizing face-to-face time. On March 18th, 2020, the Centers for Medicare and Medicaid Services (CMS) recommended limiting all non-essential care due to the COVID-19 global pandemic. Hospitals across the US reported a 4000% increase in telemedicine utilization (Schwamm et al., 2020) during the pandemic. The WHO reported that around 58% of countries globally resorted to telemedicine to meet health care needs (Aashima et al., 2021).

With the increased role of telemedicine in health care delivery before COVID-19 and now, it is evident that telemedicine will play an important role in the future. Given its reliance on technology, it is crucial to understand what technological attributes are essential for making telemedicine successful. Additionally, other attributes such as patient-provider communication, confidence, and satisfaction with telemedicine should be understood to ensure it can be optimally utilized in the future. In the past 20 years, many research studies and systematic reviews have evaluated telemedicine, to understand its technological feasibility (internet, audio, video) (Bittner et al., 2018), (Luzio et al., 2004), (Holcomb et al., 2020), provider confidence (Holcomb et al., 2020), (Bittner et al., 2018; Holcomb et al., 2020; Whitten & Love, 2005), (Young et al., 2011) patient satisfaction (Mair & Whitten, 2000), (Aashima et al., 2021), (Ramaswamy et al., 2020), (Tenforde et al., 2020) and overall clinical outcomes (Ekeland et al., 2010), (Hersh et al., 2006), (Monaghesh & Hajizadeh, 2020), and (Keilty et al., 2021).

1.1.2. Patient Satisfaction in Telemedicine

Patient-reported outcomes are a key measure of healthcare quality. While some studies have found an association between patient satisfaction and improved outcomes (Jha & Orav, 2008) and (Knutsson et al., 2022), others have not (Schneider & Zaslavsky, 2001), (Chang & Hays, 2006), and (Rao et al., 2006). Jha et al found a positive relationship between patient experiences (whether they would recommend a hospital or not) and the quality of clinical care (measured through the HQA score). Chang et al noted that while global ratings were associated with better communication with patients, technical quality of care was not associated with global ratings of care (technical quality of care was defined as the extent to which healthcare services met predefined criteria). In their systematic review, Mair and Whitten (Mair & Whitten, 2000) examined 32 studies that evaluated patient satisfaction with telemedicine using real-time interactive video. While this review found “good levels” of patient satisfaction across many specialties, the authors highlight methodological differences across studies (e.g., poorly defined study criteria, small sample size, selection bias,.) limit generalizability. Another systematic review (Whitten & Love, 2005) found that patient satisfaction is high among patients from rural primary care practices (Made & Carle, 1999), oncology (Allen & Hayes, 1995) and dermatology (Hicks et al., 2003). However, the authors suggest the need for using validated survey instruments to understand whether these results are generalizable.

With the increased use of telemedicine during the COVID-19 pandemic, its scope and role in health care delivery have been studied with greater urgency. A Pubmed search using keywords “telemedicine” and “COVID-19” yielded 8478 search results. Several studies evaluated patient experience with telemedicine during the pandemic. Aashima et al. (Aashima et al., 2021) conducted a review of studies that evaluated patient satisfaction in various medical specialties. This review found that patient satisfaction with telemedicine was high regardless of the type of telemedicine (i.e. synchronous vs. asynchronous) across many specialties. For example, in gynecology, Holcomb et al. (Holcomb et al., 2020) reported that 99% of participants reported that their needs were met using an audio - only prenatal visit. In an urban medical center, Ramaswamy et al (Ramaswamy et al., 2020) found that patient satisfaction was significantly higher for telemedicine visits (94.9%) compared to in-person visits (92.5%).

Few studies have evaluated patient satisfaction with telemedicine for rehabilitation services such as physical therapy (Bennell et al., 2021), occupational therapy, and speech therapy (Tenforde et al., 2020) during the COVID-19 pandemic. These services are like vision therapy in that the sequential therapy program often consists of in-office and home therapy and is prescribed and practiced over multiple sessions. Bennell et al evaluated patient experience in individual and group physical therapy sessions delivered via telemedicine and found that most patients had “moderate to high” positive perceptions about ease of technology, effectiveness, ease of communication, and privacy for both individual and group sessions. Over 60% of patients in both session types reported interest in choosing telemedicine in the future. Similarly, Tenforde et al found a high patient satisfaction rating with physical therapy, speech therapy, and occupational therapy delivered via telemedicine and a “high interest” in future telemedicine visits.

Patient satisfaction in eye care has also been previously reported. Before the COVID-19 pandemic, several studies have evaluated patient satisfaction with telemedicine for diabetic retinopathy screening [(Surendran & Raman, 2014), (Paul et al., 2006), (Kurji et al., 2013), (Luzio et al., 2004), (Kumar et al., 2006; Rani et al., 2006), and (Tuulonen et al., 1999)] and found a 94-99% satisfaction rate among patients who received tele-screening. Valikodath and Leveque (Valikodath & Leveque, 2017) evaluated the willingness among patients towards telemedicine for diabetic retinopathy and found that those who perceived increased convenience and had systemic comorbidities had a higher odds of participation while duration of diabetes and valued patient-physician relationship were associated with lower odds.

Few studies have evaluated patient satisfaction in teleophthalmology during the COVID-19 pandemic (Newman-Casey et al., 2021), (Kang et al., 2020), and (Kothari &

Rathod, 2020). Newman-Casey et al assessed the utilization, patient satisfaction, and safety of telemedicine at a tertiary, multispecialty eye-care practice. This study found 88% of patients reported a high overall patient satisfaction (score of 8/10) score regardless of eye care specialty service type. When comparing telephone visits with video conferencing, patients reported higher satisfaction with the latter. The utilization rate for in-person visits was found to be higher among white participants than minority participants. Kang et al. reported on oculoplastic video consultations during the COVID-19 pandemic in the UK and evaluated patient experience using a questionnaire. They found that 94% of patients reported ease with joining the consultation, while 80% preferred video consultation over face-to-face consultation.

Patient satisfaction is an important component of patient-centered care. Understanding patient experience in telemedicine is essential for patient buy-in, and successful implementation of and access to telemedicine platforms. Previous studies before and during the COVID-19 pandemic report high patient satisfaction with telemedicine. In eye care, patient-centered metrics are primarily limited to teleophthalmology screening programs. To our knowledge, telemedicine for the delivery of vision therapy including patient satisfactory and clinical outcomes with this care delivery model has not been explored. One goal of this pilot study was to explore patient ratings regarding their experience with telemedicine, during the COVID-19 pandemic. Consistent with previous studies, we hypothesize that patient satisfaction would be high with the use of telemedicine for vision therapy.

1.1.3. Efficacy of Telemedicine

A systematic review by Hersh et al. (Hersh et al., 2006) looked at telemedicine efficacy by measuring clinical outcomes, diagnosis, and management decisions, as well as access to care. This review included 106 studies published between 2000 and 2004 using three methods of telemedicine: store-and-forward, home-based, and office/hospital based. The authors concluded that telemedicine was the most effective "in specialties for which verbal interactions are a key component of assessment" such as psychiatry and neurology. Efficacy was mixed in other specialties such as dermatology, orthopedics, and ophthalmology.

In ophthalmology, several studies evaluated the diagnostic accuracy in detecting diabetic retinopathy [(Gomez-Ulla et al., 2002), (Baker et al., 2004), (Saari et al., 2004), (Shiba et al., 2002), (Yogesan et al., 2000)] and retinopathy of prematurity (Ells et al., 2003) using store-forward telemedicine. Except for one study (Gomez-Ulla et al., 2002), all reported high accuracy in detecting diabetic retinopathy and retinopathy of prematurity.

