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Acute Mountain Sickness in Mountaineers and High-Altitude Athletes: Pharmacological Prevention and Practical Considerations

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Abstract

Introduction: Acute mountain sickness (AMS) commonly follows rapid ascent to altitude and can compromise safety, physical capacity, and expedition or sport-related goals.
Aim: This narrative review summarizes evidence on pharmacological AMS prophylaxis, focusing on acetazolamide and dexamethasone, and discusses its relevance for mountaineers and high-altitude athletes.
Materials and methods: PubMed was searched for English-language publications from January 1990 to May 2026. Selected earlier landmark studies were included when important for historical or mechanistic context. Randomized trials, systematic reviews, meta-analyses, and recent clinical guidelines were prioritized, and the evidence was synthesized narratively.
Results: Acetazolamide remains the best-supported first-line option because it reduces AMS risk and facilitates acclimatization through effects on ventilation and acid-base balance. Dexamethasone may be useful in selected high-risk situations or when acetazolamide is unsuitable, but it does not promote acclimatization and may mask deterioration. Evidence for ibuprofen and other alternatives is less consistent. In athletes, benefit must be balanced against hydration, acid-base, and performance concerns.
Conclusions: Pharmacological prophylaxis is most appropriate when AMS risk is high, especially if rapid ascent is unavoidable or previous AMS suggests susceptibility. Medication should support, not replace, gradual ascent and adequate acclimatization.

Keywords: acute mountain sickness; acetazolamide; dexamethasone; high altitude; mountaineering; prophylaxis

1. Introduction

Acute mountain sickness (AMS) is a common clinical syndrome that develops after rapid ascent to high altitude and is characterized by nonspecific symptoms, including headache, nausea, dizziness, fatigue, and sleep disturbance. It usually occurs within the first hours after ascent to elevations above approximately 2,500 m and reflects an insufficient physiological response to hypobaric hypoxia.[1,2] Although AMS is often self-limited, it represents the earliest clinically relevant form of acute altitude illness and may progress to more severe conditions, including high-altitude cerebral edema, particularly when preventive or therapeutic measures are delayed or absent.[2,3]

The incidence of AMS varies according to altitude, rate of ascent, and individual susceptibility. At moderate altitudes of approximately 2,500–3,000 m, the incidence is estimated at 20%–25%, whereas at elevations above 3,500–4,000 m it may increase to 40%–60% among unacclimatized individuals.[1,4] Rapid ascent remains the most important modifiable risk factor. Additional predictors include a prior history of AMS and, possibly, genetic susceptibility, whereas physical fitness does not appear to provide meaningful protection.[2,5] Evidence regarding age is less consistent, although some studies suggest greater susceptibility in younger individuals.[2,5]

AMS has important implications for both mountaineering and sport. In trekkers and mountaineers, even mild symptoms may impair cognition, coordination, and decision-making, thereby increasing risk in demanding terrain and contributing to disrupted itineraries or unplanned descent.[6] In athletes exposed to high altitude, AMS may reduce training quality, impair recovery, and compromise performance, especially when ascent is rapid and acclimatization time is limited.[7]

Gradual ascent and adequate acclimatization remain the cornerstone of prevention.[2,3] In practice, however, these measures are often constrained by weather windows, expedition logistics, fixed competition schedules, or short-duration altitude camps. Under such circumstances, pharmacological prophylaxis becomes a clinically relevant adjunct, particularly in individuals at increased risk.

Among the available agents, acetazolamide and dexamethasone are the most extensively studied.[2,8] Their mechanisms, clinical roles, and adverse-effect profiles differ substantially, and appropriate selection therefore requires consideration of exposure characteristics, individual risk, and population-specific demands. This issue is particularly relevant in high-altitude athletes. However, direct evidence in athletic populations remains limited, and many practical recommendations for athletes are extrapolated from studies conducted in trekkers, mountaineers, or mixed high-altitude cohorts rather than from athlete-specific trials.

