Original Article

The effect of a change from face-to-face to remote positive airway pressure education for patients with sleep apnoea during the coronavirus disease-2019 pandemic: a prospective cohort study

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Background: The coronavirus disease-2019 (COVID-19) pandemic and national lockdowns necessitated a change in service delivery including positive airway pressure (PAP) education protocols, with no data on how this may impact subsequent PAP adherence. We aim to quantify adherence of PAP initiated during the COVID-19 pandemic and compare the effects of remote versus face-to-face (FTF) education in patients with obstructive sleep apnoea (OSA).

Methods: This prospective cohort study in a tertiary National Health Service (NHS) hospital sleep disorders centre in London, United Kingdom, included 141 patients aged >18 years with newly diagnosed OSA initiating PAP during the COVID-19 pandemic; 71 patients receiving standard FTF education compared to 70 patients educated on PAP remotely at the start of lockdown.

Results: Adherence over a consecutive 30-day period within the first three months of PAP usage was measured, secondary outcomes included average nightly usage, usage per nights used, percentage of nights used, and percentage of nights used for ≥4 hours. In 141 patients (two-thirds male, 56% of at least 45 years of age and 48.9% sleepy at baseline), 114 patients (81%) were diagnosed with moderate or severe OSA. 54 patients (38.3%) achieved good adherence (≥70% of nights with ≥4 hours usage), with an average of 4.7 hours of PAP usage per night used. Patients receiving FTF PAP education had a comparable level of good adherence (38% versus 38.6%, P=0.915), and hours per nights used (4.7 versus 4.6 h/night, P=0.711) to remotely educated patients. More severe OSA, lower mask leak, and a nasal mask were associated with achieving good PAP adherence.

Conclusions: PAP adherence of newly diagnosed individuals with OSA during the COVID-19 pandemic was modest at 38.30%, and not significantly affected by remote PAP education delivery.

Keywords: Positive airway pressure (PAP); obstructive sleep apnoea (OSA); pandemic; adherence; remote; face-to-face (FTF)

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Introduction

The coronavirus disease-2019 (COVID-19) global pandemic was declared on 11th March, 2020 (1). Health care systems around the globe had to fundamentally change their operational pattern, and shifted away from elective care to management of acutely and critically ill patients (2). Likewise, the activity in sleep medicine centres was significantly curtailed and had to adapt to the new environment of social distancing and virus spread prevention. Reports from around Europe say that 25% of the sleep physicians and 19% of the lab technicians were re-deployed to assist with the pandemic (3,4). Inpatient sleep studies had to be limited, and since positive airway pressure (PAP) was identified at the time as an aerosol generating procedure, its initiation was performed either remotely or, rarely, under controlled conditions while as an inpatient (5). Telephone or video consultations and home sleep studies have allowed obstructive sleep apnoea (OSA) diagnostic activity to continue to a great extent.

Telemedicine has long been praised as the evolution of clinical medicine where applicable, pending further technological advancements, investment in IT and relevant infrastructure, and a requisite switch in the mindset of the medical community and managerial assembly. The COVID-19 pandemic has, by necessity, accelerated these changes, boosting telemedicine up by 683% compared to pre-pandemic levels (6). Following national lockdown guidance in the UK, in March 2020 we made a necessary transition to telemedicine and remote PAP initiation at the Sleep Disorders Centre at Guy's and St Thomas' Hospital (GSTT), London (7).

Here, we record adherence data for patients with OSA initiated on PAP during the COVID-19 pandemic in the UK, and we compare outcomes between face-to-face (FTF) and remote PAP education protocols. These unique data provide insight for the applicability and appropriateness of telemedicine in sleep medicine and the readiness of existing infrastructure to accommodate this change in practice. We present the following article in accordance with the STROBE reporting checklist (available at https://jtd.amegroups.com/article/view/10.21037/jtd-22-1816/rc).

Highlight box

Key findings

- A change from face-to-face to remote CPAP education did not significantly impact CPAP adherence in patients starting treatment *de novo* for sleep apnoea during the first three months of treatment.

What is known and what is new?

- Telemedicine and remote service delivery is increasingly used, in the setting of progressing information technology infrastructure and growing numbers of patients. The global pandemic due to the COVID-19 necessitated a forced change to remote service delivery for many clinical centres.
- This data adds supportive evidence to remote CPAP education, when necessary, being non-inferior to usual practice (face-to-face).