Synchronous telemedicine has been shown to have a high diagnostic agreement among clinicians in the evaluation of strabismus (Cheung et al., 2000), (Dawson et al., 2002). When comparing in-office interactions to synchronous telemedicine for evaluating eye injuries (Bowman et al., 2003) and trabeculectomized eyes (Crowston et al., 2004), both studies found a higher diagnostic agreement between clinicians in the telemedicine group compared to the in-office group. A recent meta-analysis of randomized clinical trials in tele-opthalmology for age-related macular degeneration (ARMD) and diabetic retinopathy revealed that compared to in-person visits there was a significantly greater odds of patient participation with the telemedicine visit (Kawaguchi et al., 2018). However, the odds of disease detection were not different between groups suggesting that telemedicine could be an effective screening approach for ARMD and DR. In all the aforementioned studies, telemedicine was solely utilized to diagnose ocular conditions.

Bittner et al. (Bittner et al., 2018) studied the feasibility of telerehabilitation for low vision in a cross-sectional pilot study of 10 participants. Telerehabilitation involved the administration of a handheld magnifier to evaluate reading speed and fluency using the MNREAD and near acuity tests. After the telerehabilitation visit, providers and patients completed a satisfaction survey to provide their perspectives on the encounter. The study found that all participants were satisfied with the telemedicine visit and all but one expressed interest in receiving telerehabilitation again in the future. 60% of patients agreed that the telerehabilitation visit was as accurate as an in-person evaluation. From the providers' standpoint, there was little to no difficulty in assessing reading speed and accuracy.

A recent retrospective study by Keilty et al (Keilty et al., 2021) evaluated the role of synchronous telemedicine in visual neuro-rehabilitation before and during the COVID-19 pandemic. In addition to increasing access to care during the COVID-19 pandemic, this study found that short-term acceptance rates for prism trials in hemianopia, visual field neglect, and strabismus. The study also found high overall patient satisfaction from receiving these services. The authors argued that vision rehabilitation is one of the best services within eyecare to use telemedicine since biomicroscopy and other technological barriers do not exist.

The efficacy of telemedicine in eye care has been primarily studied in telescreening for diabetic retinopathy. The COVID-19 pandemic increased the utilization of telemedicine in eye care, including the delivery of treatments such as vision therapy. Many private optometric practices and academic centers adopted telemedicine to deliver vision therapy. The vision therapy service at the NECO Center for Eye Care implemented telemedicine to provide continuity of care for patients previously receiving in-office vision therapy. The service was expanded to offer telemedicine visits to all patients after the lockdown was lifted. Despite the increased utilization, to our knowledge, its efficacy in vision therapy has not been previously studied. Several randomized clinical trials have shown office-based vision therapy to be the most effective treatment for convergence insufficiency in children (Convergence Insufficiency Treatment Trial Study, 2008) & (Group, 2021) and adults (Alvarez & Scheiman, 2020). Another goal of this pilot study was to explore clinical outcomes following a tele-medicine telehealth program for a variety of binocular/accommodative disorders such as accommodative insufficiency, accommodative infacility, accommodative excess, saccadic dysfunction, convergence insufficiency, convergence excess, and convergence deficit. We hypothesize that telemedicine will be effective in conditions commonly treated with vision therapy. Given the efficacy of in-office vision therapy in treating common binocular/accommodative disorders as well as the overall feasibility of telemedicine in other fields, we believe this application of telemedicine will also be feasible and efficacious.

2.0 Research Question

The purpose of this study was two-fold, (1) to explore patient ratings regarding their satisfaction on receiving vision therapy through telemedicine and (2) evaluate the efficacy of vision therapy delivery through the telemedicine platform. Assessing these attributes are important for understanding whether telemedicine can be successfully used to deliver vision therapy services in the future.

3.0 Experimental Design and Methods

The study was conducted at the New England College of Optometry (NECO) and was deemed exempt by the NECO Institutional Review Board. Patient perspectives on telemedicine was studied prospectively by administering a patient satisfaction survey after completion of at least three telemedicine sessions and the efficacy of telemedicine was evaluated by conducting a retrospective chart review. Data from patients who received vision therapy via telemedicine between April 2020 - March 2022 was included in this study.

3.1. Telemedicine Platform and vision therapy sessions

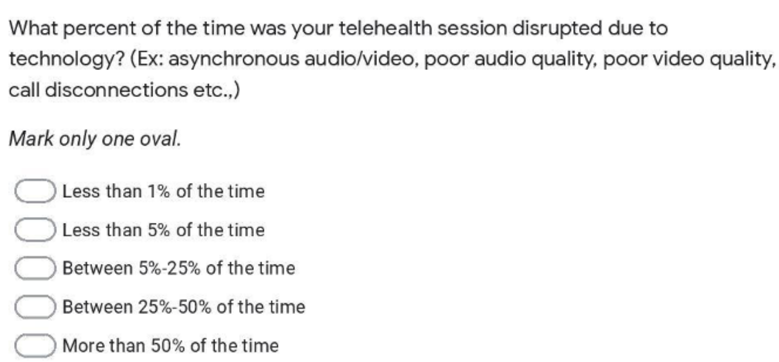
Two different telemedicine platforms were used for offering vision therapy during the study period. Between April 2020 - July 2020, EyeCare Live® (ECL) and between July 2020

- March 2022, Zoom Healthcare Platform (Zoom Video Communications, Inc) were used. Both platforms are Health Insurance Portability and Accountability Act (HIPAA) compliant and were used to deliver synchronous video sessions. A typical virtual vision therapy session was structured similar to in-office vision therapy visits and offered once a week for 45 minutes. Patients were assigned to home therapy between sessions for 15 minutes a day, 4-5 times a week. Compliance with home therapy was monitored through self-reporting to provider, with verification of participation in home therapy but not through a questionnaire/log.

3.2. Survey administration to understand patient perspectives on telemedicine

During the COVID-19 lockdown (April-July 2020), synchronous telemedicine (audio/video) was only offered to patients whose vision therapy treatment was disrupted due to the lockdown. We used this procedure to ensure that patients had access to the necessary equipment to continue vision therapy with easily transportable equipment mailed to the patient's home if difficulty level needed modification. After the lockdown was lifted and the ability to acquire equipment increased, telemedicine was offered to patients new to vision therapy. In addition, provider discretion was used to identify patients based on ocular diagnosis and age.

Since the telemedicine service was new to the practice, we wanted to understand patient perspectives using a survey for quality control and improvement. The patient satisfaction survey used in a previous study (Bittner et al., 2018) was adopted in a modified form to include questions regarding types of disruptions, perceived accuracy of service, and willingness to continue using telemedicine services beyond the pandemic. All patients enrolled in telemedicine and completed at least three telemedicine sessions between April 2020 - December 2020 met the inclusion criteria for the survey portion of the study and were contacted to complete the survey. The survey was administered by either the clinic staff or the graduate student by phone or email (using Google Forms) and took approximately 3 minutes to complete. Survey responses were obtained from patients if they were over the age of 18 or their parents/guardians for patients <18 years of age. Up to three attempts were made to reach the patient by phone or email. The survey consisted of questions regarding access to the internet, electronic device, previous and current experience with telemedicine, platform usability, audio/video quality of the telemedicine session, and overall experience of the session (Figure 1).


What percent of the time was your telehealth session disrupted due to technology? (Ex: asynchronous audio/video, poor audio quality, poor video quality, call disconnections etc.,)

Mark only one oval.

- Less than 1% of the time
- Less than 5% of the time
- Between 5%-25% of the time
- Between 25%-50% of the time
- More than 50% of the time

Figure 1: Patient Satisfaction Survey**.** A sample question on the frequency of technical disruptions during the telemedicine session. See Appendix A for the complete survey

3.3. Evaluating the efficacy of virtually-delivered vision therapy

Using the Compulink Advantage (Compulink Healthcare Solutions, Thousand Oaks, CA, USA) electronic health record system, telemedicine sessions were identified using appointment history. A retrospective chart review conducted between April 2020 - March 2022 (24-month period) was performed to collect pre- and post-treatment binocular vision evaluation data from patients who completed a majority ($\geq 50\%$) of vision therapy sessions via telemedicine. Table 1 outlines the inclusion and exclusion criteria used to retrieve patient data.

