Preoperative atelectasis in patients with obesity undergoing bariatric surgery: a cross-sectional study

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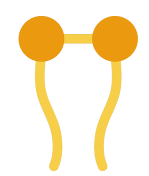
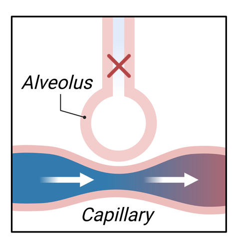
Preoperative Atelectasis in Bariatric Surgery

Background

Obesity is an important risk factor for lung complications (i.e., atelectasis) in patients undergoing anesthesia.



Altered lung surfactant production induced by obesity could cause atelectasis even before surgery.



It has been reported that atelectasis are present before surgery in obese patients. However, their prevalence has not been estimated nor their impact on peripheral saturation of oxygen (SpO2).

Research Question

1. What is the prevalence of atelectasis before surgery in patients undergoing bariatric surgery?
2. Do prevalence and extension of atelectasis increase at higher obesity categories?
3. To what extent do atelectasis meaured in the supine position explain decreasing SpO2 values in the seated position at higher BMI?

Setting

Single center specialized in bariatric surgery in Tijuana, Mexico.

This was a cross-sectional study including adult patients who underwent COVID-19 screening before bariatric surgery through chest computed tomography in June 2020 due to scarcity of SARS-CoV-2 tests.

Chest CT scans were retrospectively assessed to quantify the presence and extension of atelectasis before surgery by a senior radiologist blinded to patient medical history.

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Exclusion criteria

- CO-RADS 3 to 6
- Positive SARS-CoV-2 antibody test
- Prior COVID-19
- Bronchiectasis
- Neuromuscular disease

Methods and Results

Out of 281 scheduled surgeries, 35 (12.4%) patients did not present, 3 (1.1%) had a positive SARS-CoV-2 antibody test, and the remaining 243 (86.5%) underwent chest CT screening for COVID-19. After exclusion of 7 patients due to CO-RADS ≥3 (n=4) and who reported prior COVID-19 (n=3), 236 were included for analysis. The mean age of participants was 40.3 years (SD: 9.87) and 90.7% were women (n=214). The median BMI was 40.3 kg/m² (IQR: 34.6-46.0, range: 30.0-77.3).

Question 1

Percentage of atelectasis coverage on chest CT was registered by rounding to the lower 2.5% category (i.e. values <2.5% were rounded to 0%). Thus, all patients with an atelectasis percentage ≥2.5% were classified as having atelectasis. The prevalence of atelectasis with 95% confidence interval (95%CI) was estimated with a one-sample proportion test with Wilson score intervals. Mean atelectasis percentage was determined by bootstrapping and 95%CI with the BCa method.

- Overall prevalence of atelectasis: **32.6%** (95%CI: 27.0-38.9).
- Mean atelectasis percentage coverage: **2.66%** (95%CI:2.07-3.26).

