Determinants of non-attendance at face-to-face and telemedicine ophthalmic consultations

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ABSTRACT
Background/aims Evaluation of telemedicine care models has highlighted its potential for exacerbating healthcare inequalities. This study seeks to identify and characterise factors associated with non-attendance across face-to-face and telemedicine outpatient appointments.

Methods A retrospective cohort study at a tertiary-level ophthalmic institution in the UK, between 1 January 2019 and 31 October 2021. Logistic regression modelled non-attendance against sociodemographic, clinical and operational exposure variables for all new patient registrations across five delivery modes: asynchronous, synchronous telephone, synchronous audiovisual and face to face prior to the pandemic and face to face during the pandemic.

Results A total of 85 924 patients (median age 55 years, 54.4% female) were newly registered. Non-attendance differed significantly by delivery mode: (9.0% face to face pre-pandemic, 10.5% face to face during the pandemic, 11.7% asynchronous and 7.8%, synchronous during pandemic). Male sex, greater levels of deprivation, a previously cancelled appointment and not self-reporting ethnicity were strongly associated with non-attendance across all delivery modes. Individuals identifying as black ethnicity had worse attendance in synchronous audiovisual clinics (adjusted OR 4.24, 95% CI 1.59 to 11.28) but not asynchronous attendance across all modes (all p<0.001).

Conclusion Persistent non-attendance among underserved populations attending telemedicine appointments highlights the challenge digital transformation faces for reducing healthcare inequalities. Implementation of new programmes should be accompanied by investigation into the differential health outcomes of vulnerable populations.

WHAT IS ALREADY KNOWN ON THIS TOPIC
⇒ There is a growing evidence that digital transformation of healthcare services may exacerbate healthcare inequalities. Patients who miss multiple hospital appointments, or ‘non-attenders’, are an under-researched group who may be suffering from substantial unmet health needs. Reports revealed a consistent relationship between reduced uptake of telemedicine appointments and greater levels of socioeconomic deprivation, low-income and ethnic minority groups however few examined non-attendance rates.

WHAT THIS STUDY ADDS
⇒ In this cohort study across 86 049 patients, non-attendance in synchronous audiovisual appointments was highest among men, those from greater levels of deprivation, those experiencing a previously cancelled appointment and those not self-reporting their ethnicity.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY
⇒ Persisting disparities in healthcare engagement among certain sociodemographic groups risks exacerbating pre-existing inequalities. Development of telemedicine services should go hand in hand with investigations into differential health outcomes among underserved populations.

INTRODUCTION
In response to the COVID-19 pandemic, telemedicine became requisite to maintaining eye care delivery, with deployment across different nations.1-6 Implemented at speed, and without an evidence base to inform mitigating strategies to prevent digital exclusion, there was a risk that greater reliance on digital technology could compound existing health disparities based on accessibility to and engagement with digital tools.7-9 Emerging evidence suggests this may be occurring—one US-based study found patients of older age and from ethnic minority groups were less likely to complete a teleophthalmology appointment.10 Similar patterns have been seen in electronic health record patient portal systems.11 12 Whether such disparities reflect an exacerbation of pre-existing inequalities or simply echo those found in traditional office-based consultations remains unclear. Moreover, most findings thus far have been derived from systems where the financial costs of access may influence healthcare engagement. Little attention has also been given to asynchronous ‘store-and-forward’ teleophthalmology approaches, an increasingly popular model of healthcare delivery.13
Moorfields Eye Hospital (MEH) is the largest tertiary ophthalmic centre based in the UK, providing eye services to an ethnically and socioeconomically diverse catchment population of approximately six million people in London, UK through both telemedicine (asynchronous and synchronous) and face-to-face encounters. In this study, our primary objective was to identify sociodemographic, clinical and operational factors associated with non-attendance at telemedicine clinics in specialist ophthalmic care within the National Health Service (NHS) which provides cost-free care at the point of use. We hypothesised that those from ethnic minority groups, or living with greater socioeconomic deprivation, or with limited internet access would have higher levels of non-attendance at synchronous telemedicine clinics. We additionally compared non-attendance between asynchronous, synchronous clinic delivery modes (collectively termed telemedicine) and face-to-face clinics.