Inclusion Criteria: ● ≥ 50% of vision therapy sessions via telemedicine (typical course of vision therapy is at least 12 sessions) ● Complete in-office pre-treatment and post-treatment binocular vision evaluation to categorize based on pre-defined diagnostic and outcome criteria Exclusion Criteria: ● Fewer than 50% of vision therapy sessions via telemedicine ● Missing binocular vision evaluations after course of vision therapy

Table 1: Inclusion and Exclusion Criteria for evaluating treatment efficacy

A binocular vision evaluation included clinical tests of accommodation, vergence, and eye movements. Tests of accommodation included accommodative amplitude, accommodative accuracy, and accommodative facility. Monocular accommodative amplitude was measured by a push-up technique using a 20/30 target. Accommodative accuracy was measured using the monocular estimation method (MEM), and monocular accommodative facility was measured using ±2.00 flippers in patients below 30 years and using the amplitude scaled facility method in patients over 30 years of age.

Typical tests of vergence included near point of convergence, step vergence at distance and near, and vergence facility. Near point of convergence break and recovery was measured using an accommodative target. Positive and negative fusional vergences were measured at distance and near using a prism bar and a 20/30 accommodative target. Vergence facility was measured at 40cm using the 12 base-out/3 base-in prism.

Saccadic function was measured using the Developmental Eye Movement (DEM) test. All the aforementioned clinical tests have well-established clinical normative values. Ocular deviation was measured at distance and near using cover test with prism neutralization. Vision disorders were classified based on pre-defined diagnostic criteria (Table 2), previously established by Dr. Aparna Raghuram (Raghuram et al., 2019), Dr. Michael Gallaway (Gallaway et al., 2017), and Dr. Mitchell Scheiman (Scheiman et al., 2021) in their research on post-concussion convergence disorders and post-concussion oculomotor disorders, respectively.

Convergence Insufficiency: Requires *first* plus at least *one other* finding (for *two*-sign CI)
1. At least 4Δ greater exophoria at near than distance
2. Near point of convergence break value of at least 6cm
3. Positive fusional convergence (PFV) at near less than or equal to 15Δ or failing Sheard's criterion
4. Vergence facility, distance or near (Using 3BI and 12BO flipper) of less than or equal to 9Δ with difficulty with BO
Convergence Excess: Requires first plus at least one other finding
1. Esophoria at near of greater than or equal to 3Δ
2. Negative fusional convergence (NFV) at near less than or equal to 8Δ or failing Sheard's criterion
3. Vergence facility, distance or near (Using 3BI and 12BO flipper) of less than or equal to 9Δ with difficulty with BI
Convergence Deficit: Requires first plus one of the other two findings
1. Near point of convergence break value of at least 6cm
2. Positive fusional convergence (PFV) at near less than or equal to 15Δ or failing Sheard's criterion
3. Vergence facility, distance or near (Using 3BI and 12BO flipper) of less than or equal to 9Δ with difficulty with BO
Fusional Vergence Dysfunction: Requires either finding number 1 or 2
1. PFV less than or equal to 15Δ, NFV less than or equal to 8Δ, or fails Sheard's criterion
2. Vergence facility, distance or near (Using 3BI and 12BO flipper) of less than or equal to 9Δ with difficulty with BO and BI
Accommodative Insufficiency/Paresis: Requires either finding 1 or 2

4.	Accommodative amplitude more than or equal to 2D below mean for age (15 - age/4)
5.	Monocular accommodative facility (+2.00D/-2.00D) less than or equal to 6cpm with difficulty with minus lenses
Accommodative Excess/Spasm	
	Monocular accommodative facility (+2.00D/-2.00D) less than or equal to 6cpm with difficulty with plus lenses
Accommodative Infacility	
	Monocular accommodative facility (+2.00D/-2.00D) of less than or equal to 6cpm with difficulty with plus and minus lenses
Saccadic Dysfunction: Requires either finding number 1 or 2	
1.	Developmental Eye Movement Ratio Score of 1SD or more below the mean
2.	Developmental Eye Movement Error Score or 1SD or more below the mean

Table 2. Diagnostic Criteria for Non-Strabismic Binocular Vision Disorders (Gallaway 2017, Raghuram 2019, Scheiman 2021)

Virtual vision therapy procedures for accommodation and vergence were similar to procedures used in the Convergence Insufficiency Treatment Trials [(Group, 2008), (Group, 2019)] which included monocular and binocular accommodative rock with hart charts and/or accommodative flippers, brock string, tranaglyphs, and vergence prism jumps, free space fusion cards. Virtual therapy procedures for saccades and pursuits involved hart charts, workbooks, and wordsearch. Post-treatment outcome was categorized as "successful", "improved" or "no improvement" based on pre-defined outcome criteria (Table 3), adapted from Dr. Michael Gallaway (Gallaway et al., 2017), and Dr. Mitchell Scheiman (Scheiman et al., 2021).

Accommodative Insufficiency	
Success	Amplitude of accommodation greater than or equal to the minimum expected AND MAF greater than 6cpm
Improved	Amplitude of accommodation greater than or equal to the minimum expected OR MAF greater than 6cpm
Accommodative Excess	
Success	MAF greater than 6cpm WITHOUT difficulty with plus lenses
Improved	MAF greater than 6cpm WITH continued difficulty with plus lenses
Accommodative Infacility	
Success	MAF greater than 6cpm WITHOUT difficulty with plus or minus lenses
Improved	MAF greater than 6cpm WITH continued difficulty with plus and minus lenses
Saccadic Dysfunction	
Success	Both DEM Ratio AND errors above 50^{th} percentile
Improved	DEM Ratio OR errors above 50^{th} percentile
Convergence Insufficiency	
Success	NPC less than 6cm AND PFV greater than 15 prism diopters or meeting Sheard’s criterion
Improved	NPC less than 6cm OR PFV greater than 15 prism diopters or meeting Sheard’s criterion
Convergence Excess	
Success	NFV greater than or equal to 12 prism diopters or meeting Sheard’s criterion
Convergence Deficit	

Success	NPC less than 6cm AND PFV greater than 15 prism diopters or meeting Sheard's criterion
Improved	NPC less than 6cm OR PFV greater than 15 prism diopters or meeting Sheard's criterion

Table 3. Outcome criteria to assess treatment efficacy. MAF = monocular accommodative facility (cpm), DEM = Developmental Eye Movement test, PFV = Positive fusional vergence, NFV = Negative fusional vergence. (Gallaway 2017, Raghuram 2019, Scheiman 2021)

4.0 Results

4.1. Patient Perspectives on Telemedicine

Between April 2020 - December 2020, 27 participants were receiving vision therapy via telemedicine. Twenty-three participants completed the survey (participation rate 85.2%), three were not reachable by phone or email, and one patient declined to participate. The mean age of survey participants was 19.62 (SD 11.06, range 9-52), with 56.5% female and one gender non-conforming participant. The average number of telemedicine VT sessions completed by survey participants was 10.91 (SD 5.80, range 4-25) with an average of 16.27 overall VT sessions (SD 6.16, range 7-25). The average length of a vision therapy program is around 16 sessions but vary widely depending on diagnosis and patient compliance. The demographics of the survey participants are outlined in Table 4.

Figures 2 and 3 illustrate the technological profile of the survey respondents. Cable internet (82.6%, n = 19) was the most used internet service, followed by mobile internet (13%, n = 3), and DSL (4.3%, n = 1). For the telemedicine session, about half of the surveyed participants used a laptop (47.8%, n = 11), followed by a smartphone (30.4%, n = 7) or a tablet (21.7%, n = 5). 34.8% of patients reported using other telemedicine services in the past and 21.7% (n = 5) of patients reported concurrently receiving other forms of telemedicine services at the time of the survey.