What is the implication, and what should change now?

- Remote CPAP education and initiation is a viable service model.
- However, more study is needed to optimise remote service delivery without affecting patient care, and to review longer term CPAP adherence in patients educated remotely rather than face-to-face.

Methods

In this cohort study, we analysed Auto-PAP (APAP) adherence data during the first year of the COVID-19 pandemic on adult (>18 years) patients with a new diagnosis of OSA in the UK, with their first day of recorded PAP usage on or after the 23rd of March 2020. This date was chosen as it was the starting date of the first national lockdown in UK and the day after which we first introduced remote education for APAP treatment in our department (8). Data on FTF education were collected on consecutive patients prior to the lockdown date, matching the recruited number of remotely educated patients. Recruitment continued until 4th of August 2020, when we re-introduced limited FTF PAP education. Most of the lockdown measures remained in place in UK until the end of May and were re-introduced in late September due to rising cases of COVID-19 nationally. Sample size calculation was not performed due to the restrictions imposed at the time on FTF assessments, the belief at the time that PAP was an aerosol generating device, and the aim to include all eligible patients.

All patients included in the analysis were diagnosed with home sleep apnoea testing (HSAT) with a WatchPAT device (Itamar Medical Ltd., Caesarea, Israel). Automated scoring was reviewed by a certified sleep technician, and then additionally by a certified sleep physician in accordance with device's and American Academy of Sleep Medicine (AASM) scoring guidelines (9,10). Patients were excluded if they had incomplete diagnostic or follow-up data, or if they were not naïve to APAP treatment. Demographics, Epworth sleepiness score (ESS) (sleepiness defined as ESS >10), and co-morbidities (cardiorespiratory history including ischaemic heart disease, hypertension, congestive cardiac failure and obstructive airways disease; neurological history including epilepsy disorders; co-morbid sleep complaints including insomnia, non-rapid eye movement (NREM) parasomnia, restless legs syndrome, and psychiatric history including affective and personality disorders) were collected from the electronic patient record. Disease-severity data recorded included apnoea-hypopnoea index (AHI), 4% oxygen desaturation index (ODI), time spent below saturations of 90% (T<90), mean and nadir oxygen saturations.

Patients referred for FTF PAP education were triaged into either a group or individual session based on patient-specific clinical and ethnic needs (for example, learning difficulties, language barriers, anxiety, or patient preference). Groups were made up of up to 7 subjects who were all newly referred for PAP and were delivered in 90 minutes, whereas an individual session was 60 minutes, the time difference allowing for group interaction while the content delivered was the same. All sessions were delivered by one of the Sleep Disorders Centre Sleep Technologist/Nursing team, and education around the basic principles of OSA and PAP technology was demonstrated. In addition, patients were taught how to correctly apply the selected interface, along with daily hygiene techniques, PAP device operation and troubleshooting details. A patient question-and-answer opportunity was also provided. Remote sessions were performed via Attend Anywhere (Attend Anywhere, Melbourne, Australia) video conferencing software and consisted of 60 minutes during which a member of the Sleep Technologist/Nursing team performed the standard patient education delivered during a FTF session.

The effect of remote versus standard FTF PAP education on device adherence was explored. All patients were introduced on the same APAP device (Airsense 10, ResMed, San Diego, California, USA), and adherence data were collected using ResMed AirView software, with recorded variables including: mask type provided by the department (nasal or oronasal), residual AHI, APAP pressure delivered at 95^{th} percentile, average nightly usage and average usage per nights used (minutes), number of nights used, and mask leak at the 95^{th} percentile. Good adherence was defined as ≥4 h per night for 70% of the nights during a consecutive 30-day period within the first three months of initial usage, as previously described (11-13).

This project was internally submitted for service improvement to prospectively ascertain anonymised data in full compliance with the European Union (EU) General Data Protection Regulation. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the GSTT Research and Development (R&D) Committee (Project-No-10039) and individual consent for this retrospective analysis was waived. External ethical approval was not required.