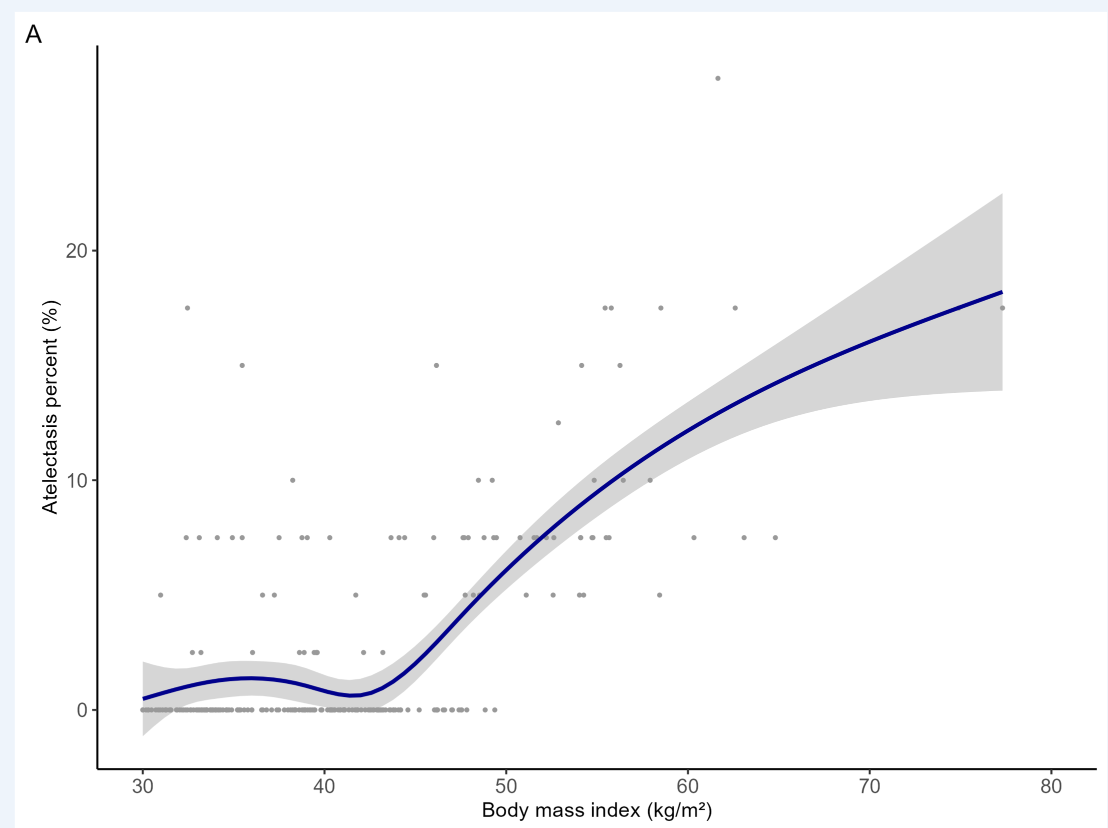


Figure 1. Relationship between BMI and atelectasis percentage on chest CT. Curves represent the fitted smoothed non-linear relationship. The shaded area is the 95% confidence interval.

Question 2

Figure 1 shows that the atelectasis percentage coverage on chest CT increased at higher BMI in a non-linear relationship. The prevalence of atelectasis and mean atelectasis coverage were estimated for the WHO obesity class categories : class 1 (30-35 kg/m²), 2 (35-40 kg/m²), and 3 (≥40 kg/m²). Class 3 obesity subgroups were further defined as: 40-45 kg/m², 45-50 kg/m², and ≥50 units. Prevalence ratios (PR) of atelectasis per obesity class (reference category: class 1) were estimated with a modified Poisson regression model with robust errors and adjusted for age, sex, and altitude of the place of residence.

Category	Prevalence	PR	95%CI	aPR[1]	95%CI
Class 1 Obesity	12.7%	Reference		Reference	
Class 2 Obesity	28.3%	2.23	1.03—4.84	2.17	1.0—4.7
Class 3 Obesity	45.0%	3.46	1.8—6.97	3.47	1.77—6.83
Subgroups (Class 3 Obesity)					
40—45 kg/m²	12.3%	0.97	0.37—2.5	0.85	0.35—2.1
45—50 kg/m²	48.4%	3.81	1.81—8.01	3.52	1.63—7.61
≥50 kg/m²	100%	7.87	4.12—15.05	8.00	4.22—15.17

[1]Adjusted for age, sex, and altitude category.
Abbreviations: 95% confidence interval (95%CI), adjusted prevalence ratio (aPR), prevalence ratio (PR).

Question 3

Mean SpO2 was modelled through fractional regression with generalized additive models to assess the extent to which BMI and atelectasis percentage explained the variation in SpO2. Inverse probability weighting (IPW) was used to estimate the total effect of BMI on SpO2, and the direct (not mediated by atelectasis) and indirect (mediated by atelectasis) effects of BMI on SpO2 in a second model (**Figure 2**). Assumptions were drawn in a directed acyclic graph documented elsewhere (see preprint).