56.5% (n = 13) of participants found the audio and video quality to be "Excellent" while 43.4% (n = 10) of participants found the audio and video quality to be either "Very Good" or "Good" (Figure 4). While 45.5% (n = 10) of participants reported not experiencing any technical disruption during the telemedicine session, 18.2% (n = 4) reported a disruption in one session and 36.4% (n = 8) reported a disruption in two sessions (Figure 5). Those using tablets (n = 5) most frequently experienced disruptions (80% (n=4) had at least one disruption) while those using laptops and smart phones had equal frequency of experiencing disruptions. Among those who experienced disruptions (12 of 23 subjects), 83.3% (n = 11) reported that the disruptions affected the session for less than 5% of the time. The telemedicine platform (41.7%, n = 5), poor internet service (16.7%, n = 2), and a problem with the devices (16.7%, n = 2) were reported as the reasons for technical disruption (Figure 6). 95.6% (n = 22) of participants reported that the telemedicine platform was "very easy" or "easy" to use, while one participant reported a neutral rating on ease of use.

Mean Age (years) [Standard Deviation]	19.62 [11.06]
Age range (years)	9-52
Gender	Males = 9 Females = 13 Gender non-conforming = 1
Average number of VT Sessions [SD, Range]	16.27 [6.16, 7-25]
Avg number of Telemedicine sessions [SD, Range]	10.91 [5.80, 5-25]
Average percent of sessions received via telemedicine	70.11%

Table 4. Survey Participant Characteristics outlining patient age, gender, average number of VT sessions and average number of telemedicine sessions.

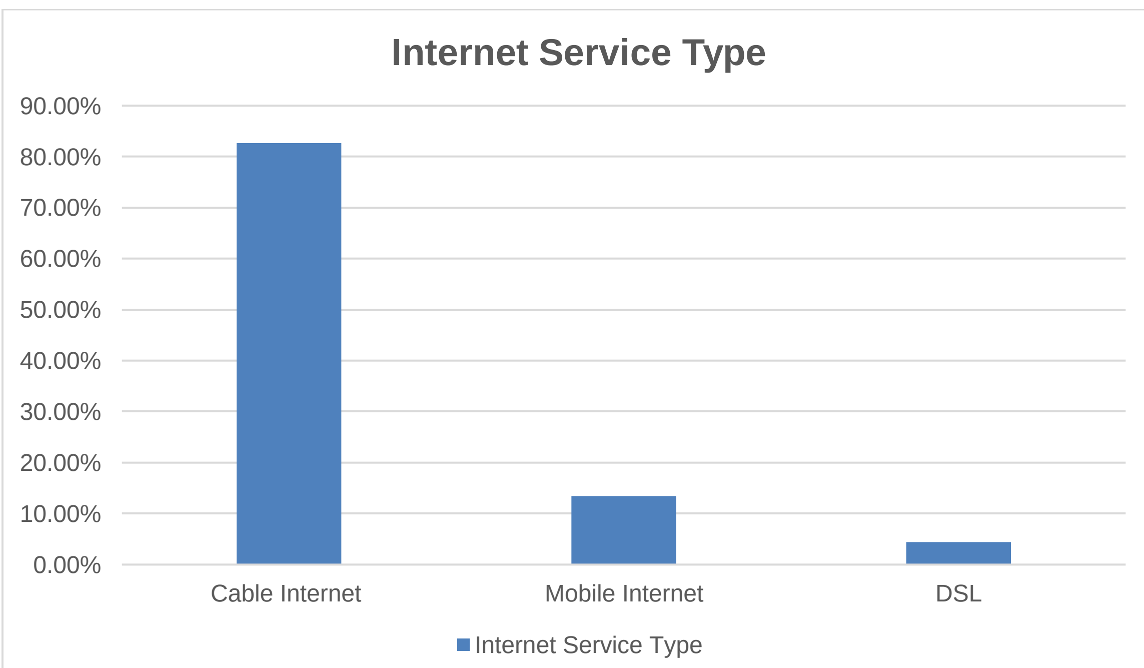


Figure 2. Internet Service Type. Survey participants were asked which internet service type was used to connect to their telemedicine session.

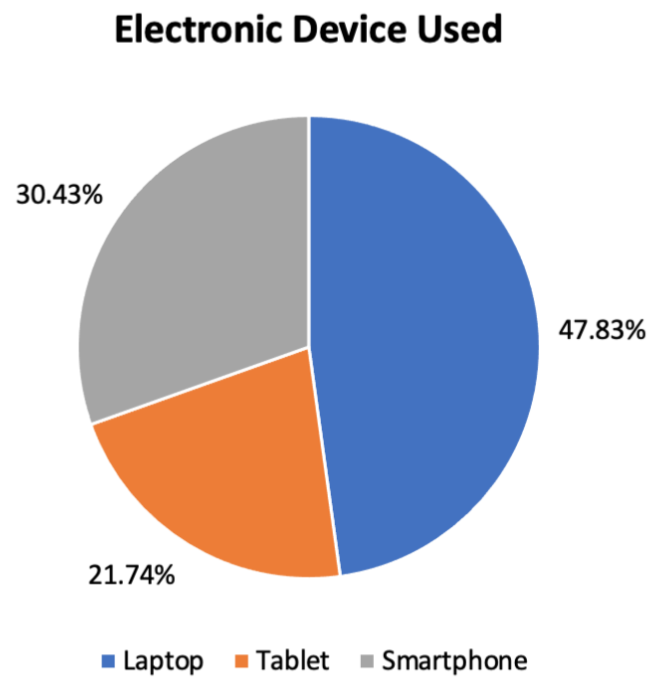


Figure 3. Electronic Device Used. Participants were asked which electronic device was used to connect to their telemedicine session.

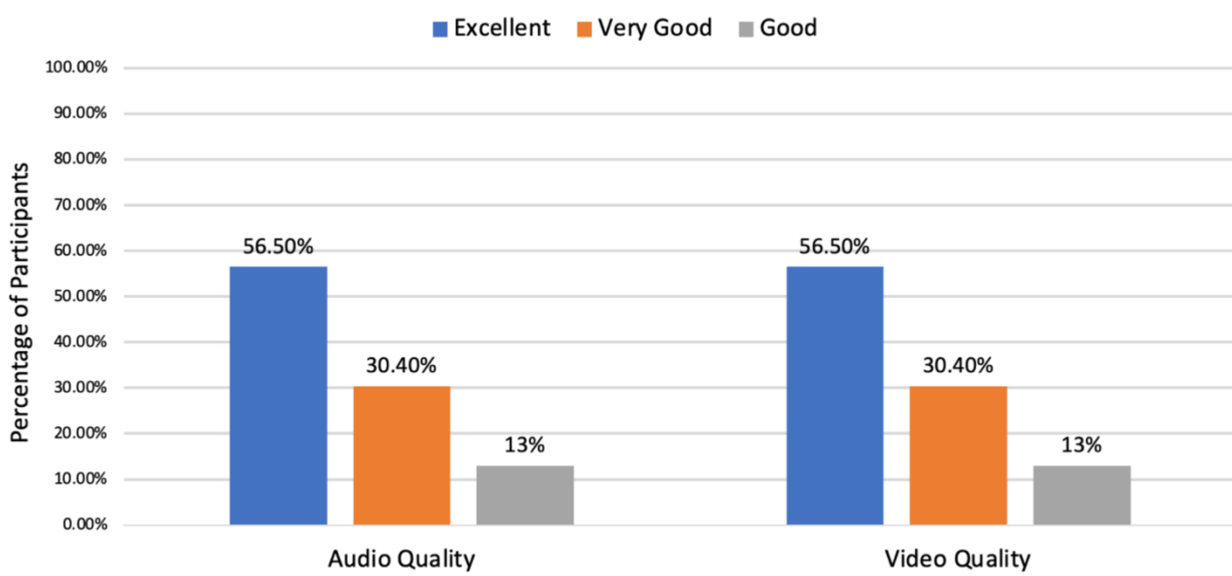


Figure 4. Ratings of audio and video quality. Participants were asked how they would rate their audio and video qualities (asked as separate questions).