METHODS
This was a retrospective cohort design of all NHS patients, aged 18 and over, who were newly registered and referred to MEH, between 1 January 2019 and 31 October 2021 inclusive. Only attendance or non-attendance at the first appointment at MEH was analysed.

Patients previously registered at MEH were excluded. We included patients referred to the adnexal, cataract, general ophthalmology, glaucoma and medical retina services as these accounted for 98.0% of all virtual clinics at that time. Sociodemographic, clinical variables and type of appointment were extracted from the MEH data warehouse, a locally held central repository of aggregated data from all electronic health record systems. Ethnicity was self-reported by the patient as (1) Asian or Asian British, (2) black or black British, (3) mixed, (4) other ethnic group, (5) white or (6) unknown. Due to data sparsity, those identifying as mixed were aggregated with other ethnic group. Socioeconomic status (SES) was measured using the Index of Multiple Deprivation (IMD) 2019, a standard UK measure of relative deprivation and SES across seven domains of income, employment, education, health and barriers to housing and services, crime and living environment. Access to and speed of home broadband internet was derived from the Digital Exclusion Risk Index (DERI), a composite continuous score between 1 and 10 developed by Greater Manchester Combined Authority and the Good Things Foundation. Due to small numbers resulting in potential loss of anonymity and limited statistical powers, patients certified as being sight impaired or severely sight impaired (equivalent to severe visual impairment or blindness using WHO criteria and conferring Government assistance) were aggregated into a single group.

Our primary outcome was attendance at the first appointment, defined as a binary variable. During the period studied, 139,908 appointments were cancelled by either the hospital or patient. As our study period included the start of the pandemic, the reason for cancellation was not consistently available and we were interested in identifying determinants of non-attendance, we used a previously cancelled appointment as an exposure variable and further classified whether it was instigated by the patient or by the hospital. Thus, the following exposure variables were defined a priori based on literature review and other hypothesised reasons for non-attendance: Sociodemographic—age (continuous), biological sex (binary), ethnic group (categorical), SES (rank), interpreter requirement (binary), broadband access (continuous). Clinical—diabetes mellitus (binary), ophthalmic subspecialty (categorical), certificate of visual impairment registration (binary). Operational—appointment time (categorical of early morning (8:00–11:00 hours), late morning (11:00–13:00 hours), early afternoon (13:00–15:00 hours) and late afternoon (15:00–17:00 hours)), previous cancellation by the hospital, previous cancellation by the patient.

Figure 1  Bubble plot showing the proportion of non-attendances for newly registered and referred patients during the time period. Size of the bubble indicates the number of patients.
Appointments were categorised by mode of delivery into one of the following three main forms of contact between the patient and clinician planning treatment:

- Store-and-forward approach where patients attend in person and undergo assessment with subsequent remote review by a clinician (hereafter termed ‘asynchronous’).
- Live technique mode where a clinician interacts in real-time with patients either through telephone or a audiovisual means (hereafter termed ‘synchronous’).
- Traditional face-to-face attendance with real-time interaction with a clinician (hereafter termed ‘F2F’).

Our primary objective was to evaluate the determinants of non-attendance at telemedicine appointments, comparing asynchronous and synchronous. Separately, we evaluated the determinants of non-attendance at F2F appointments for the same time period but also, for ‘benchmarking’ non-attendance at F2F.