Statistical analysis

The primary outcome parameter was good adherence (≥4 h per night for 70% of the nights) in the FTF and remote PAP education groups. Secondary outcome parameters included the other collected adherence data. The remote and FTF PAP education groups were compared using unpaired *t*-tests and Mann Whitney U tests for continuous parametric and non-parametric variables, respectively, and Chi-squared test was used for categorical variables. Multiple logistic regression was performed with the dependent categorical variable of 'good adherence', utilising as independent variables ESS, baseline AHI, residual AHI, APAP at the 95th percentile, mask leak at the 95^{th} percentile, PAP education protocol, mask type and clinician-documented co-morbidities from their electronic health record (insomnia, psychiatric, neurological and respiratory history, as binary variables). Data are presented as mean [standard deviation (SD)], and median (interquartile range), for normally and non-normally distributed parameters, respectively, and as a percentage for categorical data.

Results

One hundred and sixty-two consecutive patients with a *de novo* diagnosis of OSA and first day of their PAP usage recorded during the first national lockdown in the UK were considered for analysis. Two patients with incomplete diagnostic data, nine with incomplete adherence data, and 10 patients who were not naïve to APAP were excluded. 70 patients commenced PAP remotely and 71 patients underwent FTF education prior to lockdown (37 patients in groups and 34 patients individually), with 141 patients

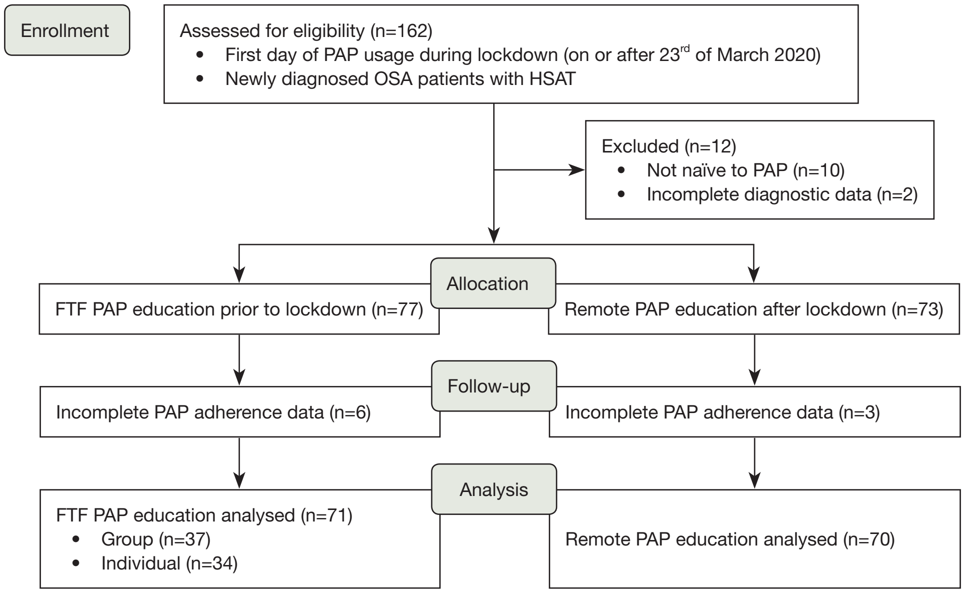

Figure 1 CONSORT recruitment flow diagram. PAP, positive airway pressure; OSA, obstructive sleep apnoea; HSAT, home sleep apnoea test; FTF, face to face.

having three months of adherence data included in the final analysis (*Figure 1*).

Patients were predominantly middle-aged (≥45 years of age, n=79; 56%) men (66.6%, *Table 1*); 115 patients (81.5%) were diagnosed with moderate or severe OSA (AHI ≥15/h), and half of the patients were sleepy at baseline; 54 patients (38.3%) achieved good adherence, with an average of 4.7 hours [282 minutes (183, 384.5 minutes)] of APAP usage per night used (*Table 2*).

Patients that received PAP education remotely were predominantly given a nasal mask (41.4% versus 2.8%, P<0.001), and displayed more severe OSA compared to the FTF group [57.1% versus 31%, P=0.012; median AHI 32.9 (20.9, 56.9) events/h versus 21.5 (14.9, 34.9) events/h, P=0.002]. A pre-morbid psychiatric history was also significantly more prevalent in this group (17.1% versus 5.7%, P=0.034).

Despite the more severe OSA in the remote group, their PAP delivered at the 95th percentile was significantly lower compared to the FTF group [10.9 (3.8) versus 12.3 (3.1) cmH_2O, P=0.018], with no repercussion for their residual AHI (P=0.984, *Table 2*). Patients in both groups used the PAP for the majority of the examined period (81.5% and 87%, *Table 2*), without a significant difference in hours used {4.6 h [277.1 (153.9) minutes] versus 4.7 h [285.8 (125.4) minutes], P=0.711; *Table 2*}. There was no significant difference in the number of subjects who achieved good adherence between the FTF and remote group (38.0% versus 38.6%, P=0.915).

