CORRESPONDENCE

Check for updates

Adherence to Continuous Positive Airway Pressure Hugely Improved during COVID-19 Lockdown in France

To the Editor:

The impact of the coronavirus disease (COVID-19) pandemic on adherence to chronic therapies is still debated and potential concerns have been raised regarding its effect on the short- and long-term outcomes of chronic diseases (1, 2). During the pandemic, access to routine care has been restricted as resources have been reallocated, prioritizing the response to COVID-19. In addition, nationwide home confinement has been extensively used to prevent the spread of COVID-19 infection, leading in some individuals to a deterioration in their mental health, greater anxiety, and unhealthy behaviors that might have impacted adherence to chronic therapies (3).

Obstructive sleep apnea (OSA) is one of the most frequent chronic diseases, affecting nearly one billion people worldwide, and is associated with cardiometabolic comorbidities and poor health outcomes (4, 5). The first line therapy for OSA is continuous positive airway pressure (CPAP), which reopens and stabilizes the upper airway during sleep. The CPAP devices can transmit individual measurements of nightly adherence to homecare providers and physicians through remote telemonitoring platforms. This digital care function provides access to robust and objective adherence data across well-defined periods of time. Preliminary data have suggested a slight increase in CPAP adherence during the first strict COVID-19 lockdown (6, 7).

In this study, we aimed to *1*) provide detailed knowledge of shifts in CPAP adherence due to lockdown through subgroup analyses by age, sex, and CPAP adherence level before lockdown (reference adhesion) and *2*) determine whether any changes in CPAP adherence were related to the level of excess mortality during the first wave of COVID-19 in the CPAP users' county of residence.

Data were collected from the remote monitoring databases of homecare providers with restricted demographic data but including age and sex. All patients had consented to their CPAP data being used for research purposes. We analyzed the impact of the first COVID-19 national lockdown in France on CPAP adherence, measured objectively by remote telemonitoring in 14,543 patients (age: median [interquartile range (IQR)], 66 [57–73] yr; male, 68.3%). A mixed linear regression model adjusted to age, sex, and prelockdown CPAP adherence was used to compare data from a pre–COVID-19 period, springtime the previous year (March 15 to April 15, 2019), with data during the first COVID-19 wave national lockdown in France (March 15 to April 15, 2020; missing values in 2020: $n = 6$ without significant impact). The model was validated by checking the normality of the residuals. CPAP adherence significantly increased from 394 (IQR, 305–458) to 414 (IQR, 324–479) minutes (median percentage of variation from baseline: 3.7% [IQR, −4.9 to 14.7], $P < 0.01$). Our model indicated that men had a 48.7% greater increase in adherence between the pre–COVID-19 period and during lockdown compared with women (absolute difference, 7.45 min [95% confidence interval, 3.26–11.59 min], $P < 0.01$). The interaction between age and the assessment period was significant ($P < 0.01$). The mixed model showed that after the lockdown, the adherence of patients aged 65–75 years was increased 20.23 minutes more compared with CPAP-treated patients under 65 years. Patients over 75 years demonstrated a 10.26 minute increase in CPAP adherence compared with those under 65 years. There was an exemplary relationship between pre–COVID-19 adherence and increase in adherence during lockdown with, in particular, a huge increase among individuals with poor adherence in the pre–COVID-19 period (Figure 1). This increase of over 30 minutes in CPAP adherence exceeds the threshold of adherence improvement considered as clinically significant (8). The geographical spatial distributions of COVID-19 infection—incident cases, number of hospitalizations, number of ICU admissions, and the level of excess of mortality by county—are collected by the French national public health agency and are publicly available data on the French government website: https://www.data.gouv.fr/fr/organizations/sante-publique-france/. Our analysis showed that high levels of COVID-19 infection parameters were not significantly associated with changes in CPAP adherence between the pre–COVID-19 and lockdown periods per county (Figure 2).