Table 1  Baseline characteristics by delivery mode

<table>
<thead>
<tr>
<th>Category</th>
<th>F2F prepandemic n=42972</th>
<th>F2F pandemic n=27356</th>
<th>Asynchronous n=8878</th>
<th>Synchronous telephone n=1480</th>
<th>Synchronous audiovisual n=5238</th>
<th>P value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex n (%)</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Female</td>
<td>23430 (54.5)</td>
<td>14773 (54.0)</td>
<td>4620 (52.0)</td>
<td>845 (57.1)</td>
<td>3068 (58.6)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Age median (IQR)</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Years</td>
<td>54 (30)</td>
<td>56 (30)</td>
<td>57 (20)</td>
<td>68 (19)</td>
<td>39 (25)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Ethnicity n (%)</td>
<td></td>
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</tr>
<tr>
<td>Asian</td>
<td>2385 (5.6)</td>
<td>1208 (4.4)</td>
<td>270 (3.0)</td>
<td>58 (3.9)</td>
<td>175 (3.3)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Black</td>
<td>1365 (3.2)</td>
<td>546 (2.0)</td>
<td>290 (3.3)</td>
<td>23 (1.6)</td>
<td>71 (1.4)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>8054 (18.7)</td>
<td>5461 (20.0)</td>
<td>743 (8.4)</td>
<td>125 (8.5)</td>
<td>1596 (30.5)</td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>5835 (13.6)</td>
<td>2613 (9.6)</td>
<td>802 (9.0)</td>
<td>66 (4.5)</td>
<td>447 (8.5)</td>
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</tr>
<tr>
<td>Unknown</td>
<td>25329 (58.9)</td>
<td>17528 (64.1)</td>
<td>6773 (76.3)</td>
<td>1208 (81.6)</td>
<td>2949 (56.3)</td>
<td></td>
</tr>
<tr>
<td>SES† median (IQR)</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Index (1=most deprived)</td>
<td>3.40 (0.44)</td>
<td>3.42 (0.47)</td>
<td>3.41 (0.43)</td>
<td>3.41 (0.45)</td>
<td>3.42 (0.47)</td>
<td>0.008</td>
</tr>
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<td>Interpreter n (%)</td>
<td></td>
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<tr>
<td>Yes</td>
<td>406 (0.9)</td>
<td>214 (0.8)</td>
<td>69 (0.8)</td>
<td>14 (0.9)</td>
<td>29 (0.6)</td>
<td>0.007</td>
</tr>
<tr>
<td>Diabetes n (%)§</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1824 (4.2)</td>
<td>1454 (5.3)</td>
<td>887 (10.0)</td>
<td>17 (1.2)</td>
<td>10 (0.2)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Time of appointment n (%)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Early morning</td>
<td>20115 (46.8)</td>
<td>12619 (46.1)</td>
<td>3618 (40.8)</td>
<td>396 (36.8)</td>
<td>1815 (34.7)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Late morning</td>
<td>2872 (6.7)</td>
<td>2426 (8.9)</td>
<td>1354 (15.2)</td>
<td>129 (8.7)</td>
<td>679 (13.0)</td>
<td></td>
</tr>
<tr>
<td>Early afternoon</td>
<td>16298 (37.9)</td>
<td>9990 (36.5)</td>
<td>2502 (28.2)</td>
<td>644 (43.5)</td>
<td>1589 (30.3)</td>
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<tr>
<td>Late afternoon</td>
<td>3687 (8.6)</td>
<td>2321 (8.5)</td>
<td>1404 (15.8)</td>
<td>311 (21.0)</td>
<td>1155 (22.1)</td>
<td></td>
</tr>
<tr>
<td>Sight-impaired n (%)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Yes</td>
<td>266 (0.6)</td>
<td>189 (0.7)</td>
<td>30 (0.3)</td>
<td>¶</td>
<td>¶</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Previous cancellation n (%)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>No</td>
<td>36477 (84.9)</td>
<td>22744 (83.1)</td>
<td>7228 (81.4)</td>
<td>1138 (76.9)</td>
<td>4675 (89.3)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>By hospital</td>
<td>4650 (10.8)</td>
<td>3482 (12.7)</td>
<td>925 (10.4)</td>
<td>275 (18.6)</td>
<td>448 (8.6)</td>
<td></td>
</tr>
<tr>
<td>By patient</td>
<td>1845 (4.3)</td>
<td>1130 (4.1)</td>
<td>725 (8.2)</td>
<td>67 (4.5)</td>
<td>115 (2.2)</td>
<td></td>
</tr>
<tr>
<td>Specialty n (%)</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Adnexal</td>
<td>3278 (7.6)</td>
<td>2441 (8.9)</td>
<td>**</td>
<td>129 (8.7)</td>
<td>1174 (22.4)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Cataract</td>
<td>7782 (18.1)</td>
<td>6017 (22.0)</td>
<td>**</td>
<td>1171 (79.1)</td>
<td>149 (2.8)</td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>20933 (46.8)</td>
<td>11025 (40.3)</td>
<td>**</td>
<td>180 (12.2)</td>
<td>3915 (74.7)</td>
<td></td>
</tr>
<tr>
<td>Glaucoma</td>
<td>3883 (9.0)</td>
<td>1955 (7.2)</td>
<td>6138 (69.1)</td>
<td>**</td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>Medical retina</td>
<td>7936 (18.5)</td>
<td>5918 (21.6)</td>
<td>2740 (30.9)</td>
<td>**</td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>Attendance status n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-attendance</td>
<td>3860 (9.0)</td>
<td>2868 (10.5)</td>
<td>1042 (11.7)</td>
<td>145 (9.8)</td>
<td>373 (7.1)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

