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ORIGINAL RESEARCH

# Telehealth Encourages Patients with Diabetes in Racial and Ethnic Minority Groups to Return for in-Person Ophthalmic Care During the COVID-19 Pandemic

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**Purpose:** The COVID-19 pandemic had a disproportionate impact on patients from racial and/or ethnic minority groups, causing many to delay healthcare. This study evaluates the role telehealth visits played in helping patients with diabetes mellitus (DM) return for subsequent, in-person eye examinations after the outbreak of COVID-19.

**Methods:** This retrospective, cross-sectional study analyzed 8147 patients with DM who had completed an outpatient ophthalmology and/or optometry visit in 2019 and who were due for return evaluation after the outbreak of COVID-19 in 2020. Factors associated with return for subsequent, in-person eye examination were assessed.

**Results:** The mean age of patients was 68.8 (±13.0) years, and 42% were women. 7.4% of patients identified as Asian; 2.9% as Black; 3.4% as Hispanic or Latin American; 0.92%, as more than one race; 1.78%, as other races; and 80.7% as White. Patients from racial and/or ethnic minority groups completed fewer in-person eye examinations after the outbreak of COVID-19 compared with White patients (35.6% versus 44.5%, $\chi^2$=36.172, $P$<0.001). However, both groups accessed telehealth services at a similar rate during this period (21.1% versus 21.9%, $\chi^2$=0.417, $P$=0.518). Importantly, patients who received telehealth services returned for subsequent, in-person eye examinations at substantially higher rates, regardless of race (51.0% and 46.6%, respectively, $\chi^2$=1.840, $P$=0.175). This offset the otherwise lower rate of return experienced by patients from racial and/or ethnic minority groups compared with White patients among the group of patients who did not receive any telehealth services (32.7% versus 42.7%, $\chi^2$=36.582, $P$<0.001). The impact of telehealth on the likelihood of in-person return remained significant after taking into account age, gender, race, language, residence, severity of diabetic retinopathy (DR), and vision in a multivariate model.

**Conclusion:** Telehealth initiatives benefited patients from racial and/or ethnic minority groups by reducing disparities in access to eye care experienced during the COVID-19 pandemic.

**Keywords:** telehealth, diabetes, diabetic retinopathy, quality improvement, medical care delivery

## Introduction

More than 34 million Americans have diabetes mellitus (DM), comprising 13% of the total adult US population.[1] DM disproportionately affects individuals belonging to racial and/or ethnic minorities in the US, and rates of diabetes-associated complications, including diabetic retinopathy (DR), are growing fastest among members of those groups.[2–7] Historically-marginalized populations have also faced barriers in accessing regular diabetic eye care, even when eye examinations are covered by health insurance.[8–12] Importantly, gaps in care can delay the detection and treatment of DR, which are crucial for preventing vision loss and associated disability.[13–16]

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The pandemic had a disproportionately greater impact on patients from racial and/or ethnic minority groups, significantly reducing their ability to access eye care.[17,18] Well-equipped offices, especially those associated with academic medical centers, rapidly transitioned to providing eye care through telehealth visits as an important method to care for vulnerable patients after the outbreak of COVID-19.[17,19] These visits protected both patients and providers from the risks associated with exposure to COVID-19,[20] and allowed providers to deliver health education and outreach as a temporizing measure while in-person care was limited by stay-at-home advisories and strict social distancing standards.[17,19]

This study evaluates the impact of telehealth visits on the likelihood that patients with DM would return for recommended in-person eye examinations in the first year of the COVID-19 pandemic. In this patient population, gaps in care can delay the detection and treatment of DR, which is crucial for preventing vision loss and associated disability.[8,9,21]

## Methods

The research followed the tenets of the Declaration of Helsinki and was approved as a quality-improvement initiative by the institutional review board of the Lahey Hospital, Burlington, MA. The requirement for informed consent was waived because of the retrospective nature of the study. Included in the study were those patients with DM who had been seen in the outpatient ophthalmology clinic in 2019 and had not returned for an eye examination in the period after the recognized outbreak of COVID-19 between March 15 to December 31, 2020.[22,23] Telehealth was utilized to deliver eye care to any patient who could not be seen in clinic because of prevailing public health conditions. Responsibility for telehealth visits was assigned to both ophthalmologists and optometrists who provided coverage on a rotating basis and often without reference to prior relationships to the patients or severity of disease. Services delivered by telehealth, as well as the criteria and timing for patient recall, were at the discretion of the treating provider. Included were a check of symptoms, refilling of any medications, and assuring future follow-up. Deceased patients were excluded. We extracted from the electronic medical record patient demographics (age, gender, race/ethnicity, and primary language spoken), clinical characteristics (visual acuity, type of DM, severity of DR, and hemoglobin A1c[%]) and ophthalmology appointment data for each patient by means of a customized reporting tool.[24] Type of DM and DR was defined by ICD-10-CM codes and stage of DR based on the more severely affected eye: mild non-proliferative diabetic retinopathy (NPDR; E10.32/E11.32), moderate NPDR (E10.33/E11.33), severe NPDR (E10.34/E11.34), and proliferative diabetic retinopathy (PDR; E10.35/E11.35). Distance to the nearest eye clinic was computed by using an Excel VBA program to access Microsoft Maps which calculated the distance between each patient's home zip code and the clinic zip code.