The major strength of our study is to provide longitudinal data on CPAP adherence by the same individuals, allowing a comparison before and during lockdown. This enabled us to confirm that nationwide CPAP adherence slightly increased, especially in those under 65 and in men, and that improvement was most marked in subgroups with the lowest adherence before lockdown. Furthermore, this improvement in CPAP adherence did not appear to be related to the burden of COVID-19 in the county in which the patients resided. These data are of great value for understanding the mechanisms leading to poor adherence in patients with CPAP-treated OSA. At present we can only speculate on the possible mechanisms involved. First, a proportion of still-working men under 65 might have had chronic sleep deprivation with reduced sleep time and thus
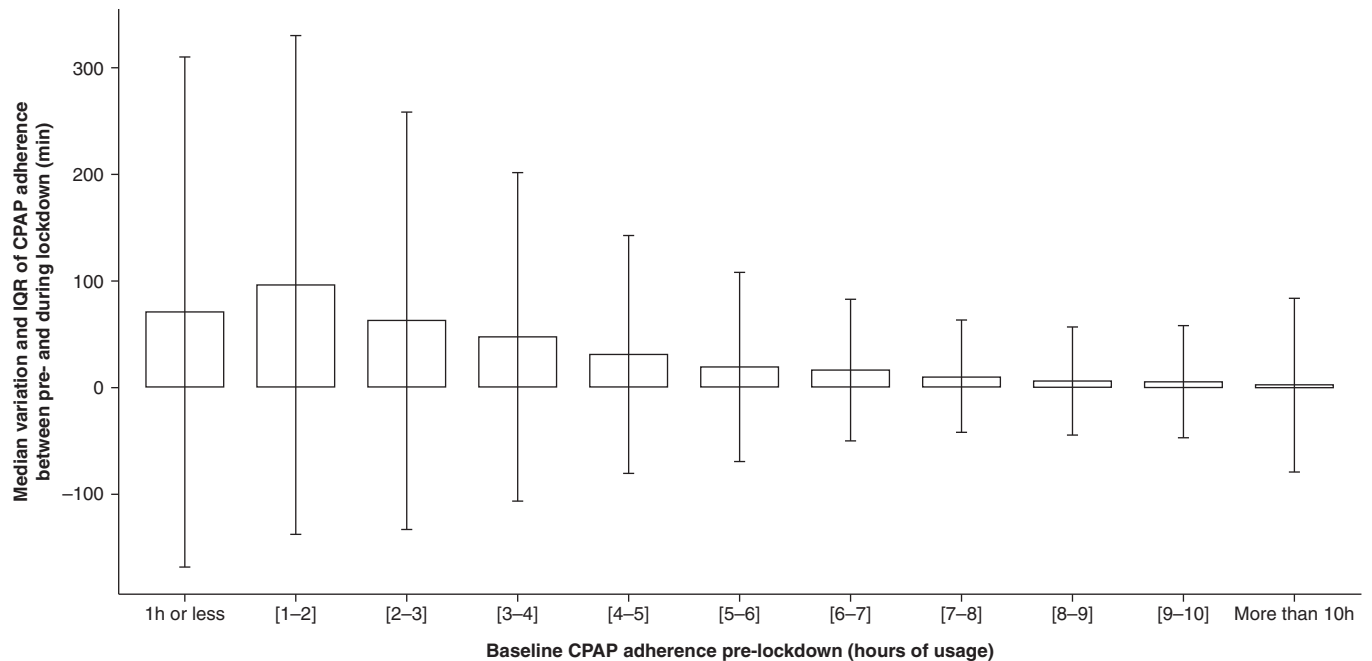
Figure 1. Waterfall plot of the change in CPAP adherence between a pre–coronavirus disease (COVID-19) period (March 15 to April 15, 2019) and during national COVID-19 lockdown (March 15 to April 15, 2020) in France, by adherence before COVID-19. CPAP = continuous positive airway pressure; IQR = interquartile range.

reduced adherence owing to their profession or employment, with additional frequent absences from their place of abode without access to their CPAP device. Lockdown curtailed their activities and allowed these individuals to recover from sleep loss, with increased duration of nightly CPAP usage and thus adherence. Second, women might have had a smaller increase in adherence than men owing to stress and duties related to children being at home. Third, CPAP-treated patients starting therapy in the spring before the pandemic (the reference period) might have increased their adherence over one year independently of lockdown effects. Lastly, OSA has been consistently reported to be significantly associated with severe COVID-19 (9) and this forewarning had been widely disseminated to patients by physicians and home care providers (10). In addition, better adherence might also be linked to a fear of hospitalization alongside patients with COVID-19. These anxieties might have triggered changes in behavior regarding CPAP use, particularly as psychological factors are known to be far greater contributors to adherence to CPAP (11) than technical aspects. In all circumstances we suggest that healthcare providers should dedicate more time to coaching and patient education so as to improve adherence.