In multiple logistic regression analysis, good adherence was associated with a higher baseline AHI (OR 1.02, 95% CI: 1.002 to 1.039, P=0.033), and negatively with mask leak (OR 0.967, 95% CI: 0.938 to 0.996, P=0.024, *Table 3*). Nasal mask type was positively associated (OR 4.38, 95% CI: 1.005 to 19.092, P=0.049) with good adherence. A coexisting psychiatric co-morbidity was negatively associated (OR 0.261, 95% CI: 0.065 to 1.049, P=0.058) with good adherence, but with borderline statistical significance. PAP education protocol (remote and FTF) did not affect treatment adherence (P=0.721).

Within patients receiving FTF education, there were no significant differences in age (49 versus 52 years, P=0.437), sex (36% versus 64% female, P=0.052), baseline AHI (23.6 versus 21.1/h, P=0.875) or adherence (median 90% versus 70% of nights used, P=0.206, mean usage 4.18 versus 3.53 h, P=0.288) between patients receiving group or individual FTF education, respectively.

Discussion

Adherence to PAP therapy was not affected by the unavoidable transition from a FTF to remote education

Table 1 Demographics, apnoea severity and comorbidities of cohort

Variables	Remote (n=70)	Face-to-face (n=71)	Total (n=141)	P value*
Age, years	47±14	51±13	49±14	0.144
Gender, female, n (%)	22 (31.4)	25 (35.2)	47 (33.3)	0.634
Nasal or oronasal, n (%)				
Oronasal	41 (58.6)	69 (97.2)	110 (78.0)	<0.001
Nasal	29 (41.4)	2 (2.8)	31 (22.0)	
ESS (baseline)	10 [6, 15]	11 [6, 15]	10 [6, 15]	0.823
Daytime somnolence (ESS >10), n (%)	33 (47.1)	36 (50.7)	69 (48.9)	0.672
OSA severity, n (%)				
None	0 (0.00)	1 (1.4)	1 (0.7)	0.012
Mild (5–15/h)	8 (11.4)	17 (23.9)	25 (17.7)	
Moderate (15–30/h)	22 (31.4)	31 (43.7)	53 (37.6)	
Severe (>30/h)	40 (57.1)	22 (31.0)	62 (44.0)	
AHI (baseline)	32.9 [20.9, 56.9]	21.5 [14.9, 34.9]	28.7 [17.5, 48.3]	0.002
ODI 4% (baseline)	23.7 [14.4, 52.8]	18.5 [12.8, 31.4]	20.6 [13.9, 37.5]	0.136
T<90 (%)	2.1 [0.4, 7.4]	1.3 [0.2, 4.3]	1.3 [0.2, 5]	0.203
SpO_2 mean (%)	94.5 [93, 95]	94 [93, 95]	94 [93, 95]	0.284
SpO_2 nadir (%)	81 [72, 86]	83 [77, 87]	82 [74, 87]	0.231
Insomnia	6 (8.6)	5 (7.1)	11 (7.9)	0.753
Co-morbid sleep issues, n (%)	12 (17.1)	20 (28.6)	32 (22.9)	0.107
Neurological history, n (%)	1 (1.4)	2 (2.9)	3 (2.1)	0.559
Psychiatric history, n (%)	12 (17.1)	4 (5.7)	16 (11.4)	0.034
Respiratory history, n (%)	10 (14.3)	9 (12.9)	19 (13.6)	0.805
Cardiovascular history, n (%)	23 (32.9)	22 (31.4)	45 (32.1)	0.856

Data are presented as mean ± SD, median [IQR] or count (percentage). Unpaired *t*-test and Mann Whitney U were performed for scale parametric and non-parametric analysis, respectively. Chi-square performed for categorical analysis. *, comparisons are between remote and face-to-face group. ESS, epworth sleepiness scale; OSA, obstructive sleep apnoea; AHI, apnoea-hypopnoea index; ODI, oxygen desaturation index; T<90, time spent below oxygen saturations of 90%; SpO_2, oxygen saturations.

protocol during the COVID-19 pandemic. The restrictions imposed by the COVID-19 pandemic were reflected in our changing patient population, including the presentation of more severe sleep apnoea and a higher degree of psychiatric difficulties, however these changes did not affect the adherence data. A moderate (38.3%) proportion of the total population achieved good PAP adherence.

Remote PAP education did not negatively impact adherence outcomes when compared to FTF PAP education {4.6 h [277 minutes (154 minutes)] versus 4.7 h [285 minutes (125 minutes)] of PAP usage on nights used, P=0.711, *Table 2*}, and 10% fewer nights with ≥4 h of PAP usage for the former group were non-significant (P=0.547, *Table 2*). A recently published letter by Turnbull *et al.* found that during the pandemic, patients initiated on continuous positive airway pressure (CPAP) remotely had a statistically significant reduction in CPAP usage during their first 30 days on treatment (−0.6 hours/night, P=0.03) (14). However, they did not see a change in their presenting patient population, with similar levels of sleep apnoea severity in each of their groups; we saw more patients presenting with severe sleep apnoea in patients presenting

Table 2 Compliance and effectiveness metrics of positive airway pressure

Variables	Remote (n=70)	Face-to-face (n=71)	Total (n=141)	P value*
Residual AHI (events/h)	1.7 [0.8, 4.0]	1.8 [0.9, 3.3]	1.8 [0.9, 3.5]	0.984
APAP, 95th% (cmH_2O)	10.9±3.8	12.3±3.1	11.6±3.5	0.018
Average usage (min)	196.5 [80.5, 376.3]	240 [91, 360]	214 [85.5, 363]	0.62
Usage/nights used (min)	277.1±153.9	285.8±125.4	282 [183, 384.5]	0.711
% of nights used	81.5 [37, 100]	87 [37, 100]	83 [37, 100]	0.414
% nights ≥4 h	43 [6, 94]	53 [17, 90]	50 [10, 90]	0.547
Good adherence (≥4 h/night for at least 70% of the nights), n (%)	27 (38.6)	27 (38.0)	54 (38.3)	0.915
Mask leak, 95th%	14 [7.9, 26.1]	15.6 [4.3, 29.3]	15 [6.4, 27.5]	0.678

Data are presented as mean ± SD, median [IQR] or count (percentage). Unpaired *t*-test and Mann Whitney U were performed for scale parametric and non-parametric analysis, respectively. Chi-square was performed for categorical analysis. *, comparisons are between remote and face-to-face group. AHI, apnoea-hypopnoea index; APAP, auto-positive airway pressure.

Table 3 Binary logistic regression model for good positive airway pressure adherence

Variables	B	χ^2	Odds ratio	95% CI for odds ratio		P value
				Lower	Upper	
Age	0.032	3.051	1.032	0.996	1.069	0.081
Gender	–0.421	0.753	0.657	0.254	1.698	0.385
Nasal mask	1.477	3.867	4.380	1.005	19.092	0.049
FTF initiation	0.175	0.128	1.191	0.457	3.104	0.721
ESS	–0.015	0.116	0.985	0.905	1.073	0.733
AHI baseline	0.020	4.557	1.020	1.002	1.039	0.033
Residual AHI	–0.003	0.004	0.997	0.901	1.102	0.951
APAP, 95^{th} centile	0.137	3.542	1.147	0.994	1.323	0.060
Mask leak, 95^{th} centile	–0.034	5.064	0.967	0.938	0.996	0.024
Insomnia or other sleep symptoms	–0.645	1.715	0.525	0.200	1.378	0.190
Neurological history	20.287	0.000	646,290,354.592*	0.000	–	0.999
Psychiatric history	–1.343	3.580	0.261	0.065	1.049	0.058

*, the extreme Odds ratio is due to the unusually low number of cases for one of the dichotomous (3/171 patients had neurological co-morbidities). FTF, face-to-face; ESS, epworth sleepiness scale; AHI, apnoea-hypopnoea index; APAP, auto-positive airway pressure.

during the pandemic, which may have contributed to a relative increase in PAP adherence in this group.

A handful of cross-sectional studies from Europe and US have identified a limited effect of the pandemic on PAP compliance on long-term treated patients with OSA (15-17). 4.4–11% of patients with OSA stopped using their PAP during the pandemic, one-third of them due to symptoms of COVID-19 or concerns that they would co-infect their household members (16,18). Our notably lower PAP adherence compared to a recent Spanish study (38.30% versus 79.5% of good PAP adherence, respectively) (15) and average PAP time per night used compared to a recent French study (282min/night versus 401 min/night, respectively) (17) may appear remarkable but are likely misleading due to different study settings. The main differences include that our patients were newly diagnosed with OSA (in contrast to the long PAP-established cohorts in the other studies) and spent their 3-month PAP acclimatization period during lockdown. Moreover, poor housing and overcrowded households, both highly prevalent in London, could have undermined self-isolation advice and impeded adequate PAP adherence in our cohort (19-21).

Our patients had no access to alternative treatments for OSA which would otherwise have been readily available, namely bespoke mandibular advancement devices, genioglossus muscle electrical stimulation and upper airway operation for suitable cases (22). Patients who would have been otherwise re-directed to an alternative treatment modality at an earlier stage, or never offered the PAP treatment in the first place (for example, patients with claustrophobia or milder forms of OSA) were commenced on PAP, reflecting a pragmatic approach to clinical practice during the pandemic (22).

In our regression analysis, the PAP-education protocol was not identified as an independent predictor of good adherence (P=0.721). We noted instead that the higher the AHI and the lower the mask leak at the 95th percentile, the more likely the patient would have achieved good adherence (*Table 3*). Most data from the literature do support, albeit weakly, that a higher AHI is associated with better PAP adherence (23-26). However, mask leak rarely survives regression analysis as a significant independent predictor of poor adherence (27-29), while it remains one of the most common and important reported side effects of the PAP treatment (30). The latest report from the AASM on the PAP treatment in 2019 calls for further studies needed on the impact of mask leak on PAP effectiveness and patient adherence, and our data strongly support this notion (28).

While not all patients who underwent remote PAP education received a nasal mask per se, the decision regarding mask type was made clinically, and nasal masks were generally regarded as more pragmatic to start remotely due to their smaller facial footprint and difficulties in measuring the size of a patient's face remotely. Our regression analysis found that, nasal masks were marginally associated with good adherence (OR 4.38, 95% CI: 1.005 to 19.092, P=0.049), which reinforces AASM recommendations and recent meta-analysis data for greater comfort, reduced pressure requirements and reduced mask leak compared to oronasal masks (29,31). However, more granular data analysis between nasal and oronasal mask use in our population was beyond the scope of this study.

A cross-sectional online survey-based study on adults living through the COVID-19 pandemic in UK between May and June 2020 showed that 65.2% of their 843 participants reported an impact on their mental health, significantly more sleep symptoms, and concern about their sleep (32). The higher prevalence of psychiatric co-morbidities in our cohort (17.1% versus 5.7%, P=0.034, *Table 1*), may have introduced a selection bias in our study, as psychological factors may have an impact on individual patients' motivation to adhere to therapy (33). Having said that, a psychiatric co-morbidity was not a significant factor in our regression model (P=0.057).

Limitations

Our study has several limitations. We were unable to record baseline body mass index (BMI) for the majority of the patients included, due to restrictions in FTF assessment and it is therefore omitted from the analysis as a possible confounder. We have already discussed the potential bias of self-referral introduced by patients who were more concerned with their sleep issues, and the potential association with their mental health comorbidities. Similarly, the pandemic-driven restrictions placed on our service delivery introduced a need to prioritise more severe cases and influenced the choice of mask type during PAP initiation. However, these should be regarded as more reflective of the unique impact of a global pandemic, which exerts heterogenous effects on patients in different health, social and economic living situations. As mentioned above, our cohort predominantly lives in London, which may limit generalisability of our data to more rural populations with different social and housing environments. Finally, the results are limited by the non-randomised controlled trial design, and the lack of sample size calculation, as explained in our methods.

Conclusions

These data suggest that remote versus FTF PAP education protocols do not significantly affect treatment adherence. This has relevance not only during a global pandemic but for future resource planning, particularly in light of evidence for telemedicine supporting PAP adherence (34). However, factors relating to the effects of the COVID-19 pandemic may have had more of an impact on PAP adherence, including the overall severity of OSA at presentation, restrictions in FTF aerosol generating procedures and health-related anxieties. With the ongoing growth of remote and telemedicine across healthcare disciplines, future research could include large-scale randomised controlled trials in both urban and rural populations, as well as different ethnic and socioeconomic backgrounds.

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