*P values derived from U-Statistic permutation test for categorical variables and Kruskal-Wallis test for continuous variables looking at differences between all groups. For individual pairwise comparisons, see online supplemental table 1.
†Missing values from 216 patients. A lower number equates to greater deprivation.
‡Missing values from 216 patients. A lower number equates to a higher risk of digital exclusion.
§Footnote reminder here that medical retina is one of the two specialties that offered asynchronous care.
¶Figures suppressed due to small number of patients.
**No or minimal appointments for these subspecialties in this mode of delivery.
F2F, face to face; SES, socioeconomic status.
appointments before the pandemic, that is, from 1 January 2019 to the first UK lockdown on 23 March 2021.

Statistical analysis
Continuous variables are summarised as median±IQR and categorical variables through percentages. Categorical variables were compared using the U-statistic permutation test of independence and continuous variables through the Wilcoxon-Mann-Whitney U test and Kruskal-Wallis Test. Individual pairwise comparisons were through the Dunn method with correction for multiple testing using the Bonferroni-Holm procedure.

Handling of missing data is reported according to recommendations issued on behalf of the STRengthening Analytical Thinking for Observational Studies initiative. There was a substantial number of missing data for self-reported ethnicity (n=53 864, 62.6%). We assumed that ethnicity data were not missing completely at random (MCAR) based on previous evidence of the sociodemographic determinants of missingness on self-reporting in healthcare. Moreover, there was strong statistical evidence to reject the null hypothesis that the data was MCAR using Little’s test (p<0.001). In our primary analysis, we hypothesised lack of self-reporting of ethnicity to be an important surrogate of altered engagement with health services and therefore separately modelled unreported ethnicity as a specific category, 'unknown', cognisant that this could shift any measures of effect for ethnic minority groups towards neutrality. Nonetheless, we analysed baseline characteristics among those who did not self-report ethnicity against those who did and, as a sensitivity analysis, we performed conditional multiple imputation 10 times with 5 iterations using multinomial logistic regression using all other exposure variables, in their raw form. Apart from self-reported ethnicity, no other variable had a large proportion of missingness (all <1%).

Adjusted ORs (aOR) with 95% CIs were estimated from multivariable binomial logistic regression using attendance status as the dependent variable and stratified by delivery mode. Five final models, fitted to all a priori exposure variables, were constructed depending on delivery mode (asynchronous, synchronous telephone, synchronous audiovisual, F2F and F2F in the year before the pandemic).