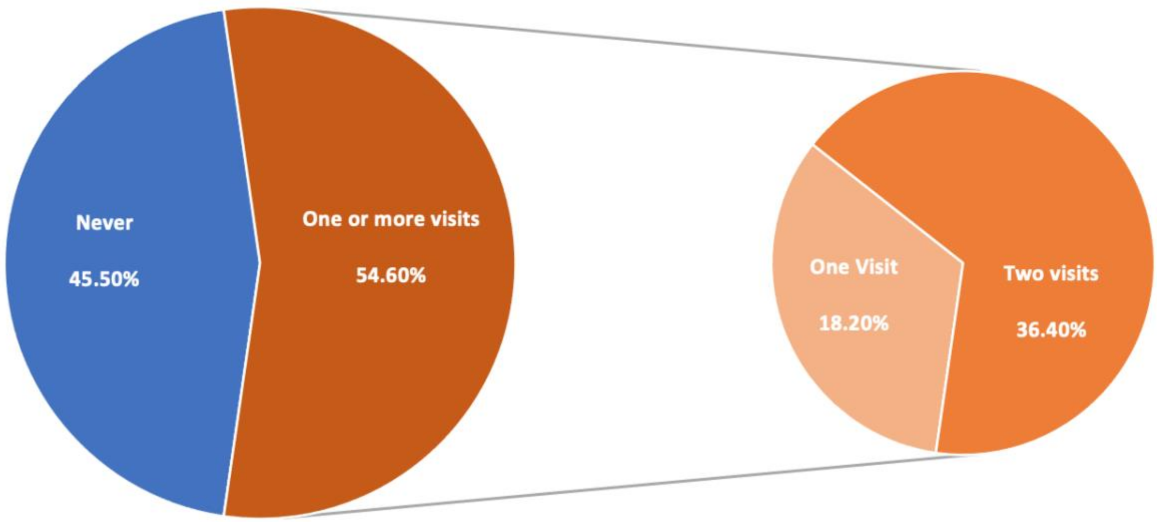


Figure 5. Frequency of technical disruption. Participants were asked 1) if they experienced a disruption during their telemedicine session and 2) how many visits they experienced disruptions during.

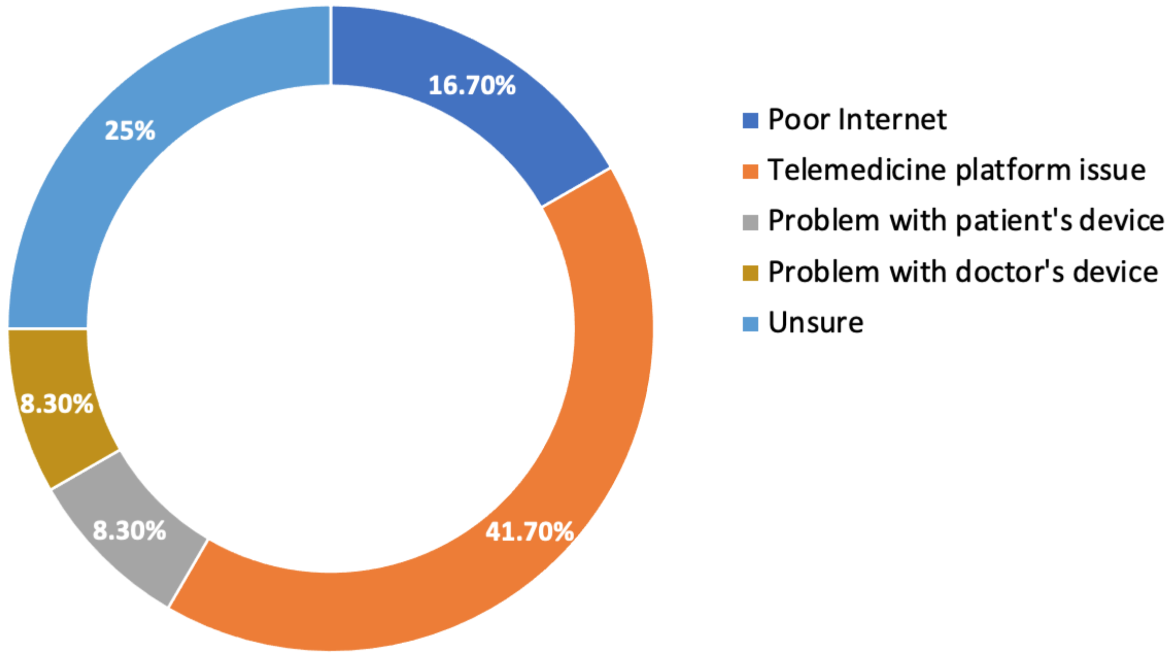
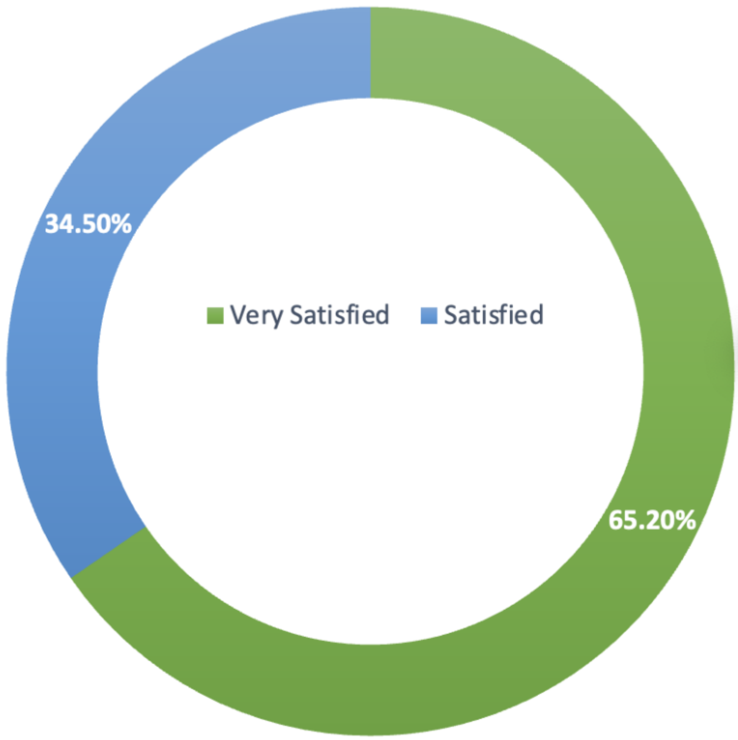


Figure 6. Reported reasons for technical disruption. Participants described if poor internet, platform issues, problems with patient's device, or problem with doctor's device were the reason for their disruption.

95.6% of participants reported having little to no difficulty in understanding the doctor's instruction during the majority of telemedicine sessions with one participant experiencing moderate difficulty. While 42.1% of participants perceived that the telemedicine sessions were as accurate (or) more accurate as in-office VT sessions, 15.8% perceived that the telemedicine was less accurate compared to in-office sessions. 42.1% of participants reported that they could not compare accuracy between the types of sessions.

Fifteen participants (65.2%) reported a preference for telemedicine sessions over in-office sessions in the future, while three (13%) participants reported otherwise. Five participants (21.7%) were "not sure". All participants reported that they were "satisfied" (34.8%) or "very satisfied" (65.2%) with receiving telemedicine services (Figure 7).



- **Figure 7.** Overall participant satisfaction. Participants were asked what their overall satisfaction level was with receiving telemedicine for vision therapy. Other options included "neutral," "dissatisfied," and "very dissatisfied."

4.2. Efficacy of Telemedicine

Between March 2020 to March 2022, 44 patients were identified as having completed telemedicine sessions. Of those, 26 patients (59.1%) were excluded from the analysis. The reasons for exclusion are insufficient number of telemedicine sessions, defined as <50% of total number of VT sessions (13 patients), and insufficient pre- and/or post-treatment exam data (12 patients). Patients who were included in the study, on average had an average household income of $124,448 (SD: $41,951, range: $62,249-$185,586) while patients who were excluded from the study had a household income of $95,286 (SD: $31,272, range: $54,521-$154,398). The distance from a patient's zip code to the NECO Center for Eye care office zip code was calculated and the median distance was 11.1 miles for the group receiving virtual VT and 12.1 miles for the group that did not meet the eligibility criteria.