### Statistical Analyses

Visual acuity was converted to the logarithm of the minimum angle of resolution (LogMAR) for analyses. Categorical variables are presented as percentages and compared using the two-sided chi-square test. Data for continuous variables are recorded as mean ± standard deviation (SD) and compared by using the two-sided Student's *t*-test. Binary logistic regression analyses were used to identify demographic, clinical, and sociomedical factors associated with follow-up. For the logistic regression of multiple variables, we used a generalized linear model to determine the association between the variables included in the model and in-person return. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated for each variable. The *Z*-ratio was calculated for the significance of the difference in OR between groups. Stepwise multiple regression was performed to understand which of the identified factors predicted in-person return when combined into a single model. All tests were two-sided, and *P*-values below 0.05 were considered statistically significant (SPSS® Statistics version 27.0, IBM Corp., Armonk, NY).

## Results

In 2019, 9977 patients with DM were seen in the eye clinic. Out of that number, our study looked at 8147 patients who had yet to return for an eye examination by the time that the COVID-19 state of emergency was declared on March 15, 2020.[23] The mean age of these individuals was 68.8 years (SD ± 13.0 years) and 42.1% were female. Most patients identified as White, non-Hispanic (80.73%; herein after referred to as White), 7.39% identified as Asian; 2.87%, as Black or African American (herein after referred to as Black); 3.41%, as Hispanic or Latin American; 0.92%, as more than one race; 1.78%, as other races (including American Indian or Alaska Native, Native Hawaiian, or other Pacific Islander); and 2.90% of patients had unreported information regarding race and/or ethnicity. Additional demographic and sociomedical characteristics are in Table 1.