In addition to its clinical relevance, AMS has important operational consequences in both recreational and performance-oriented settings. In mountaineering, even relatively mild symptoms may alter pacing, reduce confidence in technical terrain, and affect adherence to expedition plans. In athletes, the consequences may be different but no less relevant: subclinical or early symptoms may impair training quality, limit recovery, and reduce the effectiveness of short altitude exposures that are often planned with specific performance goals in mind.[6,7] These practical considerations help explain why interest in pharmacological prophylaxis extends beyond purely medical decision-making and increasingly intersects with issues of performance, logistics, and risk management.

At the same time, the decision to use prophylactic medication is rarely binary. In real-world settings, it often reflects a balance between expected benefit, anticipated tolerability, route profile, prior altitude history, and the feasibility of non-pharmacological prevention. This is particularly important in heterogeneous high-altitude populations, in whom the same ascent

profile may carry different practical implications depending on the purpose of exposure, whether it is summit-oriented mountaineering, trekking, or time-limited athletic preparation. Framing prophylaxis within this broader decision-making context is therefore essential for clinically useful interpretation of the available evidence.[2,4]

2. Aim of the review

This narrative review aims to critically evaluate current evidence regarding pharmacological prophylaxis of acute mountain sickness, with particular emphasis on acetazolamide and dexamethasone. In addition, this review assesses the practical applicability of these strategies in two distinct populations—mountaineers and high-altitude athletes—and provides clinically oriented recommendations for real-world decision-making.

3. Materials and methods

This narrative review was undertaken to summarize and critically interpret the available literature on the pharmacological prevention of acute mountain sickness in individuals exposed to high altitude. A structured literature search was performed in the PubMed database for English-language publications from January 1990 to May 2026. The final search update was conducted in May 2026. In addition, seminal pre-1990 studies were included when they were considered historically important for understanding the efficacy or mechanism of established prophylactic agents.

The search strategy combined terms related to AMS, altitude exposure, and pharmacological prevention. Example search strings included “acute mountain sickness” AND prophylaxis, “altitude illness” AND acetazolamide, “acute mountain sickness” AND dexamethasone, “high altitude” AND pharmacological prevention, and “altitude training” AND athletes. Reference lists of selected articles were also screened manually to identify additional relevant studies.

Priority was given to randomized controlled trials, systematic reviews, meta-analyses, and clinical practice guidelines. Mechanistic studies and narrative reviews were included when they substantially informed the physiological rationale or practical interpretation of preventive strategies. Preference was given to studies addressing prophylaxis rather than treatment and to publications with direct relevance to mountaineers, trekkers, or athletes exposed to high altitude.

Study selection and synthesis were narrative and expert-driven rather than systematic. No formal review protocol was registered, and no structured risk-of-bias assessment was performed. The literature was interpreted with emphasis on clinical applicability, physiological plausibility, and relevance to real-world high-altitude exposure.

Given the scope of the topic, particular attention was paid to studies evaluating clinically meaningful outcomes, including AMS incidence, symptom severity, tolerability of prophylactic agents, and practical implications for continued altitude exposure. When available, evidence relevant to performance, hydration, ventilatory adaptation, and short-duration altitude camps was also considered. Because literature specific to high-altitude athletes remains limited, mechanistic and applied studies from broader high-altitude populations were interpreted cautiously and used primarily to inform context rather than to support definitive athlete-specific conclusions.

4. Pathophysiological basis of AMS relevant to pharmacological prevention

4.1. Hypobaric hypoxia and ventilatory response

The fundamental trigger for AMS is hypobaric hypoxia caused by reduced barometric pressure at altitude. The resulting decrease in the partial pressure of inspired oxygen leads to arterial hypoxemia and initiates a series of compensatory responses intended to preserve tissue oxygen delivery.[1,9] One of the earliest and most important of these responses is increased ventilation mediated by peripheral chemoreceptors in the carotid bodies.