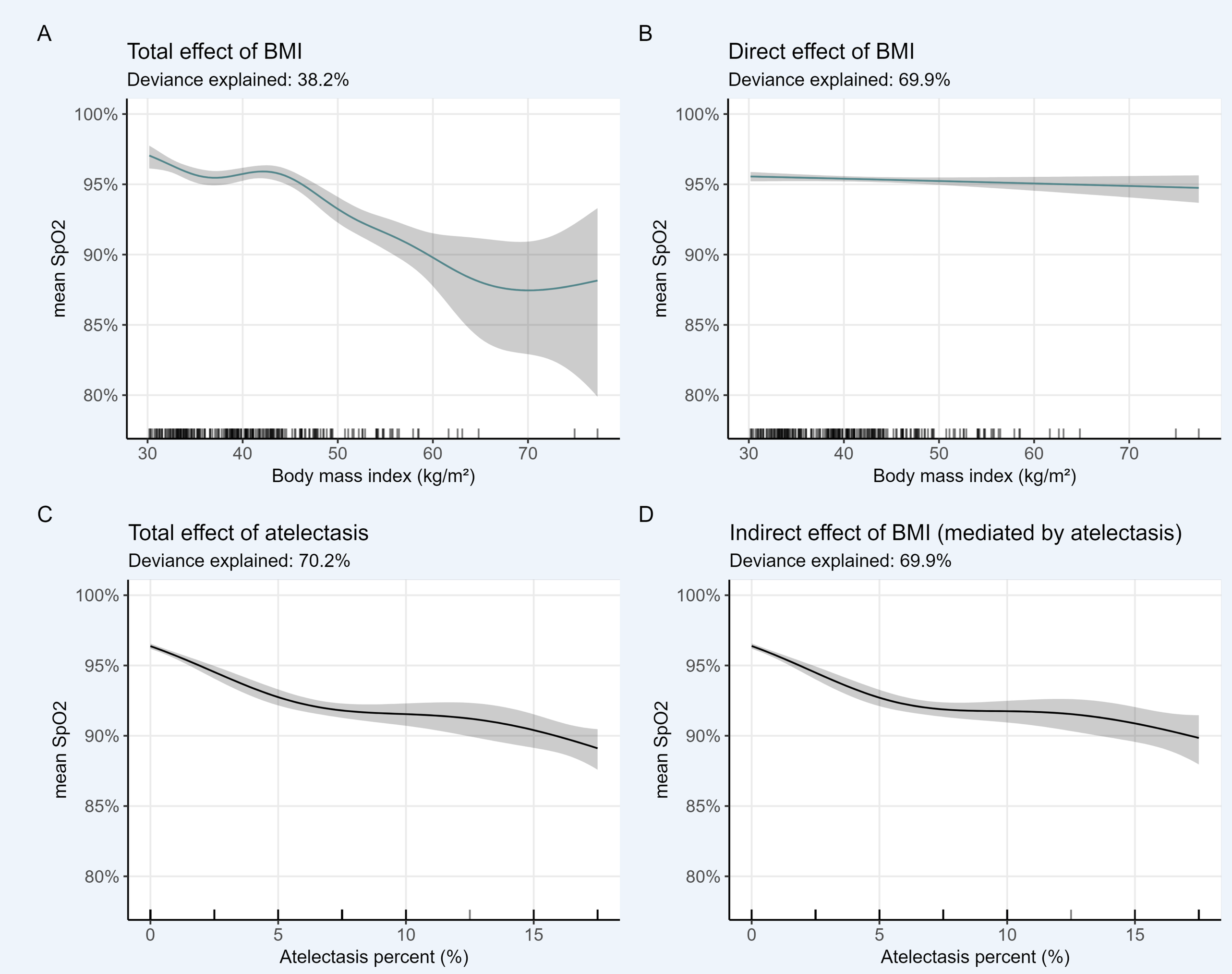
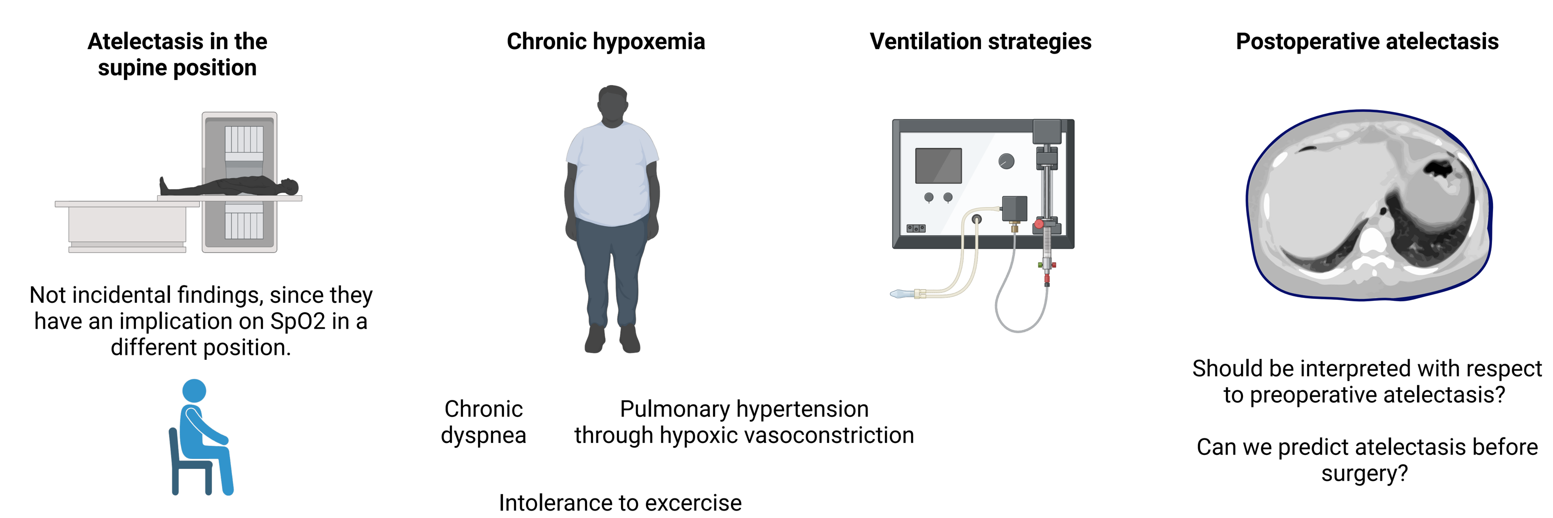