**Table 1** Demographic and Clinical Characteristics of Patients Who Completed in-Person Follow-Up Appointments

| Characteristic | All Patients (N=8147) | In-Person Follow-Up | | Difference, % (95% CI) | P-value[†] |
|---|---|---|---|---|---|
| | | Completed (N=3453) | None (N=4694) | | |
| **Age** | | | | | |
| Mean, years (SD) | 68.82 (13.02) | 70.30 (11.83) | 67.72 (13.73) | — | **<0.001** |
| Median, years | 70 | 71 | 69 | — | — |
| Under age 65, % (n) | 34.06% (N=2775) | 28.41% (n=981) | 38.22% (n=1794) | −9.83 (−11.88 to −7.78) | **<0.001** |
| Age 65 or older, % (n) | 65.94% (n=5372) | 71.59% (n=2472) | 61.78% (n=2900) | 9.83 (7.78 to 11.88) | **<0.001** |
| **Sex** | | | | | |
| Female, % (n) | 42.06% (n=3427) | 43.56% (n=1504) | 40.97% (n=1923) | 2.59 (0.42 to 4.76) | **0.019** |
| Male, % (n) | 57.93% (n=4720) | 56.44% (n=1949) | 59.03% (n=2771) | −2.59 (−4.76 to −0.42) | **0.019** |
| **Race** | | | | | |
| White (non-Hispanic), % (n) | 80.73% (n=6577) | 84.85% (n=2930) | 77.69% (n=3647) | 7.16 (5.47 to 8.85) | **<0.001** |
| Asian, % (n) | 7.39% (n=602) | 6.11% (n=211) | 8.33% (n=391) | −2.22 (−3.35 to −1.10) | **<0.001** |
| Black/African American, % (n) | 2.87% (n=234) | 2.40% (n=83) | 3.22% (n=151) | −0.81 (−1.53 to −0.09) | **0.018** |
| Hispanic/Latin American, % (n) | 3.41% (n=278) | 2.84% (n=98) | 3.83% (n=180) | −1.00 (−1.78 to −0.22) | **0.008** |
| More than one race, % (n) | 0.92% (n=75) | 0.78% (n=27) | 1.02% (n=48) | −0.24 (−0.65 to 0.17) | 0.216 |
| Other races,[¶] % (n) | 1.78% (n=145) | 1.62% (n=56) | 1.90% (N=89) | −0.27 (−0.85 to 0.30) | 0.278 |
| Unavailable, % (n) | 2.90% (n=236) | 1.39% (n=48) | 4.01% (n=188) | −2.62 (−3.30 to −1.93) | — |
| **Primary language spoken** | | | | | |
| English, % (n) | 94.59% (n=7707) | 42.8% 95.60% (n=3301) | 93.86% (n=4406) | 1.73 (0.76 to 2.70) | **0.001** |
| Other, % (n) | 5.40% (n=440) | 34.5% 4.40% (n=152) | 6.14% (n=288) | −1.73 (−2.70 to −0.76) | **<0.001** |
| **Distance to clinic** | | | | | |
| Mean Distance, miles (SD) | 25.16 (154.83) | 18.62 (107.69) | 29.98 (181.74) | — | **0.001** |
| Residence Out of State, % (n) | 8.69% (n=708) | 7.30% (n=252) | 9.71% (n=456) | −2.46 (−1.25 to −3.68) | **<0.001** |
| **Insurance type** | | | | | |
| Commercial Insurance, % (n) | 28.66% (n=2335) | 26.04% (n=899) | 30.59% (n=1436) | −4.56 (−6.53 to −2.59) | **<0.001** |
| Medicaid, % (n) | 9.01% (n=734) | 7.21% (n=249) | 10.33% (n=485) | −3.12 (−4.35 to −1.90) | **<0.001** |
| Medicare, % (n) | 59.33% (n=4834) | 64.41% (n=2224) | 55.60% (n=2610) | 8.80 (6.67 to 10.94) | **<0.001** |
| Other government, % (n) | 1.50% (n=122) | 1.45% (n= 50) | 1.53% (n=72) | −0.09 (−0.62 to 0.45) | 0.724 |
| Uninsured, % (n) | 0.70% (n=57) | 0.49% (n= 17) | 0.85% (n=40) | −0.36 (−0.71 to −0.01) | 0.051 |
| Unavailable, % (n) | 0.80% (n=65) | 0.41% (n=14) | 1.09% (n=51) | −0.68 (−1.05 to −0.32) | — |
| **Type of diabetes** | | | | | |
| Type 1, % (n) | 7.41% (n=604) | 8.22% (n=284) | 6.82% (n=320) | 2.27 (−1.95 to 6.50) | **0.017** |
| Type 2, % (n) | 92.59% (n=7543) | 91.78% (n=3169) | 93.18% (n=4374) | −2.27 (−6.50 to 1.95) | **0.017** |
| **Disease severity** | | | | | |
| NPDR, % (n) | 27.61% (n=2249) | 28.61% (n=988) | 26.86% (n=1261) | 1.75 (−0.22 to 3.72) | 0.081 |
| PDR, % (n) | 3.12% (n=254) | 4.75% (n=164) | 1.92% (n=90) | 2.83 (2.02 to 3.64) | **<0.001** |
| No retinopathy, % (n) | 69.28% (N=5644) | 66.64% (n=2301) | 71.22% (n=3343) | −4.58 (−6.62 to −2.54) | **<0.001** |
| HbA1c, % (SD) | 7.14 (1.33) | 7.10 (1.26) | 7.18 (1.42) | — | **0.039** |
| **Average vision** | | | | | |
| Worse eye vision, LogMAR (SD) | 0.21 (0.24) | 0.23 (0.26) | 0.19 (0.22) | — | **<0.001** |
| Better eye vision, LogMAR (SD) | 0.15 (0.20) | 0.16 (0.21) | 0.14 (0.19) | — | **<0.001** |

**Notes**: [†]Significance is marked in bold (P < 0.05). Comparison between those patients who completed telehealth encounters compared with those who did not. Categorical variables were compared by using the chi square test and continuous variables using a two-sided Student's t-test. [¶]Includes American Indian or Alaska Native, Native Hawaiian or other Pacific Islander, and other races.
**Abbreviations**: NDPR, nonproliferative diabetic retinopathy; PDR, proliferative diabetic retinopathy; HbA1c(%), hemoglobin A1c(%); LogMAR, logarithm of the minimum angle of resolution.

