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Perioperative respiratory risk in adults with class III obesity: predictors and management from preoxygenation to extubation

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Abstract

Class III obesity markedly reduces respiratory reserve during general anaesthesia. Lower functional residual capacity, early airway closure and increased oxygen consumption shorten the time available for airway interventions, while sleep-disordered breathing and adverse anatomy may add a separate risk of obstruction or difficult laryngoscopy. The aim of this review was to summarise clinically useful predictors of perioperative respiratory risk in adults with class III obesity and to examine current evidence for positioning, preoxygenation, apnoeic oxygenation, tracheal intubation, intraoperative ventilation and post-extubation respiratory support. A structured narrative review was performed using targeted PubMed/MEDLINE searches up to 17 August 2026. Reference lists of relevant guidelines, systematic reviews and clinical trials were also screened. Priority was given to professional-society guidance, systematic reviews and meta-analyses, randomised trials and prospective studies; older studies were retained when they established practices that remain clinically relevant. Body mass index alone does not reliably identify a difficult tracheal intubation. Risk assessment is more useful when it combines airway features such as Mallampati class, neck circumference, cervical mobility and previous airway difficulty with markers of limited physiological reserve, including resting hypoxaemia, obstructive sleep apnoea and suspected obesity hypoventilation syndrome. Head-up or ramped positioning improves the conditions for preoxygenation and laryngoscopy. Positive-pressure preoxygenation can improve lung recruitment and denitrogenation, whereas high-flow nasal oxygen has the distinct advantage of continuing oxygen delivery during laryngoscopy and apnoea. These techniques are not interchangeable: non-invasive ventilation may be preferable when derecruitment is prominent, whereas high-flow nasal oxygen is useful when a longer apnoeic interval is expected. Current airway guidance favours an intubation plan designed for first-attempt success, commonly with videolaryngoscopy, together with continuous attention to oxygenation and an explicit rescue plan. During maintenance of anaesthesia, tidal volume should be based on predicted rather than actual body weight; routine high positive end-expiratory pressure with recruitment manoeuvres improves some physiological variables but has not consistently reduced postoperative pulmonary complications. Extubation should be planned in the head-up position after complete neuromuscular recovery, with early resumption of continuous positive airway pressure or non-invasive respiratory support in selected high-risk patients. Overall, perioperative safety in class III obesity depends less on a

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single device than on matching the oxygenation and airway strategy to the patient's anatomical difficulty and physiological reserve.

Keywords: Airway Management; Noninvasive Ventilation; Obesity, Morbid; Obesity Hypoventilation Syndrome; Oxygen Inhalation Therapy; Sleep Apnea, Obstructive.

Introduction

Class III obesity, usually defined by a body mass index of at least 40 kg/m^2, changes the margin for error during anaesthesia. Reduced functional residual capacity, lower chest-wall compliance, cephalad displacement of the diaphragm and a greater tendency to dependent atelectasis reduce the oxygen store available during apnoea [1,2]. These changes become more pronounced after induction and neuromuscular blockade, when spontaneous respiratory muscle activity is lost.

The airway problem is not purely anatomical. Some patients with severe obesity are straightforward to intubate but desaturate quickly when ventilation is interrupted. Others have both a limited oxygen reserve and difficult upper-airway anatomy. This distinction is consistent with the concept of the physiologically difficult airway, in which the consequences of an otherwise routine airway manoeuvre may become clinically important before the technical problem has been solved [5]. Recent guidance from the Society for Obesity and Bariatric Anaesthesia and the Difficult Airway Society therefore places emphasis on positioning, continuous oxygen delivery, first-attempt success and a planned extubation strategy rather than on a single preferred device [3,4].

Aim

To summarise current evidence on perioperative respiratory risk in adults with class III obesity and to identify practical strategies for risk assessment, preoxygenation, tracheal intubation, intraoperative ventilation and post-extubation respiratory support.