RESULTS
Between 1 January 2019 and 31 October 2021, 85 924 patients were newly registered and referred to services across all MEH sites (70 328 F2F, 8878 asynchronous and 6718 synchronous (online supplemental figures 1 and 2). Change in non-attendance rates over the study period are shown in figure 1. Median age of the cohort was 55±13 years and 54.4% (n=46 795) were female. Patients receiving their first appointment through synchronous audiovisual were the youngest (median 39±12.5 years) whereas those undergoing asynchronous review were older (median 57±10 years, p<0.001, table 1). Further baseline characteristics by delivery mode can be found in table 1. Individual pairwise comparisons among the delivery modes for age, sex, ethnicity, SES and non-attendance are in online supplemental table 1. Individuals who did not self-report ethnicity were more likely to be female, older, have diabetes mellitus and experience greater levels of socioeconomic deprivation and worse broadband access (online supplemental table 2).

Factors associated with non-attendance
Distribution of attendance status by exposure variables for all appointments can be seen in table 2. Overall non-attendance was 9.7% across all first appointments (n=8306). Non-attendance was highest in asynchronous clinics (11.7%) and lowest in synchronous clinics (11.5%) and figure 2. Across all delivery modes, men, those with greater levels of deprivation (except synchronous telephone) and those with a previously cancelled appointment by the hospital had higher levels of non-attendance. Increasing age was associated with greater levels of attendance across F2F and asynchronous clinics but not with synchronous.

In regard to teleophthalmology clinics, patients identifying as Black ethnicity were more likely to not attend a
synchronous audiovisual appointment (4.24, 95% CI 1.59 to 11.28, p=0.0039). However, there was no association between Asian or Black ethnicity with attendance status in asynchronous clinics. Patients had 105% and 48% greater odds of not attending their appointment when looking at F2F means during pandemic (0.56, 95% CI 0.47 to 0.68) and in asynchronous teleophthalmology (0.46, 95% CI 0.36 to 0.59). Those who were sight-impaired also independently had lower levels of non-attendance both prior to (0.39, 95% CI 0.22 to 0.70) and during the pandemic (0.50, 95% CI 0.28 to 0.94). Patients requiring an interpreter were more likely to attend prior to the pandemic (0.39, 95% CI 0.22 to 0.70) and during pandemic (0.56, 95% CI 0.45 to 0.70) compared with early afternoon appointments.

Table 3 Adjusted ORs for non-attendance derived from multivariable logistic regression stratified by delivery mode