In the study cohort, 1739 patients (21.3%) completed a telehealth visit prior to an in-person, follow-up visit to the eye clinic. Most telehealth visits were conducted by telephone, with only 11 encounters recorded as being video-based (0.63%). 55% of telehealth services were provided by ophthalmologists. Importantly, the rate at which White patients completed telehealth (21.9%) was not significantly different from Asian patients (19.9%, $\chi^2$=1.21, $P$ = 0.271), Black

patients (20.5%, $\chi^2$=0.242, P=0.623), or Hispanic and/or Latin American patients (25.2%, $\chi^2$=1.709, P=0.191). Overall, patients from racial and/or ethnic minority groups completed telehealth visits at a rate similar to White patients (21.1% versus 21.9%, $\chi^2$=0.417, P=0.518). Similarly, there was no difference in the rate at which patients who spoke English as their primary language (95% of total) completed telehealth, compared with those who did not speak English as their primary language (21.3% versus 22.7%, $\chi^2$=0.529, P=0.467).

## Characteristics of Patients Who Completed in-Person Visits

A total of 3453 patients (42.4%) completed an in-person, follow-up visit to the clinic during the study period. This was a significantly lower rate of return compared with patients with DM who were seen in 2018 and due for return over the same months in 2019, exactly one year prior to the COVID-19 pandemic (68.4%, $\chi^2$=874.25, P<0.001). 53% of the in-person, return visits during the period of our study were conducted by ophthalmologists. Patients completing in-person visits were older (70.3 ± 11.8 years versus 67.7 ± 13.7 years, P<0.001) and more likely to be female (43.6% versus 41.0%, P=0.019). As to race, patients who were White returned at a higher overall rate (44.5%), compared with those who were Asian (35.0%, $\chi^2$=20.22, P<0.001), Black (35.5%, $\chi^2$=7.55, P=0.006), or Hispanic or Latin American (35.3%, $\chi^2$=9.35, P=0.002). Overall, patients from racial and/or ethnic minority groups completed fewer in-person eye examinations compared with White patients (35.6% versus 44.5%, $\chi^2$=36.172, P<0.001). This again contrasts with the same period but one year prior, in which the rate of return for White patients (68.4%) was similar to that for other racial and/or ethnic groups (Asian, 66.4%, $\chi^2$=0.727, P=0.394; Black, 64.6%, $\chi^2$=1.17, P=0.280; and Hispanic or Latin American, 65.2%, $\chi^2$=0.532, P=0.466).

## Factors Associated with Likelihood of Return for in-Person Eye Care

Patients who had completed a telehealth appointment, most of which took place in the first 90 days after the outbreak COVID-19 (Figure 1), were 25% more likely to return for a subsequent eye examination (50.2% versus 40.3%, $\chi^2$=55.332, P<0.001). Interestingly, patients who had a telehealth encounter with a physician (54% of all telehealth encounters) had a greater than 50% higher rate of return, compared with those who did not receive telehealth services (64.8% versus 39.4%, $\chi^2$=222.85, P<0.001). By contrast, patients who had a telehealth visit with an optometrist were
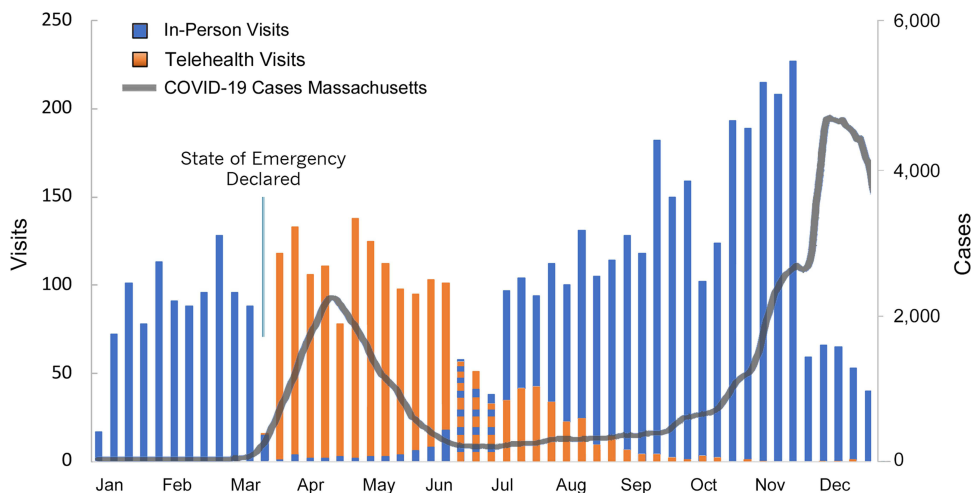