Figure 2. A) Total effect of BMI in a model including only a smooth term for BMI (p<0.001). **B)** Direct effect of BMI (not mediated by atelectasis), with a smooth term for BMI (p=0.182) controlled for the effect of atelectasis. **C)** Total effect of atelectasis percent coverage on chest CT in a model including only a smooth term for atelectasis percent (p<0.001). **D)** Indirect effect of BMI (mediated by atelectasis), with a smooth term for atelectasis percent (p<0.001) controlled for the effect of BMI. Inverse probability weights were obtained for the following sets:

- *w1* (age, sex, and altitude), panel A;
- *w2* (BMI, age, sex, altitude, obstructive sleep apnea, asthma, and COPD), panel C;
- *w* (product of *w1* and *w2*), panels B and D.

Discussion



Conclusions

Preoperative atelectasis were highly prevalent in patients with obesity and a BMI above 45 kg/m² was associated with a higher relative prevalence and atelectasis percentage coverage, the latter of which alone explained 70.2% of the variation in SpO2, with 81.5% (95%CI: 56.0-100) of the effect of BMI on SpO2 <96% mediated through atelectasis (*results not shown here, but available in the preprint*). These could be important factors to consider when deciding ventilation strategies and for the interpretation of postoperative atelectasis.

Data and code for this study have been deposited and are openly available. You can find the links and documentation in my github repository: