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doi: 10.1016/j.bja.2020.04.078
Advance Access Publication Date: 04 May 2020


# Obesity as a risk factor for poor outcome in COVID-19-induced lung injury: the potential role of undiagnosed obstructive sleep apnoea

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**Keywords:** COVID-19; morbidity; obesity; OSA; outcome; risk factor

Editor—As the severe acute respiratory syndrome-coronavirus disease 2019 (SARS-COVID-19) pandemic is unfolding around the world, reports are being published identifying risk factors for severe and critical disease.[1–3] In this context, published observations suggest that the presence of comorbidities associated with the metabolic syndrome, such as diabetes, are commonly present in this patient population.[4] Although not addressed extensively in the published literature at this time, physician groups are increasingly concerned about the high incidence of severe and critical COVID-19 in patients who are overweight, obese, or both. In this context, an over-proportional prevalence of obesity has been anecdotally reported by clinicians around the world. As defined by the WHO, overweight is a BMI ≥25, and obesity is a BMI ≥30.

This study was determined to be exempt from Institutional Review Board consideration under United States Health and Human Services code 45 CFR 46.104(d). In an analysis of all critically ill patients receiving mechanical ventilation with respiratory failure as a result of COVID-19 across three randomly selected ICUs at our institution, the average BMI was: males, 28.3 [SD 5.3] ($n$=41) and females, 30 [6.3] ($n$=16); collectively, 20/60 (33%) had a BMI ≥30. Similarly, in patients severely ill with respiratory failure (i.e. those not in an ICU and therefore not requiring mechanical ventilation) in three randomly selected in-patient care units, the average BMI was: males, 29 [6.1] ($n$=35) and females, 33.5 [12.1] ($n$=21), with approximately the same proportion classified as obese (17/47, 36.2%) as in the ICU population. These numbers are greater than the reported prevalence of New Yorkers who are overweight (34%) or obese (22%) as provided by the New York City Department of Health (https://www1.nyc.gov/site/doh/health/health-topics/obesity.page). Additional details regarding basic patient characteristics of this population can be found in Table 1.

A mechanism explaining the co-presence of obesity, metabolic syndrome, and severe to critical COVID-19, however, remains elusive. Evidence, which is largely non-clinical in nature, suggests that obesity is associated with a proinflammatory state that potentially predisposes patients to lung injury.[5] While this theoretical concept may not be sufficient to explain a potential link between COVID-19-associated propensity to develop acute severe or critical lung disease based on the concept of a 'double hit phenomenon', it is well known that obesity is highly correlated with the presence of obstructive sleep apnoea (OSA).[6] Amongst these individuals, OSA remains undiagnosed in the vast majority,[7] and thus remains untreated. The low incidence of diagnosed OSA in a high-risk patient population, such as described here, is congruent with underdiagnosis of this disease.[7]

Research suggests that when controlling for obesity, the presence of OSA is associated with decreased lung function, decreased lung-transfer factor for carbon monoxide, and, importantly, increased lung inflammation.[8] These conditions may therefore explain, at least in part, why patients with OSA are at increased risk for pneumonia in general.[9] Further supporting our hypothesis that OSA is an additional risk for the development of severe disease in patients with COVID-19 is the observation that patients with OSA are at increased risk of developing adult respiratory distress syndrome following noncardiac surgery.[10] These observations therefore may provide for the possibility of increased severity in disease in the setting of COVID-19. In this context, the pathophysiology associated with untreated OSA may not just present a predisposing factor for developing severe or critical disease in COVID-19, but once infection has occurred, repeated airway obstruction with generation of negative intrathoracic pressure and associated shear forces may actually lead to worsening in lung injury. It is of interest that reports from Jiangsu province in China suggest that when proning non-intubated patients with COVID-19, oxygenation and pulmonary heterogeneity can be improved.[11] Although speculative, this intervention—in addition to the known benefits of improved clearance of secretions and perfusion, reduction of lung ventilation/perfusion mismatch, and promoting recruitment of non-aerated dorsal lung regions of the lung—also reduces the risk and rate of airway obstruction.[12] The latter effect might be especially beneficial in patients with respiratory compromise[13] attributable to COIVD-19 infection, and this should be explored in more detail.

In conclusion, preliminary evidence suggests that COVID-19 seems to lead to a more morbid course amongst the

**Table 1** Patient characteristics of severely and critically ill patients with respiratory failure.

| | ICU (*n*=60) | | Non-ICU (*n*=64) | |
|---|---|---|---|---|
| | Male | Female | Male | Female |
| Age (yr), mean (*n*) | 61.5 (27–86) (44) | 61.3 (32–87) (16) | 69.8 (42–95) (42) | 65.5 (39–86) (22) |
| BMI (kg $m^{-2}$), mean [SD][*] (*n*) | 28.3 [5.3] (41) | 30 [6.3] (16) | 29 [6.1] (35) | 33.5 [12.1] (21) |
| Hypertension, *n* (%) | 24 (54.5) | 6 (37.5) | 27 (64.3) | 15 (68.2) |
| Diabetes mellitus, *n* (%) | 13 (29.5) | 5 (31.3) | 12 (28.6) | 7 (31.8) |
| CVD[†], *n* (%) | 20 (45.5) | 3 (18.8) | 23 (54.8) | 7 (31.8) |
| Malignancy[‡], *n* (%) | 4 (9.1) | 4 (25) | 8 (19.0) | 0 (0) |
| Pulmonary disease[¶], *n* (%) | 6 (13.6) | 2 (12.5) | 4 (9.5) | 4 (18.2) |
| Obstructive sleep apnoea, *n* (%) | 5 (11.4) | 0 (0) | 2 (4.8) | 2 (9.1) |

[*] In some instances, the sample size for BMI calculation is less than the number of patients as either height or weight was not recorded in the medical record.
[†] CVD, cardiovascular disease, including diagnoses of: hyperlipidaemia, coronary artery disease, myocardial infarction, electrical arrhythmias.
[‡] Malignancy, including diagnosis of both solid organ and haematologic malignancies. OSA, obstructive sleep apnoea.
[¶] Pulmonary disease, including diagnoses of: asthma, chronic obstructive pulmonary disease, interstitial fibrosis.

elderly, and that a variety of comorbidities are prevalent, most notably hypertension, diabetes mellitus, and cardiovascular disease; to that list, we should now add obesity. A potential contributor to the high morbidity amongst obese patients might be the high prevalence of undiagnosed OSA. Proinflammatory processes in the lungs of OSA patients might further worsen by repeated airway obstruction during the disease process. Additional research into these potential mechanisms of increased morbidity in obese patients with COVID-19 seems prudent, given the basic patient characteristic observations. Additionally, the utility of interventions to prevent secondary lung damage via awake proning might be considered. While noninvasive ventilation is frequently avoided in order to prevent aerosolisation of the virus, other methods such as nasopharyngeal airway devices may be used in this setting.

## Declarations of interest

The authors declare that they have no conflicts of interest.

## Acknowledgments

This work was supported by the Dept. of Anesthesiology, Weill Cornell Medicine. One author (PAG) receives basic science research support from Akelos, Inc. (New York, NY) and the U.S. National Institutes of Health (1UG3NS114947-01) for work unrelated to this study.

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doi: 10.1016/j.bja.2020.04.078
Advance Access Publication Date: 01 May 2020