**Figure 1** Total Telehealth and In-person Visits for Patients with Diabetes. Reporting of COVID-19 cases in the Commonwealth of Massachusetts began on March 12, 2020 (13 cases).[23] The seven-day average number of confirmed cases recorded by the Department of Public Health is shown (grey line). In-person weekly visits to the eye clinic (blue bars) dramatically decreased after the recognized outbreak of COVID-19 and declared state-of-emergency on March 15.[31] The first local peak in COVID-19 cases occurred on April 20, 2020 (2299 cases). This coincided with the largest number of weekly telehealth visits (Orange bars). During the month of July, telehealth visits were nearly equal to in-clinic visits (cross hatched bars). Patients began to return for in-person eye examinations during the summer and fall when local case counts were declining and businesses, including eye care practices, were allowed to re-open.[37] A second local peak in COVID-19 cases occurred on December 7, 2020 (4779 cases), prompting additional public health measures to be imposed and total clinic visits to again decrease. Relatively few telehealth visits were conducted during this period. This may reflect an expectation that cases would again decline, permitting in-person care to resume, or relate to the development and approval of vaccines effective for the prevention of COVID-19.[38]

slightly less likely to follow-up for an in-person visit, compared with patients who did not receive telehealth services (34.9% versus 43.2%, $\chi^2$=20.534, $P$<0.001). Notably, a majority of patients with a history of PDR who completed a telehealth visit returned for in-person care regardless of whether the telehealth visit was with an ophthalmologist or an optometrist (83.1% and 62.5%, respectively, $\chi^2$=2.045, $P$=0.152). By contrast, those without a history of DR were less likely to return for care overall (66.6% versus 71.2%, $\chi^2$=19.615, $P$<0.001).

As to race, telehealth provided by an ophthalmologist was associated with a significantly higher rate of return for patients who were White (64.8% versus 39.4%, $\chi^2$=143.301, $P$<0.001), Asian (73.7% versus 31.0%, $\chi^2$=41.282, $P$<0.001), Black (70.1% versus 30.8%, $\chi^2$=18.073, $P$<0.001), or Hispanic or Latin American (60.7% versus 32.4%, $\chi^2$=8.844, $P$=0.003). Notably, the rate of return for the subset of patients who received telehealth in 2020 were similar to the rate at which patients seen in 2018 returned over the same months in the year 2019, prior to the pandemic (data not shown). Significantly, patients who were less likely to complete an in-person return visit included those who did not speak English as their primary language (34.5% versus 42.8%, $\chi^2$=1.17, $P$=0.001), lived farther from the clinic (18.6 ± 107.7 miles versus 20.0 ± 181.7 miles, $P$=0.001), or had a primary residence out-of-state (35.6% vs 43.2%, $\chi^2$=15.133, $P$<0.001). As to insurance, a larger proportion of all patients insured by Medicare returned for in-person care (46.0%, $\chi^2$ = 67.03, $P$<0.001), compared with a lower proportion of patients who had commercial insurance (38.5%, $\chi^2$=23.29, $P$<0.001) or Medicaid (33.9%, $\chi^2$ = 24.69, $P$<0.001). Finally, patients with better controlled diabetes, reflected by a lower average hemoglobin A1c(%), were more likely to return for in-person care (7.10% ± 1.26% versus 7.18% ± 1.42%, $P$=0.039), as were those who had Type 1 DM (47.0% vs 42.0%, $\chi^2$=5.742, $P$=0.017), DR (46.0% vs 40.8%, $\chi^2$=19.615, $P$<0.001), or worse vision in both the worse-seeing eye (LogMAR 0.21 ± 0.24 versus LogMAR 0.23 ± 0.26, $P$<0.001) or better-seeing eye (LogMAR 0.15 ±0.20 versus LogMAR 0.16 ± 0.21, $P$<0.001). The association of each of these individual factors with the likelihood of completing a subsequent in-person return visit is presented in Table 2.