18 patients met the inclusion criteria for the study. The average age was 18.2 years (SD 11.15, range 8-51). There were 9 males and 9 females. On average, patients completed 15.44 overall vision therapy sessions (SD 5.42, range 8-25) of which an average of 12.66 visits were completed via telemedicine (SD 5.52, range 5-25). The average spherical refractive error was -0.47D ± 1.93 diopters (D) OD (SD 1.93, range +1.00 to -6.50) and -0.51 D ± 1.87 D OS (SD 1.87, range +0.50 to -6.00). The average astigmatic refractive error was -0.28 D ± 0.44 D OD (SD 0.44, range 0.00 to -1.50) and -0.51 D ± 0.42 D OS (SD 0.42, range 0.00 to -1.25). The average ocular deviation, as measured by was 1.35 prism diopters (pd) of exophoria at distance (SD 5.59, range 10 esophoria to -16 exophoria) and 4.93 pd of exophoria at near (SD 8.58, range 8 esophoria to 25 exophoria). Patient demographics are in Table 5.

Mean Age (years) [Standard Deviation]	18.2 [11.15]
Age range (years)	8-51

Gender	Males = 9 Females = 9
Average number of VT Sessions [SD, Range]	15.44 [5.42, 8-25]
Average number of Telemedicine sessions [SD, Range]	12.66 [5.52, 5-25]
Average percent of sessions received via telemedicine	81.17%
Average magnitude of deviation at distance (As measured by cover test)	1.35 prism diopters of exophoria
Average magnitude of deviation at near (As measured by cover test)	4.93 prism diopters of exophoria
Average stereopsis [Range]	30.5 seconds of arc [160 – 12.5]

Table 5. Efficacy Analysis Participant Characteristics. VT = Vision Therapy

Table 6 below represents the breakdown of the diagnoses in the study. Based on the diagnostic criteria, 6 patients (31.6%) had accommodative disorders, with accommodative excess being the most common diagnosis (42.8%). 7 patients (38.9%) had saccadic dysfunction, and 12 patients (66.7%) had a vergence disorder, with convergence insufficiency (63.1%) being the most common diagnosis. Of the 18 patients, 9 patients (50%) had more than one diagnosis.

While all patients met the diagnostic criteria for an accommodative disorder, since the success and improved criteria are different from the diagnostic criteria, there was one patient that met the criteria for diagnosis of accommodative excess but also met the improvement criteria at the time of diagnosis. This patient changed from meeting the improvement criteria at diagnosis to meeting the success criteria after treatment. Overall, in those with accommodative disorders, 66% (n=4) were successfully treated whereas 33% (n=2) showed improvement (Figure 8). The two patients who met the improved criteria had a diagnosis of accommodative insufficiency and accommodative infacility. None of the patients with saccadic dysfunction met the success criteria while 71.4% (n=5) met "improved" criteria and 28.5% (n=2) showed no improvement. Two patients with a diagnosis of saccadic dysfunction also met the improvement criteria at the time of diagnosis. Among those with vergence disorders, 3 patients started their vision therapy treatment having met the improvement criteria. All three patients met the success criteria following treatment and overall, 83.3% (n=10) were successfully treated while 16.6% (n=2) met the improved criteria. The two patients who met the improved criteria had a diagnosis of convergence insufficiency and convergence deficit. Overall, across all conditions, there were 6 patients who met their improvement criteria at the time of diagnosis while also meeting the diagnostic criteria to categorize them into each condition. Of the six patients, four of those who met the improvement criteria at diagnosis progressed to meet their success criteria at the post-vision therapy evaluation (1 patient with an accommodative disorder and 3 patients with a vergence disorder).

Condition	**Number of Participants**	**Percentage (%)**
Vergence Disorders		
Convergence Insufficiency	10	83.33
Convergence Excess	1	8.33
Convergence Deficit	1	8.33

Total	**12**	**66.67**
Accommodative Disorders		
Accommodative Insufficiency	2	33.33
Accommodative Excess	3	50.00
Accommodative Infacility	1	16.67
Total	**6**	**33.33**
Eye Movement Disorders		
Saccadic Dysfunction	7	100.00
Total	**7**	**38.89**
Accommodative and Vergence Disorder	3	16.67
Accommodative Disorder and Saccadic Dysfunction	2	11.11
Saccadic Dysfunction and Vergence Disorder	4	22.22

Table 6. Frequency of Disorders in Study Population

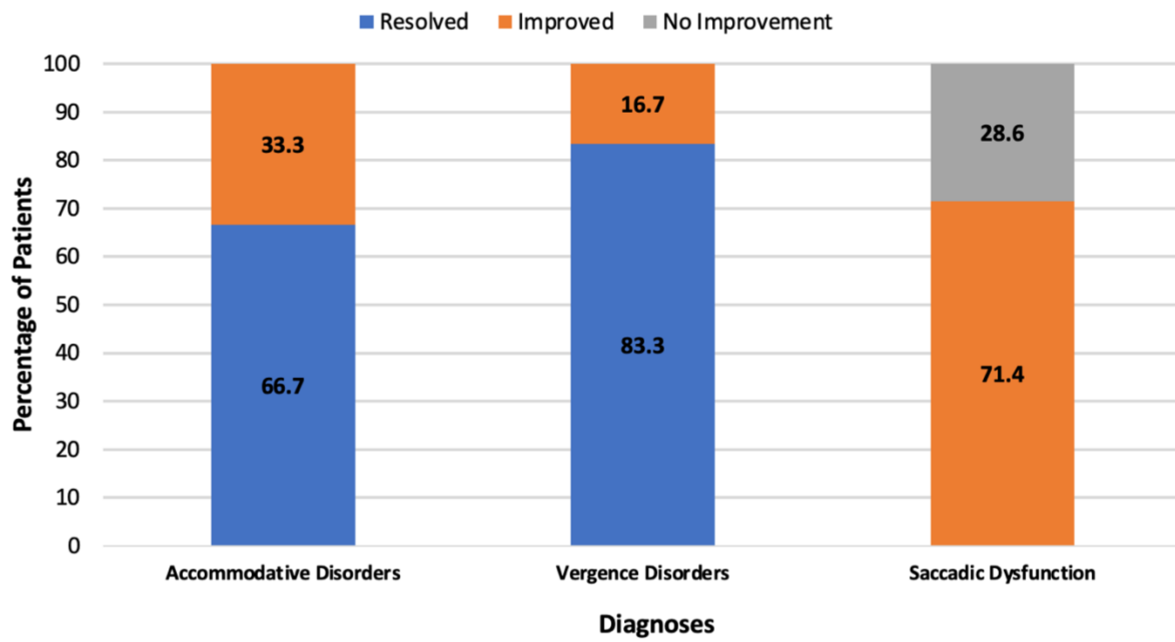


Figure 8. Treatment outcomes based on single diagnosis. Outcomes included saccadic dysfunction, accommodative, and vergence disorders that either resolved, improved, or showed no improvement after vision therapy treatment.

Nine patients (50%) had two diagnoses. Of these patients, seven patients (77%) met the success criteria for at least one condition and improved criteria for the other condition, while one patient (11%) met the success criteria for both conditions, one (11%) met the improved criteria for both. Figure 9 outlines the outcomes for patients with two diagnoses.