Materials and Methods

This article was prepared as a structured narrative review. Targeted searches were performed in PubMed/MEDLINE up to 17 August 2026 using combinations of the terms "class III obesity", "morbid obesity", "airway management", "difficult airway", "preoxygenation", "high-flow nasal oxygen", "apnoeic oxygenation", "non-invasive ventilation", "ramped position", "videolaryngoscopy", "obstructive sleep apnoea", "obesity hypoventilation syndrome" and "postoperative respiratory support". Reference lists of key guidelines, systematic reviews and clinical trials were screened manually.

Professional-society guidance, systematic reviews and meta-analyses, randomised clinical trials and prospective adult studies were prioritised. Older publications were included selectively when they described practices that remain central to current management, particularly ramped positioning and head-up preoxygenation. Studies involving broader obesity categories were used when the intervention or physiological mechanism was directly relevant to patients with class III obesity. No formal meta-analysis or quantitative quality score was performed.

Review

Risk assessment: anatomy and physiological reserve

Severe obesity should not be treated as a synonym for difficult tracheal intubation. The predictive value of body mass index alone is limited. A higher Mallampati class, restricted cervical movement, reduced mouth opening, previous difficult airway management and a large neck circumference are more informative when considered together [3]. Mallampati class is a warning sign rather than a stand-alone decision rule.

Physiological reserve deserves equal attention. Obstructive sleep apnoea is common in this population and is associated with perioperative obstruction and increased sensitivity to sedative and opioid effects. Screening with tools such as STOP-Bang is useful when the diagnosis is not already established [6]. Suspected obesity hypoventilation syndrome

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warrants particular caution: daytime hypoxaemia, unexplained elevation of serum bicarbonate, pulmonary hypertension or marked intolerance of the supine position should prompt further assessment and early planning of postoperative ventilatory support [7]. Resting oxygen saturation, orthopnoea, home use of continuous positive airway pressure or non-invasive ventilation, and a history of postoperative hypoxaemia are simple bedside markers that often influence the airway plan more directly than another anatomical score.

Positioning and preoxygenation

Positioning is one of the few interventions that helps both physiology and laryngoscopy. A head-up or reverse Trendelenburg position reduces the cephalad load on the diaphragm, while the ramped position aligns the external auditory meatus more closely with the sternum and improves laryngoscopic geometry. A randomised study established better preoxygenation in a 25° head-up position [8], while current obesity-specific guidance supports ramped positioning for airway management [3]. More recent work suggests that reverse Trendelenburg positioning combined with pressure support and positive end-expiratory pressure can further prolong the non-hypoxic apnoea period [9].

A tightly fitting facemask with an inspired oxygen fraction of 1.0 remains a reasonable baseline technique, but its performance depends on seal, ventilation and preservation of end-expiratory lung volume. In patients with marked derecruitment, positive pressure may be more important than simply extending the duration of oxygen breathing. The PREOPTIPOP trial found that non-invasive ventilation produced better preoxygenation than high-flow nasal oxygen in adults with obesity [10]. This is physiologically plausible: non-invasive ventilation provides pressure support and end-expiratory pressure, which improve recruitment and denitrogenation before induction.

High-flow nasal oxygen has a different strength. It can remain in place during laryngoscopy and continue oxygen delivery after ventilation has stopped. In a randomised study of patients with body mass index at least 40 kg/m^2, high-flow nasal oxygen prolonged safe apnoea time by about 76 seconds compared with facemask oxygenation [11]. A systematic review found an overall signal of benefit for high-flow nasal oxygen during apnoea, although effect size varied across protocols [12]. A 2024 network meta-analysis ranked high-flow nasal oxygen combined with a head-up position favourably for prolonging safe apnoea time, while pressure-supported facemask techniques performed well for prevention of arterial desaturation [13]. A 2025 trial in parturients living with obesity also showed better oxygenation indices with high-flow nasal oxygen, although the clinical difference was modest [14]. Table 1 summarises the main comparative findings.

The practical implication is that high-flow nasal oxygen and non-invasive ventilation are not competing versions of the same intervention. When derecruitment and poor denitrogenation are the main concerns, positive pressure may be the better pre-induction tool. When a prolonged laryngoscopy or apnoeic interval is expected, nasal oxygen can add value because it does not need to be removed. Sequential use of the two techniques may be reasonable in selected high-risk patients, although direct evidence for combined protocols remains limited.