**Table 2** Factors That Impacted the Likelihood of in-Person Follow-Up

| Characteristic | OR | 95% CI | | P-value[†] |
|---|---|---|---|---|
| | | Lower Bound | Upper Bound | |
| **Telehealth** | 1.496 | 1.345 | 1.664 | **<0.001** |
| **Telehealth by provider (relative to none)** | | | | |
| Physician (n=957) | 2.763 | 2.398 | 3.184 | **<0.001** |
| Optometrist (n=813) | 0.806 | 0.692 | 0.939 | **0.006** |
| **Age** | | | | |
| Age (years) | 1.016 | 1.012 | 1.019 | **<0.001** |
| Age 65 or older | 1.56 | 1.42 | 1.715 | **<0.001** |
| **Male sex** | 0.899 | 0.823 | 0.983 | **0.019** |
| **Race (relative to White, non-Hispanic)[‡]** | | | | |
| Asian | 0.672 | 0.564 | 0.800 | **<0.001** |
| Black or African American | 0.684 | 0.521 | 0.898 | **0.006** |
| Hispanic or Latin American | 0.678 | 0.527 | 0.871 | **0.002** |
| More Than One Race[¶] | 0.700 | 0.436 | 1.125 | 0.140 |
| Other Races | 0.783 | 0.559 | 1.098 | 0.156 |
| **Primary language not English** | 0.704 | 0.576 | 0.862 | **0.001** |
| **Insurance type (relative to commercial)[¥]** | | | | |
| Medicaid | 0.82 | 0.689 | 0.976 | **0.026** |
| Medicare | 1.361 | 1.231 | 1.505 | **<0.001** |
| Other Government | 1.109 | 0.766 | 1.606 | 0.583 |
| Uninsured | 0.679 | 0.383 | 1.205 | 0.186 |
| **Distance** | | | | |
| Nearest eye clinic (miles) | 0.999 | 0.999 | 1.00 | **0.002** |
| Residence Out of State | 0.728 | 0.62 | 0.855 | **<0.001** |

*(Continued)*

**Table 2** (Continued).

| Characteristic | OR | 95% CI | | P-value[†] |
|---|---|---|---|---|
| | | **Lower Bound** | **Upper Bound** | |
| **Type 1 diabetes** | 1.225 | 1.037 | 1.446 | **0.017** |
| **Disease severity (relative to no retinopathy)** | | | | |
| Nonproliferative diabetic retinopathy | 1.138 | 1.031 | 1.256 | **0.010** |
| Proliferative diabetic retinopathy | 2.647 | 2.036 | 3.442 | **<0.001** |
| HbA1c (%) | 0.961 | 0.928 | 0.995 | **0.025** |
| **Average vision** | | | | |
| Worse eye vision [LogMAR] | 4.464 | 3.209 | 6.209 | **<0.001** |
| Better eye vision [LogMAR] | 0.37 | 0.251 | 0.544 | **<0.001** |

**Notes**: [†]Significance is marked in bold (P < 0.05). Comparison between those patients who completed telehealth encounters compared with those who did not. Categorical variables were compared by using the chi square test and continuous variables using a two-sided Student's t-test. [‡]Patients with missing or unreported race are excluded. [¶]Includes American Indian or Alaska Native, Native Hawaiian or other Pacific Islander, and other races. [¥]Patients with missing or unreported insurance are excluded.
**Abbreviations**: NDPR, nonproliferative diabetic retinopathy; PDR, proliferative diabetic retinopathy; HbA1c(%), hemoglobin A1c(%); LogMAR, logarithm of the minimum angle of resolution.

Finally, stepwise multiple regression was used to develop a multivariate model of the factors that influenced in-person return among patients with DM. Telehealth, age, gender, race, primary language spoken, residence out-of-state, presence of retinopathy, and vision in the worse- and better-seeing eyes were included in this model as significant stepwise predictors (Table 3). The other demographic and clinical variables included in Table 2 were excluded from our multiple

