



Into Thin Air(ways): A scoping review of the effects of high altitude on anaesthetic administration in pre-hospital environments

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BACKGROUND

- Accessibility and demand for adventure travel has dramatically increased the number of people travelling to high altitude (HA)¹.
- HA poses a unique challenge to anaesthesia due to hypobaric hypoxia affecting human physiology, pharmacodynamics and equipment performance, complicating pre-hospital delivery.
- No clinical guidelines exist for anaesthetic administration at HA; a critical evidence gap.

RESEARCH OBJECTIVES

- Determine how anaesthetics are used at HA.
- Evaluate the impact of HA on anaesthetic use and, *where possible*, offer cautious clinical insights.
- Identify research gaps to inform future studies.

RESEARCH METHODS

Protocol: Designed and reported using the Arksey & O'Malley² and PRISMA-ScR frameworks³.

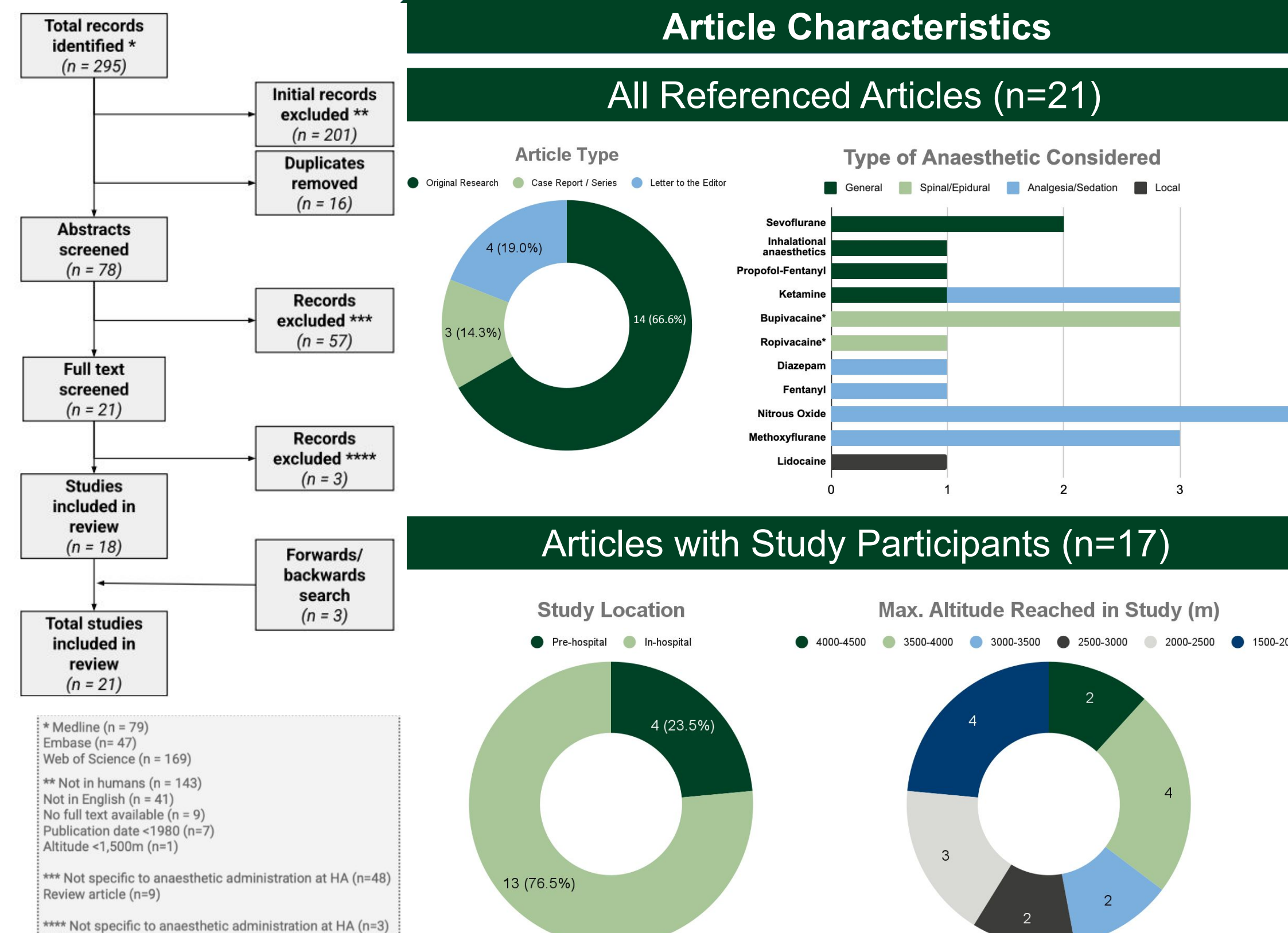
Eligibility: Identified using the "population, concept, context" (PCC) framework recommended by the Joanna Briggs Institute (JBI)⁴ and endorsed by the PRISMA-ScR framework.

Population	Human participants.
Concept	Administration of any anaesthetic agent, sub-categorised as general, regional, sedation/analgesia and local.
Context	English-language articles published after 1980, examining environments >1,500m (real or simulated).

Data sources: Medical Literature Analysis and Retrieval System Online (MEDLINE), Excerpta Medica dataBASE (EMBASE) and Web of Science were searched from Oct 2024-May 2025.

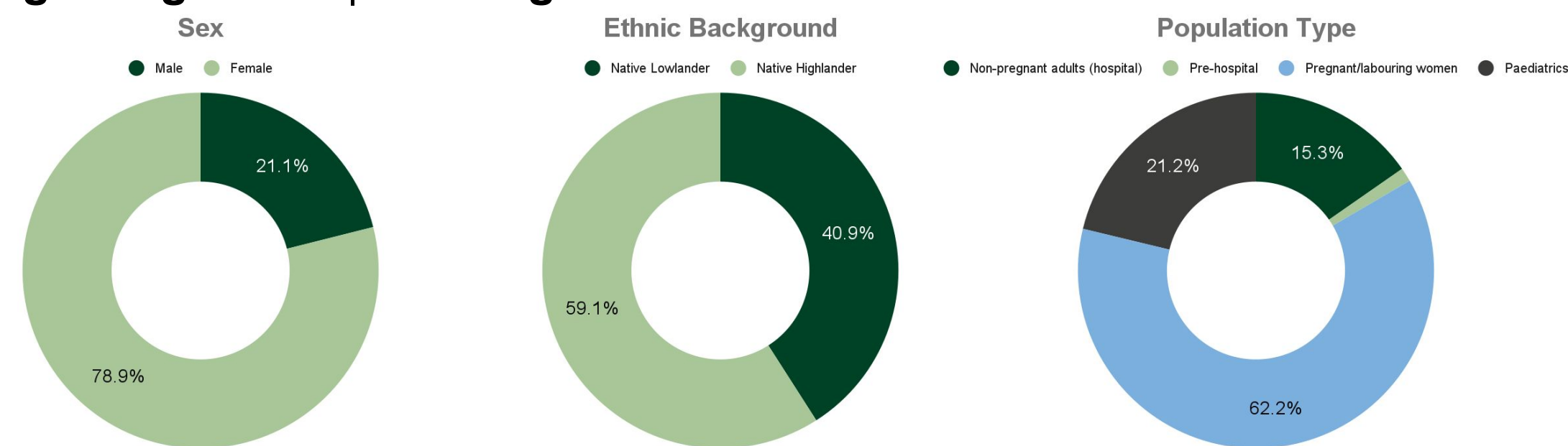
Data synthesis: Key data characteristics are visually represented. Narrative synthesis of conclusions, by subcategory, is provided. There is no meta-analysis as data collected were very heterogeneous. The Grading of Recommendations, Assessment, Development and Evaluation (GRADE)⁵ tool is used to offer a systematic and transparent approach to rating the strength of conclusions (quality; strength).

RESULTS



Participant Characteristics

Total study subjects: 3,162 from 17 articles (excludes letters)
Age range: 0-61 | **Mean age:** 20.7



General Anaesthetics (GA)

- Pre-hospital GA should be avoided, especially at HA** (low; strong)⁶⁻⁸.
- If unavoidable, GA should adhere to in-hospital anaesthetic standards as per the Anaesthetic Association of Great Britain and Ireland (AAGBI)⁶.

Conclusions	GRADE	Comments
• Inhalational anaesthetics are unreliable at HA.	Low, Strong	Consistent observation ⁹⁻¹¹ ; high potential harm.
• Propofol , titrated to BIS, may be safe at HA.	Low, Conditional	Supported by small, controlled study ¹² ; plausible.
• Ketamine may be a safe at HA; simple ventilatory equipment/skills mandated.	Low, Conditional	Consistent across multiple small studies ¹³⁻¹⁵ ; plausible.

Regional Anaesthetics

- Neuraxial is the preferred method of *in-hospital* anaesthesia at HA due to its minimal effect on ventilation and decreased aspiration risk¹⁶, **but** is unlikely to be practical in *pre-hospital* environments¹⁷.

Conclusions	GRADE	Comments
• Onset of neuraxial anaesthesia at HA is slower and higher doses required.	Low, Strong	Consistent across small studies ¹⁸⁻¹⁹ ; plausible.
• Bupivacaine is the recommended agent	Low, Conditional	Single comparative study ²⁰ , further studies needed.

- No data exist for other regional techniques; research into field-expedient regional blocks (FERBs) would be extremely valuable.

Sedation / Analgesia

Conclusions	GRADE	Comments
• Methoxyflurane is safe and effective at HA.	Low-moderate, Strong	Consistent observation ²¹⁻²³ ; plausible.
• Ketamine is safe at HA; careful titration required.	Low, Conditional	Consistent across studies ¹³⁻¹⁵
• Nitrous oxide is inconsistent at HA and should be avoided.	Low, Strong	Consistent across studies ²⁴⁻²⁷
• Opioids are theoretically unsafe at HA.	Very low, Strong	Consistent across studies ²⁴⁻²⁷
• Benzodiazepines are theoretically unsafe at HA.	Low-moderate, Strong	Single observational study ²⁸ ; high potential harm. RCT evidence ²⁹ ; high

Local Anaesthesia

- No robust data exist.

CONCLUSIONS

- Limited research exists** on the effects of high altitude on pre-hospital anaesthetic administration.
- Heterogeneity among included articles limits direct comparisons and synthesis.**
- Robust observational cohorts or pragmatic RCTs** with standardised data, multicentre collaboration, and altitude-specific methods are needed across all areas.
 - Specific focus on FERBs would be valuable.
- A clinical guideline informed by the above studies, alongside expert consultation and consensus should be developed** to standardise care and improve safety in pre-hospital, HA anaesthetic delivery.
- Until then, clinicians must adapt practise based on physiological principles and prioritise safety.**

REFERENCES