<table>
<thead>
<tr>
<th></th>
<th>Prepandemic F2F OR (95% CI)</th>
<th>Pandemic F2F OR (95% CI)</th>
<th>Asynchronous OR (95% CI)</th>
<th>Synchronous (telephone) OR (95% CI)</th>
<th>Synchronous (audiovisual) OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (Decade)</td>
<td>0.91 (0.89 to 0.93)</td>
<td>0.89 (0.87 to 0.91)</td>
<td>0.89 (0.85 to 0.93)</td>
<td>0.81 (0.72 to 0.93)</td>
<td>1.02 (0.95 to 1.09)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Male</td>
<td>1.18 (1.10 to 1.26)</td>
<td>1.12 (1.03 to 1.21)</td>
<td>1.28 (1.12 to 1.46)</td>
<td>1.28 (0.90 to 1.82)</td>
<td>1.31 (1.06 to 1.63)</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
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<td>White</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
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<td>Reference</td>
</tr>
<tr>
<td>Asian</td>
<td>1.07 (0.88 to 1.30)</td>
<td>1.08 (0.79 to 1.47)</td>
<td>1.60 (0.94 to 2.75)</td>
<td>1.49 (0.31 to 7.11)</td>
<td>2.40 (0.99 to 5.82)</td>
</tr>
<tr>
<td>Black</td>
<td>1.33 (1.07 to 1.65)</td>
<td>1.63 (1.14 to 2.33)</td>
<td>1.09 (0.62 to 1.92)</td>
<td>2.03 (0.31 to 13.37)</td>
<td>4.24 (1.59 to 11.28)</td>
</tr>
<tr>
<td>Other</td>
<td>1.48 (1.29 to 1.70)</td>
<td>2.02 (1.63 to 2.50)</td>
<td>2.61 (1.77 to 3.86)</td>
<td>2.28 (0.61 to 8.49)</td>
<td>1.48 (0.74 to 2.94)</td>
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<tr>
<td>Unknown</td>
<td>1.71 (1.51 to 1.92)</td>
<td>2.51 (2.05 to 3.05)</td>
<td>2.92 (2.09 to 4.08)</td>
<td>2.09 (0.64 to 6.89)</td>
<td>3.39 (1.77 to 6.48)</td>
</tr>
<tr>
<td>SES (greater deprivation)</td>
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</tr>
<tr>
<td>Per decile decrease</td>
<td>1.12 (1.10 to 1.13)</td>
<td>1.09 (1.07 to 1.11)</td>
<td>1.09 (1.05 to 1.12)</td>
<td>1.05 (0.97 to 1.13)</td>
<td>1.17 (1.11 to 1.23)</td>
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<tr>
<td>Broadband</td>
<td></td>
<td></td>
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<tr>
<td>Index</td>
<td>0.94 (0.87 to 1.02)</td>
<td>1.00 (0.91 to 1.10)</td>
<td>0.97 (0.93 to 1.14)</td>
<td>0.81 (0.52 to 1.26)</td>
<td>1.07 (0.85 to 1.36)</td>
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<td>Interpreter</td>
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<tr>
<td>Yes</td>
<td>0.53 (0.35 to 0.81)</td>
<td>1.07 (0.70 to 1.63)</td>
<td>1.31 (0.66 to 2.60)</td>
<td>3.31 (1.00 to 10.96)</td>
<td>0.46 (0.01 to 3.39)</td>
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<tr>
<td>Diabetes mellitus</td>
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<tr>
<td>Yes</td>
<td>0.87 (0.74 to 1.03)</td>
<td>0.56 (0.47 to 0.68)</td>
<td>0.46 (0.36 to 0.59)</td>
<td>1.41 (0.30 to 6.53)</td>
<td>*</td>
</tr>
<tr>
<td>Subspecialty</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adnexal</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Cataract</td>
<td>1.51 (1.28 to 1.78)</td>
<td>1.06 (0.91 to 1.23)</td>
<td>*</td>
<td>1.31 (0.60 to 2.83)</td>
<td>1.12 (0.67 to 1.87)</td>
</tr>
<tr>
<td>General</td>
<td>1.37 (1.19 to 1.59)</td>
<td>0.50 (0.43 to 0.58)</td>
<td>*</td>
<td>1.42 (0.64 to 3.13)</td>
<td>0.70 (0.55 to 0.90)</td>
</tr>
<tr>
<td>Glaucoma</td>
<td>1.68 (1.41 to 1.99)</td>
<td>1.00 (0.83 to 1.20)</td>
<td>Reference</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>MR</td>
<td>2.08 (1.78 to 2.43)</td>
<td>1.48 (1.28 to 1.70)</td>
<td>2.55 (2.20 to 2.96)</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Certified sight-impaired</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Yes</td>
<td>0.39 (0.22 to 0.70)</td>
<td>0.50 (0.28 to 0.89)</td>
<td>0.66 (0.15 to 2.84)</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Appointment time</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Early afternoon</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Early morning</td>
<td>1.09 (1.01 to 1.17)</td>
<td>1.07 (0.98 to 1.17)</td>
<td>1.16 (0.98 to 1.37)</td>
<td>0.83 (0.51 to 1.35)</td>
<td>0.96 (0.75 to 1.24)</td>
</tr>
<tr>
<td>Late morning</td>
<td>0.71 (0.60 to 0.83)</td>
<td>0.99 (0.85 to 1.15)</td>
<td>1.01 (0.81 to 1.26)</td>
<td>0.61 (0.27 to 1.39)</td>
<td>0.79 (0.55 to 1.15)</td>
</tr>
<tr>
<td>Late afternoon</td>
<td>0.63 (0.54 to 0.73)</td>
<td>0.56 (0.45 to 0.70)</td>
<td>1.20 (0.97 to 1.48)</td>
<td>1.64 (1.07 to 2.50)</td>
<td>0.64 (0.45 to 0.90)</td>
</tr>
<tr>
<td>Previous cancellation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>By the hospital</td>
<td>1.29 (1.16 to 1.43)</td>
<td>1.75 (1.58 to 1.94)</td>
<td>2.05 (1.70 to 2.48)</td>
<td>0.46 (0.25 to 0.84)</td>
<td>2.22 (1.65 to 2.98)</td>
</tr>
<tr>
<td>By the patient</td>
<td>1.83 (1.59 to 2.09)</td>
<td>1.72 (1.45 to 2.03)</td>
<td>1.48 (1.18 to 1.86)</td>
<td>1.67 (0.81 to 3.46)</td>
<td>1.65 (0.92 to 2.97)</td>
</tr>
</tbody>
</table>