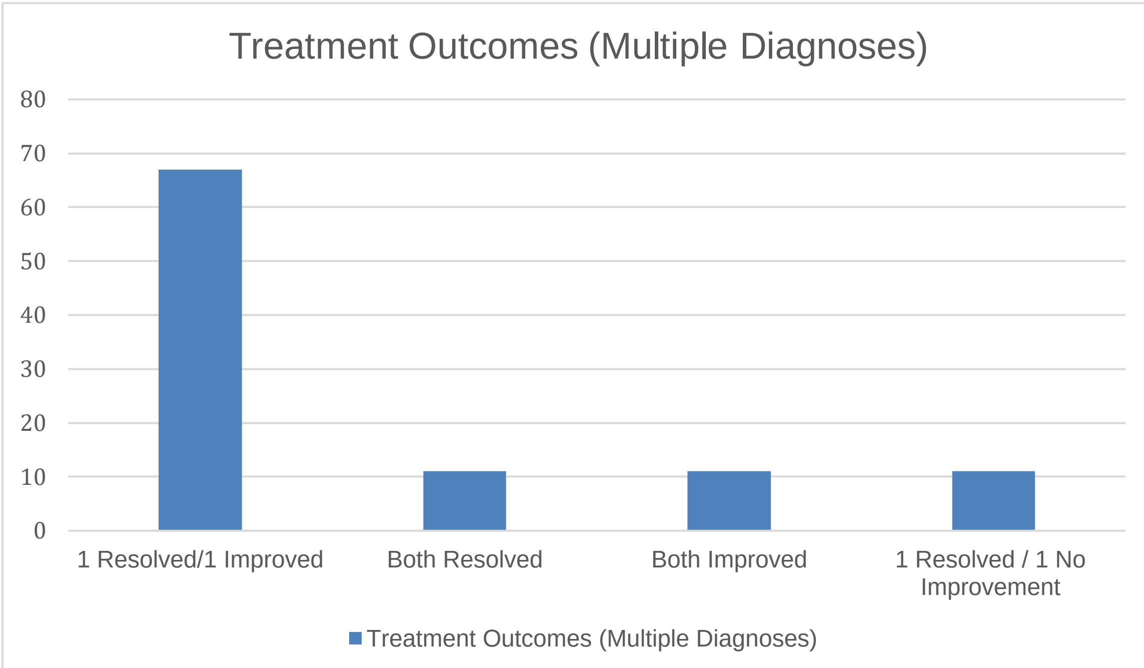


Figure 9. Treatment outcomes based on multiple (two) diagnoses. Amongst those with multiple diagnoses, outcomes included resolution of the condition, improvement, or no improvement of the conditions.

5.0 Discussion

Since the pandemic started, there has been increased interest in the utilization of telemedicine to deliver eye care, including vision therapy for the continuation of care. The College of Optometrists in Vision Development (COVD) highlighted the scope of telemedicine implementation across various practice modes to deliver vision therapy services (Leonard J Press, 2020). As telemedicine gains prominence in health care delivery, some authors have highlighted the need for further investigation into the efficacy and feasibility of telemedicine for vision therapy. This retrospective study was conducted to contribute to this paucity of evidence.

5.1. Patient Satisfaction

By administering a survey, we evaluated the technological attributes of the telemedicine session and patient perspectives after receiving vision therapy during the COVID-19 pandemic. Cable internet was the most used internet connection for the telemedicine session, consistent with the national data on internet connection types (File & Ryan, 2014). 48% (n = 11) of the participants reported using a laptop, while about 50% (n = 12) reported using either a tablet or a smartphone for the telemedicine session. We did not evaluate the impact of device type on patient satisfaction or audio/video quality. Considering the device type used will become crucial given the growing use of tablets and smartphones by the US population (Zickuhr, 2013). Understanding how the device type influences telemedicine could lead to better telehealth experiences. Additionally, (Bittner et al., 2018) found that the audio and video quality were superior with iPad mini compared to Android tablets when used for low vision telerehabilitation.

All participants ranked the audio/video quality of the telemedicine sessions as high, with 54.6% reporting minimal disruptions during one or more sessions. Participants were asked about audio and video quality in two separate questions, however each respondent answered with the same rating for audio and video quality ("excellent"/" very good"/" good" for both audio and video). The most reported reason for technical disruptions was problems with the telemedicine platform. Understanding the nature of the issue with the platform and its compatibility with different device types needs further exploration. While a vast majority of patients reported ease with using the telemedicine platform, all patients reported being satisfied or very satisfied with the telemedicine sessions.

High patient satisfaction found in this study compares well to the previous studies that evaluated patient satisfaction with telemedicine before and after the COVID-19 pandemic. Despite methodological limitations, two systemic reviews conducted before the COVID-19 pandemic (Mair & Whitten, 2000), (Hersh et al., 2006) found that patient satisfaction was high for audio-video telemedicine visits (Mair & Whitten, 2000) and store-forward and audio-video based telemedicine visits (Hersh et al., 2006). A review conducted by (Aashima et al., 2021) evaluated patient satisfaction with telemedicine after the start of the COVID-19 pandemic and reported that satisfaction was high in both synchronous and asynchronous visits. Likewise, in eye care, patient satisfaction with telemedicine has been reported to be high before (Bittner et al., 2018), (Mohammadpour et al., 2017) and after the COVID-19 pandemic (Newman-Casey et al., 2021).

5.1.1. Strengths and limitations

This study has strengths and limitations. Strengths are that this is the first study, to our knowledge, that evaluated technological viability and patient satisfaction with telemedicine for receiving vision therapy. Even though the sample size was small, the survey participation rate was high. Limitations include a small sample size, lack of control group, selection bias, use of a non-validated survey, and survey administration prior to completion of VT. Selection biases included the influence of patients that opted in to receiving telemedicine VT, patients who were willing to participate in the survey, and patients who were chosen by providers as good candidates for receiving this type of service. While this was not inquired about, parents of patients participating in telemedicine who opted into these services may be more comfortable using technology than those who preferred to use in-office services. While administering the survey after completing VT with telemedicine would have been optimal, we could not anticipate how many patients would continue to stay enrolled in telemedicine either due to the provider's discretion to switch patients back to in-person visits or the patient's self-interest to continue receiving telemedicine.

The use of standardized survey instruments such as the Telehealth Usability Questionnaire (Parmanto et al., 2016) should be considered in the future. Additionally, it would be beneficial to know whether patient satisfaction differs between in-office and telemedicine visits. As telemedicine continues to play an important role in the future of health care delivery, future studies on telemedicine in eye care should address these deficits to further understand the patient experience.

5.2. Efficacy

In this retrospective study with small sample, across all diagnoses, vision therapy with telemedicine was largely effective in improving patient signs. Overall, 92% (n = 16) of patients met either “success” or “improved” criteria across all diagnoses. Accommodative disorder was observed in 33% of patients (n = 6), vergence disorder in 66.67% (n = 12) and saccadic dysfunction in 38.9% (n = 7). The proportion of completed telemedicine visits ranged from 53% - 100% (percent of sessions conducted virtually). While demographics such as average household income and distance to the eye clinic were calculated, there was not a statistically significant difference between the household incomes or the median distance from the patient’s home zip code to the clinic for the two groups, although those were receiving virtual VT services had a higher average household income.

Among those with accommodative disorders, 66% (n = 4) were successfully treated with telemedicine while the rest of this sub-group (n = 2) improved. It is important to note that one of these patients was classified as “improved” due to insufficient clinical data (monocular amplitude of accommodation was not recorded) required to meet “Success” criterion, therefore mildly underestimating the efficacy of telemedicine.

Of the twelve patients with vergence disorders, 83% (n = 10) of patients met the “success” criteria. A majority of patients who met the success criteria (80%) had convergence insufficiency. It is possible for the two participants (one with convergence deficit and one with convergence insufficiency) to have not met the success criteria due to lack of compliance. However, due to the lack of consistency in the documentation of patient compliance, we were not able to evaluate its impact on the outcome. Additionally, the vision therapy protocol and treatment duration were not standardized across patients with similar diagnoses, which may contribute to differences in degree and/or rate of improvement.

It is possible for patients who met the "improved" criteria to have experienced an improvement in symptoms. Using a validated survey such as the convergence insufficiency symptom survey (CISS) could have helped us evaluate whether receiving treatment through telemedicine improved patient symptoms.

None of the patients with saccadic dysfunction (n = 7) met the "success" criteria. Five of the seven patients (71.4%) improved with telemedicine. In the patients who met the improvement criteria at the time of diagnosis, two patients still only met the improvement criteria after treatment. One patient, with a diagnosis of saccadic dysfunction met the improvement criteria at the time of diagnosis for DEM ratio and failed DEM errors and continued to meet only the improvement criteria after treatment due to improved DEM error scores but failed DEM ratio in the post-treatment evaluation. We defined criteria for success as DEM ratio and errors above 50^{th} percentile and "improved" as DEM ratio (or) errors above 50^{th} percentile. DEM errors were not recorded in one of the five patients who improved, and in both patients who showed no improvement. In this study, saccadic dysfunction was the only condition that was not treated successfully with telemedicine. However, as stated before, the paucity of clinical data might underestimate the true efficacy of treatment with telemedicine in addition to non-compliance and differential rates of improvement with treatment.

This study adds to the existing body of literature supporting the efficacy of vision therapy for treating convergence insufficiency (Convergence Insufficiency Treatment Trial Study, 2008), (Scheiman et al., 2020) and accommodative disorders (Scheiman et al., 2011), (Chen et al., 2021). The Convergence Insufficiency Treatment Trial (CITT), the Convergence Insufficiency Treatment Trial - Attention & Reading Trial (CITT-ART) are randomized clinical trials that showed office-based vision therapy as the most effective treatment for improving clinical signs of convergence insufficiency in children (9-18 years of age) compared to placebo therapy. Similar results have been shown in adults (Alvarez & Scheiman, 2020).

While there is a need for randomized clinical studies evaluating the efficacy of vision therapy for eye movement disorders, some prospective studies have found that vision therapy can be effective in treating eye movement disorders (disorders of saccades, pursuits, and fixation) in children (Solan et al., 2001), (Solan et al., 2003), (Solan, 1967), (Young et al., 1982), (Punnett & Steinhauer, 1984) and adults (Solan et al., 1995) and (Rounds et al., 1991).

A recent large-scale retrospective study by Gallaway & Scheiman (Gallaway et al., 2017) evaluated the efficacy of in-office vision therapy in post-concussion vision disorders in children and adults. The success rate was reported to be 85%, 33%, and 83% for convergence insufficiency, accommodative insufficiency, and saccadic dysfunction respectively. Although there are methodological differences, the high success rate for treating convergence insufficiency reported by Gallaway & Scheiman is comparable to the results of this retrospective study.

5.2.1. Strengths and Limitations

To our knowledge, this is the first study that evaluated the efficacy of telemedicine for treatment delivery (i.e., vision therapy) in eye care. Efficacy was evaluated by predefined and established diagnostic and outcome criteria (Gallaway et al 2017, Raghuram 2019, Scheiman 2021). Limitations include small sample size, lack of control group, selection bias, retrospective design, and non-standardized treatment protocol. Given the establishment of separate diagnostic, success, and improvement criteria, there were several patients (n = 1 for accommodative disorders, n = 2 for saccadic dysfunction, and n = 3 for vergence disorders) that met the "improvement" criteria at the time of diagnosis. Our sample primarily consisted of non-strabismic binocular vision disorders. Because vision therapy is prescribed for patients with other diagnoses such as strabismus, amblyopia, and visual perceptual disorders, the results of this study cannot be extrapolated to these conditions.

6.0 Conclusion

The COVID-19 pandemic has invigorated the utility of telemedicine in all medical specialties, including eye care. This pilot study was the first of its kind in evaluating patient perspectives on and efficacy of telemedicine for vision therapy. Patient perspectives revealed high patient satisfaction, high ratings for audio and video quality, high perceived service accuracy, ease of use of the telemedicine platform, and interest in future telemedicine use beyond the pandemic. Telemedicine was largely effective in the treatment of non-strabismic binocular disorders. Large-scale randomized clinical trials are needed to validate its continued use. Furthermore, patient and provider perspectives on telemedicine for vision therapy need further investigation with validated telemedicine questionnaires. Lastly, the role of telemedicine in increasing access to vision therapy services should be evaluated.

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Appendix A. Telemedicine Patient Survey

Telemedicine Survey

1. Compulink ID # *

____

____

2. Date of Survey

Example: January 7, 2019

3. Date of Telehealth Visit *

____

Example: January 7, 2019

4. Consent? * Mark only one oval.

- o Yes
- o No
- o No Response (after 3 failed attempts)

Internet Access/Device Usage

5. How will you describe the type of internet service you currently have? Mark only one oval.
   - o Cable internet (administrator to explain if patient does not know definition: internet service is delivered red through a cable modem which can be connected to a router for a wireless service)
   - o Digital Subscriber Line (DSL) (internet service is delivered through a telephone line. If patient is confused about DSL or Dial-up: if your phone is tied-up when using internet, then it is not DSL)
   - o Satellite internet (internet service is delivered through a satellite dish which then brings the signal home through a modem
   - o Mobile internet (internet service is provided through cellular networks)

6. Which electronic device did you use for a majority of your telehealth encounters? Mark only one oval.
    - o Smartphone
    - o Tablet
    - o Laptop
7. Have you received other telehealth services in the past? Mark only one oval.
    - o Yes
    - o No
    - o Decline to Answer

8. Are you receiving other telehealth services now? Mark only one oval.
    - o Yes
    - o No
    - o Decline to Answer

9. The telemedicine platform was easy to use Mark only one oval.
    - o Very Easy to Use
    - o Easy to Use
    - o Neutral
    - o Hard to Use
    - o Very Hard to Use

10. Are you receiving other telehealth services now? Mark only one oval.
    - o Yes
    - o No
    - o Decline to Answer

11. The telemedicine platform was easy to use Mark only one oval.
    - o Very Easy to Use
    - o Easy to Use
    - o Neutral
    - o Hard to Use
    - o Very Hard to Use

12. How would you rate the audio quality for a majority of your telehealth encounters? Mark only one oval.

   - Excellent
   - Very Good
   - Good
   - Fair
   - Poor

13. How would you rate the video quality for a majority of the telehealth encounters? Mark only one oval.

   - Excellent
   - Very Good
   - Good
   - Fair
   - Poor

14. Of the three telehealth visits, how often did you experience a disruption due to technology? Mark only one oval.

   - One visit
   - Two visits
   - More than 2 visits
   - Every visit
   - None

Disruptions

15. If patient has used both ECL and Zoom: Which telemedicine platform, EyeCareLive or Zoom did you experience disruptions in? Mark only one oval.

   - Zoom
   - Eye Care Live
   - Both

16. What percent of the time was your telehealth session disrupted due to technology? (Ex: asynchronous audio/video, poor audio quality, poor video quality, call disconnections etc.,) Mark only one oval.

   - Less than 1% of the time

- Less than 5% of the time
- Between 5-25% of the time
- Between 25-50% of the time
- More than 50% of the time

17. How would you describe the technical disruption? Mark only one oval.

- Poor internet service
- Problem with telehealth platform
- Problem with my device
- Problem with my doctor’s device
- Not sure

Overall Experience

18. How much difficulty did you experience in following the doctor’s instruction during a majority of the encounters? Mark only one oval.

- No difficulty
- Little difficulty
- Moderate difficulty
- Severe difficulty
- Unsure

19. How accurate were the telemedicine sessions compared to in-office sessions? Mark only one oval.

- More accurate than in-office sessions
- As accurate as in-office sessions
- Less accurate than in-office sessions
- Don’t know
- Have not had any in-office VT sessions

20. If there are no COVID-related health concerns, would you prefer to receive telehealth services in the future instead of regular in-office services? Mark only one oval.

- Yes
- No
- Not sure

21. Overall, how would you rate your level of satisfaction in receiving telehealth services? Mark only one oval.

    - Very Satisfied
    - Satisfied
    - Neutral (not satisfied or dissatisfied)
    - Dissatisfied
    - Very dissatisfied

22. Comments