**Table 3** Multiple Logistic Regression Analysis of All Variables Associated with Likelihood of in-Person Follow-Up

| Characteristic | β | Standard Error | Wald $\chi^2$ | OR | 95% CI | | P-value[†] |
|---|---|---|---|---|---|---|---|
| | | | | | **Lower Bound** | **Upper Bound** | |
| **Telehealth by provider (relative to none)** | | | | | | | |
| Physician | 0.833 | 0.075 | 123.53 | 2.299 | 1.985 | 2.663 | **<0.001** |
| ptometrist | −0.233 | 0.079 | 8.638 | 0.792 | 0.678 | 0.925 | **0.003** |
| **Age 65 or older** | 0.363 | 0.051 | 50.062 | 1.438 | 1.300 | 1.590 | **<0.001** |
| **Male sex** | −0.124 | 0.048 | 6.760 | 0.883 | 0.804 | 0.970 | **0.009** |
| **Race/Ethnicity (relative to White, non-Hispanic)[‡]** | | | | | | | |
| Asian | −0.297 | 0.096 | 9.660 | 0.743 | 0.616 | 0.896 | **0.002** |
| Black or African American | −0.287 | 0.143 | 3.991 | 0.751 | 0.567 | 0.995 | **0.046** |
| Hispanic or Latin American | −0.205 | 0.14 | 2.134 | 0.815 | 0.619 | 1.072 | 0.144 |
| More than one race | −0.246 | 0.249 | 0.976 | 0.782 | 0.480 | 1.274 | 0.323 |
| Other races[¶] | −0.143 | 0.179 | 0.638 | 0.867 | 0.610 | 1.232 | 0.425 |
| **Primary language (relative to English)** | −0.303 | 0.118 | 6.611 | 0.738 | 0.586 | 0.930 | **0.010** |
| **Residence out of state** | −0.339 | 0.086 | 15.61 | 0.713 | 0.603 | 0.843 | **<0.001** |
| **Disease severity (relative to having no retinopathy)** | | | | | | | |
| Nonproliferative diabetic retinopathy | 0.087 | 0.053 | 2.725 | 1.091 | 0.984 | 1.211 | 0.099 |
| Proliferative diabetic retinopathy | 0.862 | 0.145 | 35.218 | 2.368 | 1.781 | 3.147 | **<0.001** |
| **Average vision** | | | | | | | |
| Worse eye vision [LogMAR] | 1.222 | 0.173 | 49.643 | 3.395 | 2.417 | 4.770 | **<0.001** |
| Better eye vision [LogMAR] | −1.061 | 0.203 | 27.200 | 0.346 | 0.232 | 0.516 | **<0.001** |
| **Constant** | −0.585 | 0.057 | 104.365 | 0.557 | | | **<0.001** |

**Notes**: [†]Significance is marked in bold (P < 0.05). [‡]Patients with missing or unreported race are excluded from the multivariate logistic regression. [¶]Includes American Indian or Alaska Native, Native Hawaiian or other Pacific Islander, and other races.
**Abbreviations**: NDPR, nonproliferative diabetic retinopathy; PDR, proliferative diabetic retinopathy; HbA1c(%), hemoglobin A1c(%); LogMAR, logarithm of the minimum angle of resolution.

regression model owing to their lack of unique predictive value regarding likelihood of in-person return. Utilizing this model, we examined race and/or ethnicity as a factor that could influence the likelihood of in-person return. On its own, telehealth had a similar impact on the likelihood that patients who were non-White and/or Hispanic would return for in-person eye examination, compared with patients who were White (OR: 1.80, 95% CI 1.38–2.35, $P<0.001$, versus OR: 1.40, 95% CI 1.24–1.57, $P<0.001$; $Z=1.702$, $P=0.089$). However, after accounting for all the other factors in our multivariate model, telehealth provided by an ophthalmologist was associated with a greater likelihood of in-person return, and the impact of this factor was twice as great for non-White and/or Hispanic patients compared with White patients (OR: 4.18, 95% CI 2.78–6.29, $P<0.001$, versus OR: 2.10, 95% CI 1.79–2.45], $P<0.001$, $Z=3.166$, $P<0.001$). Analysis of individual racial and/or ethnic groups with such a model is limited by sample size but showed similar results for the impact of telehealth on likelihood of in-person return (data not shown).

## Discussion

The sudden outbreak of COVID-19 caused a precipitous decline in return visits among patients with DM, compared with the same period one year prior. This decline was most pronounced for patients from racial and/or ethnic minority groups in our study. By contrast, prior to the emergence of COVID-19, the rate-of-return was similar for White patients, compared with those identifying as other races and/or ethnicities at our medical center. Not surprisingly, COVID-19 acted as a barrier to care, exacerbating historic inequities,[17,18,21,25–28] especially given that individuals from racial and/or ethnic minority groups were disproportionately affected by COVID-19 infections.[19] In view of the rapid transition required to make services possible for our patients during the COVID-19 pandemic, the finding that telehealth increased the rate at which diabetic patients returned for in-person eye examinations is an encouraging finding, especially with regard to those who had DR and worse vision. It is also encouraging that telehealth partially offset the steeper decline in the rate-of-return for patients from racial and/or ethnic minority groups. Although the Affordable Care Act improved access to eye examination among the US working-age population with DM, disparities among racial and/or ethnic groups persist.[29,30] Additional steps are needed to close the gaps. Our study suggests telehealth could be part of a comprehensive strategy to engage patients and help them follow through with recommended eye examinations.[8,9]