Effect estimates in bold were statistically significant (see online supplemental table 3 for more information)

* Either no cases or very few leading to unstable estimates.

F2F, face to face; MR, medical retina; SES, socioeconomic status.
effect for non-attendance among Black and South Asian ethnic
groups were more extreme for synchronous audiovisual appoint-
ments and South Asian patients had greater non-attendance in
asynchronous (1.44, 95% CI 1.01 to 2.04, p=0.0416, (online
supplemental table 4).

DISCUSSION
From an analysis of 85 924 patients newly registered in a tertiary
ophthalmic healthcare service in the UK between 1 January
2019 and 31 October 2021, we found non-attendance across
all delivery modes to be associated with male sex, greater
socioeconomic deprivation, lack of ethnicity self-reporting and
previously cancelled appointments (instigated by the patient
or hospital). Self-identified Black ethnicity was the factor most
strongly associated with non-attendance at a synchronous audio-
visual appointment. Our report demonstrates that even within
healthcare systems free at the point of service, socioeconomic
deprivation is a major challenge to engagement with digital
transformation of services.

The results of this study must be considered in the context
of its limitations. First, as in any observational epidemiological
study, we cannot rule out residual confounding (eg, employment
and accommodation status)—however, the IMD score of socio-
economic deprivation does encompass some relevant metrics.
In regard to self-reported ethnicity, there was a significant amount
of missing data. Individuals choosing not to self-report their
ethnicity demonstrate reduced engagement with healthcare
services and we sought to describe this effect by assigning a cate-
gory of unreported ethnicity in our primary analysis. Given that
individuals from ethnic minority groups are less likely to self-
report their ethnicity and the high non-attendance rates among
those who failed to self-report, differential miscategorisation bias
is likely to have underestimated the aOR for non-attendance
for these groups. Indeed, this hypothesis was supported by our
supplementary analyses using multiple imputation, a technique
which reduces bias even with large proportions of missing-
ness.26 27 There were a large number of cancelled appointments
during the study period (~15%), resembling that seen in the
UK NHS during a similar time period.28 We were able to distin-
guish between those initiated by the patient versus those by the
hospital, however, the reasons for cancellation were not available
rendering any association with our outcome or other exposure
variables unclear. While formal standard operating procedures
were not in place at this time regarding suitable candidates for
teleophthalmology, administrative and healthcare professionals
are likely to have risk-stratified patients being offered synchro-
nous teleophthalmology appointments resulting in a selection
bias. Similarly, we do not know if a patient had declined their
teleophthalmology or F2F appointment, however, this is being
explored in future work. Finally, our evaluation pertained to
healthcare provision in an exceptionally diverse population
under the provisions of a universal healthcare system (NHS).
Conclusions drawn must be considered in the context of an
organised healthcare system from a single-provider single-payer
system and may not be generalisable to regions without organi-
sed health systems.29