Table 1. Selected evidence on preoxygenation and apnoeic oxygenation in patients with obesity

Study	Population and comparison	Main finding	Clinical interpretation
Couture, 2023	Obesity; reverse Trendelenburg + PSV/PEEP vs ramped + ZEEP	Longer non-hypoxic apnoea period with position plus positive pressure	Position and positive pressure can have additive effects
PREOPTIPOP,	Obesity, n=100; HFNO	NIV produced better	Prefer NIV when

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Study	Population and comparison	Main finding	Clinical interpretation
2019	60 L/min vs NIV	preoxygenation and fewer mild desaturation events	recruitment/denitrogenation is the main problem
Wong, 2019	BMI ≥40 kg/m^2, n=40; HFNO vs facemask	Safe apnoea time increased by about 76 s with HFNO	Supports continuing nasal oxygen during apnoea
de Carvalho, 2024	Network meta-analysis; 52 RCTs, 3914 adults	HFNO + head-up ranked highly for safe apnoea time; pressure-supported mask for desaturation prevention	No technique was best for every endpoint
Zhou, 2025	Parturients living with obesity, n=54; HFNO vs facemask	Higher PaO_2 and EtO_2 with HFNO; clinical difference modest	Supports a physiological effect in a specific high-risk group

Tracheal intubation

A failed first attempt carries a greater physiological cost when oxygen reserve is small. Current guidance therefore favours an initial technique with a high probability of success rather than repeated attempts with progressively more advanced equipment [3,4]. Videolaryngoscopy is a reasonable first-line option for many patients with class III obesity. A 2024 meta-analysis reported a higher first-attempt success rate with videolaryngoscopy than with direct laryngoscopy in patients living with obesity, without a consistent increase in intubation time [17].

Awake tracheal intubation should not be triggered by body mass index alone. It becomes appropriate when induction is expected to create an unacceptable risk of losing oxygenation or ventilation, for example in the presence of major anatomical obstruction, a previous failed intubation with difficult ventilation, or another combination of factors suggesting that loss of spontaneous breathing would be hazardous. The rescue plan should be explicit before induction and should include effective facemask ventilation, a second-generation supraglottic airway, early help and a clear threshold for front-of-neck access if oxygenation cannot be restored [4].

Intraoperative ventilation

After intubation, pneumoperitoneum, Trendelenburg positioning and anaesthesia itself can further reduce compliance and promote atelectasis. Tidal volume should therefore be based on predicted rather than actual body weight. Positive end-expiratory pressure often improves intraoperative mechanics and oxygenation, but higher settings should not be equated with better clinical outcomes. In the PROBESE trial, a strategy using positive end-expiratory pressure of 12 cm H_2O with recruitment manoeuvres reduced intraoperative hypoxaemia but did not reduce the composite rate of postoperative pulmonary complications compared with lower positive end-expiratory pressure [15]. A later review and meta-analysis reached a similar conclusion [16]. In practice, positive end-expiratory pressure is better titrated to oxygenation, compliance, driving pressure and haemodynamic tolerance than prescribed as a fixed high value for every patient.

Extubation and postoperative respiratory support

Extubation deserves the same planning as induction. The patient should be fully awake when appropriate, quantitatively recovered from neuromuscular block and positioned head-up, with a reintubation plan available [3]. Patients with obstructive sleep apnoea or obesity

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hypoventilation syndrome should generally resume their usual continuous positive airway pressure early. Supplemental oxygen alone can conceal hypoventilation, particularly in obesity hypoventilation syndrome, so respiratory rate, clinical ventilation and capnography, when available, may be more informative than pulse oximetry alone [6,7].

Evidence from critically ill and postoperative populations supports prophylactic non-invasive respiratory support in selected patients with obesity. A 2025 network meta-analysis found benefit from non-invasive support after extubation [20], and a secondary analysis of the EXTUBOBESE trial suggested a larger effect among patients with body mass index at least 40 kg/m^2 [21]. These data should not be applied indiscriminately to every elective surgical patient, but they support a low threshold for early positive-pressure support when preoperative reserve is poor or post-extubation obstruction and hypoventilation are likely.