A recent study at an urban medical center found that during the first year of the COVID-19 pandemic in the United States, historically-marginalized populations were less likely to receive ophthalmic care, including care delivered through telehealth services.[17] Though our study spanned the same period marked by the outbreak of COVID-19 in the state of Massachusetts,[31,32] our study differed in that we focused on the outcomes for established patients with DM who had had recent eye examinations. Our practice is also based in a suburban, rather than an urban setting. Disparities in care typically identified along lines defined by gender, race/ethnicity, and social class are often most visible in urban settings because of additional barriers to accessing care.[33] Finally, the utilization rate of telehealth was higher for the patients in our study, compared with the patients in their report. Most of our telehealth encounters were phone-based, rather than performed by video as in their practice. This might account for the greater uptake among the patients we looked at, many of whom were older or may not have had access to smart-phone or computer-based, video services. Whether these factors account for why telehealth was delivered to a larger proportion of total patients and with relative equality across racial and/or ethnic groups cannot be assessed. However, our study shares the critical finding that historically-marginalized populations were far less likely to return for in-person care. This indicates that barriers to accessing care in America continue to cross geographic, social, and economic lines.

During the first year of the COVID-19 pandemic, ophthalmologists and optometrists in our cooperative group practice successfully worked together to deliver nearly equal proportions of eye care, whether by telehealth or in-person. However, telehealth was not universally correlated with an increase in in-person return. This suggests that telehealth was not simply delivered to patients who were more engaged in their eye care and therefore more likely to schedule return visits. Our multivariate analysis also excludes disease severity as accounting for this difference, and telehealth visits showed a similar impact for patients in key demographics such as those with PDR who had an increased rate of return, regardless of provider type. On the other hand, patients who lacked a history of DR or had better vision returned less frequently for in-person care during the period of the COVID-19 public health emergency. Future studies should be performed to determine whether

differences exist in the way ophthalmologists, who are physicians, as compared with optometrists, communicate with patients, or recommend timing for a return visit. This may be important for helping to standardize the delivery of telehealth. Such a detailed analysis of telehealth encounter documentation is beyond the scope of this project.

## Limitations

The limitations of the present study include its retrospective nature and derivation from a suburban population based at an academic medical center. Repeating this study in a population with an even greater share of patients from racial and/or ethnic minority groups is likely to further our understanding of the utility of telehealth. This is especially important because the number of patients from diverse backgrounds continues to increase[34,35] and comprises the fastest growing segments of patients receiving care at our medical center (data not shown). We did not control for other comorbid eye diseases, treatment history (eg, prior intravitreal injections of medications, laser, or surgery), or provider-recommended follow-up interval. Nor did we directly take into account other barriers to care, such as transportation, level of education, or specifics related to socioeconomic or employment status, all of which could influence the ability of patients to follow-up. The subset of patients who received telehealth services did so largely during the early part of the COVID-19 outbreak. Changes made to state-specific guidelines, as well as the expansion of coverage for telehealth services for those insured by Medicare, may have affected patient eligibility or likelihood to accept telehealth visits.[33,36] The actions taken by providers were also left to individual clinical judgment and were not based on a standardized set of telehealth guidelines. Our analysis based on data derived from billing records also limits our ability to assess who was offered telehealth but declined, who was unreachable, or who was never scheduled for such services. Finally, the short-term nature of our evaluation, under the very specific conditions of the COVID-19 pandemic, limits our ability to draw conclusions about how telehealth will affect the longitudinal risk of patients failing to return or becoming lost to follow-up. Future directions for this research should ideally include a longer study period and assess DR complications and visual outcomes in patients engaged by telehealth.

## Conclusion

Telehealth delivered during the COVID-19 pandemic increased the rate at which patients with DM returned for in-person eye examinations. Patients from historically-marginalized groups, many of whom experienced inequalities in access to eye care exacerbated by the outbreak of COVID-19, showed an even more favorable rate of return after completing telehealth visits compared with White patients. Future studies should seek to determine whether telehealth delivered as a part of ordinary eye care can help close gaps and thereby improve health outcomes for our patients.

## Abbreviations

COVID-19, Coronavirus disease 2019; DM, Diabetes mellitus; DR, Diabetic retinopathy; NPDR, Non-proliferative diabetic retinopathy; PDR, Proliferative diabetic retinopathy; SD, Standard deviation; OR, Odd ratio; CI, Confidence Interval; HbA1c(%), Hemoglobin A1c(%); LogMAR, Logarithm of the minimum angle of resolution.

## Ethical Approval

This case series was conducted in accordance with the Declaration of Helsinki. The collection and evaluation of all protected patient health information was performed in a HIPAA (Health Insurance Portability and Accountability Act)-compliant manner.

## Statement of Informed Consent

This study received institutional review board approval. A waiver of informed consent was obtained for the research and publication of this article.

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## Disclosure

The authors declare no conflicts of interest.

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