To our knowledge, there has been no similar large-scale
investigation of factors associated with non-attendance within
specialist ophthalmic care with which we can compare our find-
ings. However, many of our findings echo those in other fields
of healthcare.30 31 In ophthalmology, Eberly et al patients iden-
tifying as Asian and receiving Medicaid had fewer completed
telemedicine visits while those identifying as black and with
lower income demonstrated lower use of video for telemedi-
cine, respectively.32 Such sociodemographic patterning in non-
attendance is particularly concerning in ophthalmology given
that many potentially blinding eye conditions are more common
among those from the most socioeconomically deprived back-
grounds and/or from ethnic minority groups.33–35 A key priority
telemedicine services mature will be the investigation of
differential visual outcomes between patients undergoing F2F
and telemedicine models of care.

In our study, the synchronous group was significantly younger
than the asynchronous counterpart. This is likely to have resulted
from older patients declining video consultations when offered.
Furthermore, a large number of video consultations comprised

Figure 2  Forest plot showing regression coefficient estimates with 95% CIs by delivery mode derived from logistic regression. Note that sight-
impairment registration, diabetes mellitus and subspecialty are not shown due to unstable estimates from small numbers.
assessments of patients with external (adnexal) eye conditions in particular benign eyelid lesions, who tend to be younger than the average ophthalmology patient.36 Our study demonstrates the association of self-reported black ethnicity and greater socioeconomic deprivation with lower attendance within synchronous models of care delivery as opposed to asynchronous. This may support a phenomenon gaining significant traction, ‘digital exclusion’, which refers to a sector of the population who suffer from inequitable access and limited competency to use Information and Communication Technologies.37 To probe this further, we investigated whether lack of access to broadband internet was associated with non-attendance using the DERI.38

The lack of association between the DERI and non-attendance in our study may have several possible explanations. The DERI refers to aggregate postcode-level data rather than at the individual level. In our predominantly urban-based population, small geographical areas likely contain populations with varying levels of access to digital services. Moreover, synchronous telemedicine is increasingly delivered using smartphone-based technology where internet access may be mediated through cellular signal.

While those from ethnic minority groups generally exhibited higher levels of non-attendance, especially in synchronous audiovisual appointments, opting not to self-report ethnicity was among the strongest associations. We hypothesised this to be an important determinant given previous evidence suggesting failure to self-report may be a surrogate of non-engagement with healthcare services.21–23 In our report, those with ‘unknown’ ethnicity were older, more socioeconomically deprived, had worse broadband access and greater levels of diabetes mellitus suggesting a group already at risk of worse health outcomes. While it is unclear whether targeted communication on the benefits of health engagement may improve attendance rates in this group, there are distinct advantages in improving the recording of ethnicity data through informing equity of access, clinical practice, supporting high quality research and service planning.38

Countering our hypothesis, we observed better attendance among those requiring an interpreter prior to the pandemic, however, this ‘protective effect’ was not present during the pandemic. Our findings may suggest that patients who have used the interpreter service in person demonstrate higher engagement with healthcare services, and this needs to be accounted for when planning interpretations support available in telemedicine services. Similarly, patients, who have been certified as sight-impaired, had lower non-attendance, possibly reflecting active engagement with the larger welfare apparatus by enrolling themselves in the system to receive sight-impaired status, a better understanding of the implications of sight loss and/or a fear of further deterioration. This finding should be somewhat reassuring to clinicians as this especially vulnerable group does not appear to need additional measures to ensure good attendance.

Ambitions towards digital healthcare transformation are such that teleophthalmology is likely to remain a core part of service delivery in countries with resources to implement it. The findings of our study concord with building evidence from other areas of healthcare of persistent limited engagement with healthcare services among certain groups, such as those from ethnic minority groups and those living in greater socioeconomic deprivation. Further investigation is warranted of how such differential engagement could be addressed—for example with improved, targeted communication on the benefits of improved engagement on the outcomes that matter to patients. We suggest that the development and maturation of telemedicine services should go hand in hand with investigations into differential health outcomes among underserved populations, as the best strategy to minimise the risk of amplifying and embedding pre-existing inequalities for patients.

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