Human factors and local implementation

Rapid desaturation creates time pressure, and time pressure encourages repeated attempts and tunnel vision. A brief pre-induction briefing, clear roles, an agreed sequence of airway plans and early escalation are therefore part of respiratory risk management rather than administrative extras [18]. In a Ukrainian survey of anaesthesiologists, airway complications were the most frequently reported group of critical incidents in surgical patients with morbid obesity, and some respondents reported the absence of formal difficult-airway algorithms in their institutions [19]. Equipment is important, but a stocked airway trolley without a rehearsed team plan is an incomplete safety intervention.

Discussion

The evidence reviewed here supports a simple distinction that is clinically useful: anatomical difficulty and physiological vulnerability overlap, but they are not the same problem. Body mass index contributes strongly to the second and only indirectly to the first. This helps explain why airway assessment based only on Mallampati class or body mass index performs poorly in practice. A patient with an apparently uncomplicated airway may still have very little tolerance for apnoea because of resting hypoxaemia, obesity hypoventilation syndrome or severe supine intolerance.

The preoxygenation literature also explains why apparently conflicting trials can all be correct. Studies use different endpoints: end-tidal oxygen concentration, arterial oxygen tension, minimum oxygen saturation, time to a threshold saturation, or the occurrence of any desaturation. These outcomes are related but not equivalent. Non-invasive ventilation may achieve better lung recruitment and denitrogenation before induction, while high-flow nasal oxygen may provide less complete preoxygenation yet continue to deliver oxygen during the apnoeic interval [10-14]. Choosing between techniques should therefore start with the clinical problem rather than with a device hierarchy.

The main limitation of the evidence is heterogeneity. Many trials include patients with body mass index thresholds of 30 or 35 kg/m^2 and do not report a separate class III obesity subgroup. Severe outcomes such as cannot-intubate-cannot-oxygenate events, aspiration, intensive care admission or death are uncommon and most trials are powered for physiological surrogate outcomes. In addition, evidence on combined strategies, such as non-invasive ventilation for preoxygenation followed by high-flow nasal oxygen during laryngoscopy, remains limited. Future studies should use standard definitions of clinically important desaturation and safe apnoea time and should report outcomes separately for class III obesity.

Conclusions

Class III obesity should be viewed primarily as a condition of reduced respiratory reserve, with airway anatomy assessed as a related but separate dimension of risk. The most defensible perioperative approach is to identify both problems before induction, position the patient head-up or ramped, choose preoxygenation according to the need for recruitment and

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the expected duration of apnoea, and use an intubation strategy designed for first-attempt success. High-flow nasal oxygen is particularly useful when ongoing oxygen delivery during laryngoscopy is important, whereas non-invasive ventilation may provide stronger pre-induction recruitment in patients prone to derecruitment. Neither technique is universally superior.

During maintenance of anaesthesia, tidal volume based on predicted body weight and individually titrated positive end-expiratory pressure remain reasonable principles. Extubation should be planned, performed after adequate neuromuscular recovery and followed by early continuous positive airway pressure or other non-invasive support when the patient's preoperative physiology suggests a high risk of obstruction or hypoventilation. The practical novelty of this approach lies in matching each intervention to the dominant mechanism of risk rather than treating severe obesity as a single airway phenotype.

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Conflict of Interest

The authors declare no conflict of interest.

Consent to Publication

Both authors consent to publication of this manuscript.

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AI Statement

ChatGPT (OpenAI) was used for English-language translation and language editing. The authors reviewed and revised all AI-assisted text and remain responsible for the scientific content, interpretation and accuracy of the references.

Author Contributions (CRediT)

Andrii Borysenko: Conceptualization, Investigation, Writing – Original Draft. Kateryna Bielka: Conceptualization, Methodology, Supervision, Writing – Review & Editing. Both authors approved the final version of the manuscript.

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