A logical next step will be to document the evolution of these changes in CPAP adherence, including any relapse to pre–COVID-19 patterns once the strict lockdown period had ended, and then the impact of successive COVID-19 waves and the different degrees of lockdown enforced by governments. ■

Jean-Louis Pépin, M.D., Ph.D.*‡
Najeh Daabek, M.S.*
Sébastien Bailly, Ph.D.
Renaud Tamisier, M.D., Ph.D.
Grenoble Alpes University
Grenoble, France
and
Grenoble Alpes University Hospital
Grenoble, France

David Attias, M.D.§
Clinique Pasteur
Toulouse, France

Atul Pathak, M.D., Ph.D.§
Princess Grace Hospital
La Colle, Monaco
and
Centre for Anthropobiology and Genomics of Toulouse
Toulouse, France

*Co–first authors.
‡Corresponding author (e-mail: jpepin@chu-grenoble.fr).
§Co–senior authors.

Mortality excess levels
March 30, 2020

Exceptional
High
No excess

Variation of CPAP adherence

Decrease in CPAP adherence
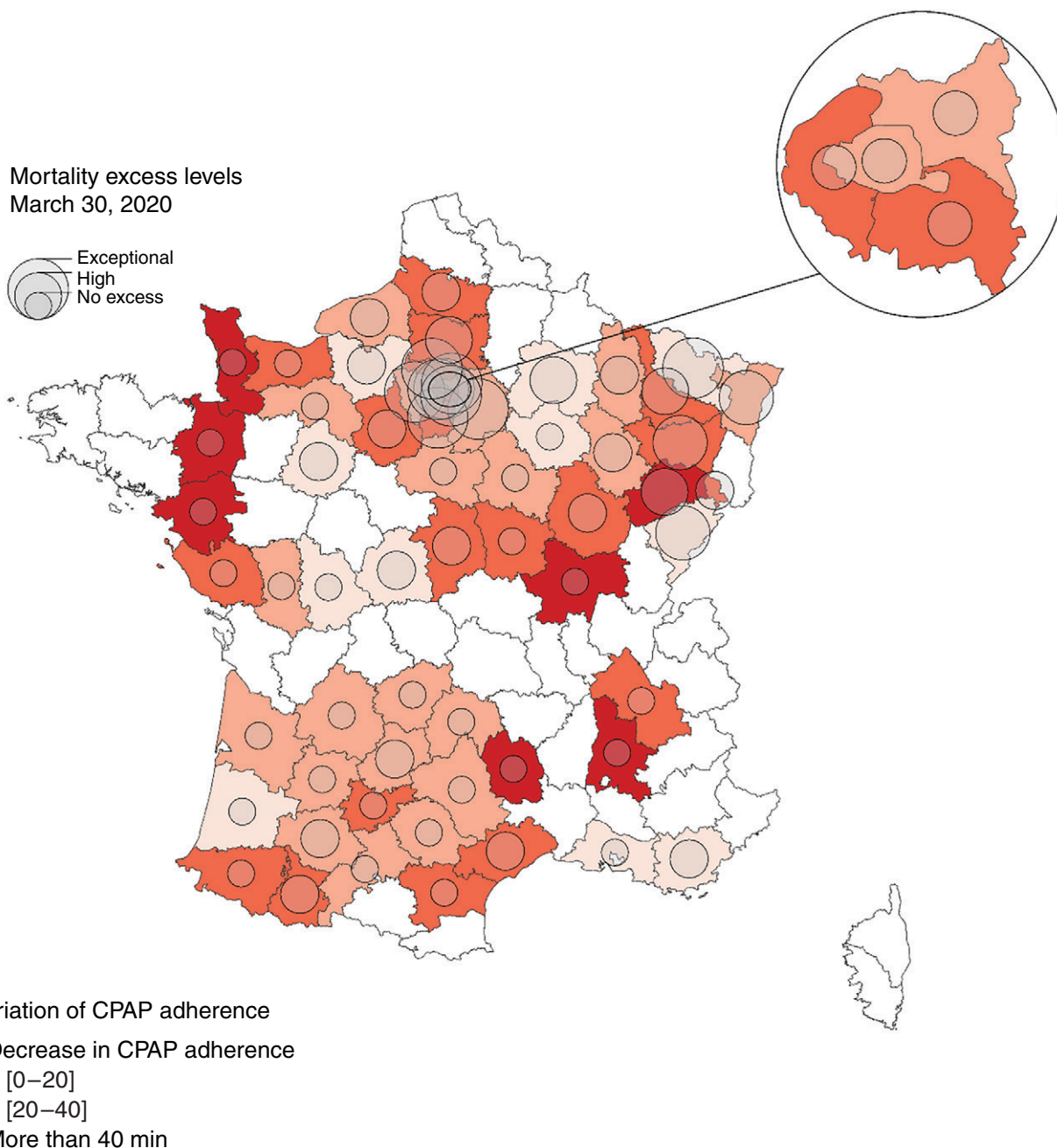+ [0−20]
+ [20−40]
More than 40 min

Figure 2. The geographical distribution of the level of excess of mortality during the first coronavirus disease (COVID-19) wave by county was not significantly associated with changes in CPAP adherence between the pre–COVID-19 period and during the first strict lockdown period. Data on CPAP adherence and level of excess of mortality were not available for counties in white. CPAP = continuous positive airway pressure.

References

1. Chagué F, Boulin M, Eicher JC, Bichat F, Saint Jalmes M, Cransac-Miet A, *et al.* Impact of lockdown on patients with congestive heart failure during the coronavirus disease 2019 pandemic. *ESC Heart Fail* 2020;7:4420–4423.
2. Degli Esposti L, Buda S, Nappi C, Paoli D, Perrone V; Network Health-DB. Implications of COVID-19 infection on medication adherence with chronic therapies in Italy: a proposed observational investigation by the Fail-to-Refill Project. *Risk Manag Healthc Policy* 2020;13:3179–3185.
3. Brooks SK, Webster RK, Smith LE, Woodland L, Wessely S, Greenberg N, *et al.* The psychological impact of quarantine and how to reduce it: rapid review of the evidence. *Lancet* 2020;395:912–920.
4. Benjafield AV, Ayas NT, Eastwood PR, Heinzer R, Ip MSM, Morrell MJ, *et al.* Estimation of the global prevalence and burden of obstructive sleep apnoea: a literature-based analysis. *Lancet Respir Med* 2019;7: 687–698.
5. Lévy P, Kohler M, McNicholas WT, Barbé F, McEvoy RD, Somers VK, *et al.* Obstructive sleep apnoea syndrome. *Nat Rev Dis Primers* 2015;1: 15015.

6. Attias D, Pepin JL, Pathak A. Impact of COVID-19 lockdown on adherence to continuous positive airway pressure by obstructive sleep apnoea patients. *Eur Respir J* 2020;56:2001607.
7. Del Campo F, Lopez G, Arroyo CA, de Frutos JF, Crespo A, Cerezo-Hernandez A, *et al.* Study of adherence to continuous positive airway pressure treatment in patients with obstructive sleep apnea syndrome in the confinement during the COVID-19 pandemic. *Arch Bronconeumol* 2020;56:818–819.
8. Patil SP, Ayappa IA, Caples SM, Kimoff RJ, Patel SR, Harrod CG. Treatment of adult obstructive sleep apnea with positive airway pressure: an American Academy of Sleep Medicine systematic review, meta-analysis, and GRADE assessment. *J Clin Sleep Med* 2019;15: 301–334.
9. Strausz S, Kiiskinen T, Broberg M, Ruotsalainen S, Koskela J, Bachour A, *et al.*; FinnGen. Sleep apnoea is a risk factor for severe COVID-19. *BMJ Open Respir Res* 2021;8:e000845.
10. Pépin JL, Sauvaget O, Borel JC, Rolland C, Sapéne M, Amroussia I, *et al.* Continuous positive airway pressure-treated patients' behaviours during the COVID-19 crisis. *ERJ Open Res* 2020;6: 00508–02020.
11. Poulet C, Veale D, Arnol N, Lévy P, Pepin JL, Tyrrell J. Psychological variables as predictors of adherence to treatment by continuous positive airway pressure. *Sleep Med* 2009;10: 993–999.

Check for updates

Lung Function Levels Influence the Association between Obesity and Risk of COVID-19

To the Editor:

Obesity is associated with immune suppression and may be associated with increased risk of coronavirus disease (COVID-19) (1). This association may be modified by factors such as lung function (2–4). We explored here the association between obesity and COVID-19 in relation to the underlying lung function strata. To our knowledge, this possible interaction has not been investigated to date.

We investigated the association between obesity and risk of a positive severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) test and how lung function levels influenced this association in 36,896 participants in the UK Biobank tested for SARS-CoV-2 (5). The UK Biobank study recruited 502,543 participants aged 40–69 years living close to one of 22 assessment centers across England, Scotland, and Wales, between March 2006 and July 2010; however,

data on SARS-CoV-2 test results (for the period of March 16 to November 24, 2020) derives from the English subgroup alone. Body mass index (BMI) at recruitment (baseline) was used to define normal (BMI < 25), overweight ($25 \leqslant BMI < 30$), and obese ($BMI \geqslant 30$) groups. FEV_1, FVC, and their ratio at baseline were categorized using the median and quartiles (of their *z*-score values). Multivariable logistic regression models were generated to investigate the association of obesity with SARS-CoV-2 positivity adjusting for age, sex, smoking, socioeconomic status (Townsend index), diabetes, cardiovascular disease, physical activity, and ethnicity. Stratified analyses for lung function levels and formal interaction tests to investigate potential effect modification were conducted.

Of the 36,896 participants tested (mean age 69.3 ± 8.3 years), 5,757 were positive for SARS-CoV-2. Characteristics of those who tested positive and those who tested negative are shown in Table 1.

Table 1. Characteristics of Those Tested Positive and Those Tested Negative

	Negative Test Result (n = 31,139)	Positive Test Result (n = 5,757)
Age, mean (SD), yr		
At recruitment*	58.04 (8.01)	54.31 (8.84)
At SARS-CoV-2 test*	69.18 (8.03)	65.34 (8.82)
Sex*, n (%)		
F	16,549 (53)	2,871 (50)
M	14,590 (47)	2,886 (50)
Ethnicity*, n (%)		
White	29,102 (93)	5,247 (91)
Mixed	188 (1)	41 (1)
Asian	767 (2)	243 (4)
Black	579 (2)	137 (2)
Other ethnic background	428 (1)	81 (1)
Household income*, n (%)		
<18,000	6,888 (22)	1,279 (22)
18,000–30,999	6,610 (21)	1,147 (20)
31,000–51,999	6,335 (20)	1,332 (23)
52,000–100,000	4,774 (15)	944 (16)
>100,000	1,477 (5)	229 (4)
Education*, n (%)		
None of the following	302 (1)	74 (1)
College or university degree	9,038 (29)	1,339 (23)
A levels or AS levels or equivalent	3,164 (10)	527 (9)
O levels or GCSEs or equivalent	6,468 (21)	1,243 (21)
CSEs or equivalent	1,528 (5)	495 (9)
NVQ, HND, HNC, or equivalent	2,205 (7)	471 (8)
Other professional qualifications	1,800 (6)	277 (5)
Smoking history, n (%)		
Never	15,636 (50)	2,928 (51)
Past	11,732 (38)	2,148 (37)
Current	3,522 (11)	641 (11)
Smoking pack-years, median (IQR)	20.70 (10.88–34.38)	21.00 (11.45–34.00)
BMI, kg/m², mean (SD)*	27.99 (5.04)	28.41 (5.03)

Definition of abbreviations: A = advanced; AS = advanced subsidiary; BMI = body mass index; CSE = Certificate of Secondary Education; GCSE = General Certificate of Secondary Education; HNC = Higher National Certificate; HND = Higher National Diploma; IQR = interquartile range; NVQ = National Vocational Qualification; O = ordinary; SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2.
*$P < 0.05$.