The magnitude of the hypoxic ventilatory response varies markedly between individuals and represents a major determinant of AMS susceptibility. Individuals with a relatively blunted

ventilatory response tend to achieve lower arterial oxygen saturation and are at increased risk of symptom development.[6,9] During early altitude exposure, hyperventilation lowers arterial carbon dioxide tension, producing respiratory alkalosis. This alkalotic state may attenuate central respiratory drive and thereby limit further ventilatory compensation despite ongoing hypoxic stimulation.

Acetazolamide improves ventilatory adaptation through a well-established physiological mechanism. By inhibiting carbonic anhydrase, it promotes renal bicarbonate excretion and induces mild metabolic acidosis, which counteracts respiratory alkalosis and supports sustained hyperventilation. Improved oxygenation is considered a central mechanism underlying its prophylactic efficacy.[8,10]

4.2. Acid-base balance and acclimatization

Acid-base regulation is central to acclimatization. The initial hyperventilatory response to hypoxia lowers arterial carbon dioxide levels and leads to respiratory alkalosis, which may blunt further ventilatory drive and slow early adaptation.[9,10] Renal compensation gradually develops through bicarbonate excretion, allowing partial correction of pH and improved ventilatory responsiveness. However, this process usually requires several days and may be inadequate during rapid ascent.

Acetazolamide accelerates this compensatory process by enhancing bicarbonate loss and inducing a mild metabolic acidosis, thereby facilitating ventilation and improving oxygenation.[8,10] In this way, it acts as a pharmacological accelerator of acclimatization rather than merely a symptomatic agent. Dexamethasone, in contrast, does not meaningfully influence ventilatory control or acid-base homeostasis.

4.3. Cerebral fluid shifts and symptom generation

AMS is also associated with changes in cerebral hemodynamics and fluid balance. Hypoxia causes cerebral vasodilation, increases cerebral blood flow, and may contribute to mild vasogenic edema, which is thought to underlie characteristic symptoms such as headache.[1,6] Disturbances in cerebrovascular autoregulation may further intensify symptoms.

Dexamethasone is believed to act mainly through anti-inflammatory effects and stabilization of the blood-brain barrier, thereby limiting capillary leakage and cerebral fluid accumulation.[4,9] This mechanism helps explain its efficacy in reducing AMS symptoms, but it does not promote physiological adaptation to hypoxia.

4.4. Clinical implications of pathophysiology

The pathophysiology of AMS reflects an interaction between hypoxemia, ventilatory regulation, acid-base balance, and cerebral responses to altitude. This has direct relevance for pharmacological prevention. Acetazolamide primarily improves tolerance of ascent by enhancing ventilatory adaptation and accelerating acclimatization, whereas dexamethasone mainly reduces symptom expression through effects on cerebral permeability and inflammatory pathways. This mechanistic distinction is clinically relevant because the two agents do not serve identical preventive roles and should not be regarded as interchangeable in all exposure scenarios.

5. Indications for pharmacological prophylaxis of acute mountain sickness

5.1. Individual risk factors

The decision to initiate pharmacological prophylaxis should be based on structured risk assessment. A prior history of AMS remains the most consistent predictor of recurrence.[1,2] Individuals who previously developed AMS, particularly in moderate or severe form, are at substantially increased risk during subsequent ascent, especially when exposure profiles are similar.

Rapid ascent is another major determinant of risk. Ascending to altitudes above approximately 2,500–3,000 m within a short time frame, particularly within a single day, markedly increases the likelihood of AMS and often justifies prophylaxis.[2,4] This is especially relevant for

travelers ascending by air or motorized transport, where physiological adaptation has insufficient time to develop.

Possible additional contributors include younger age and genetic susceptibility, although evidence in these areas is less consistent.[5] Importantly, physical fitness should not be considered protective and should not reduce the perceived need for prophylaxis in at-risk individuals.[1,2]

5.2. Environmental and logistical factors

Even when gradual ascent would be ideal, real-world conditions often limit its feasibility. Mountaineers may be constrained by weather, route characteristics, or expedition schedules, whereas athletes commonly face fixed event dates or short altitude camps.[7] Under such conditions, pharmacological prophylaxis becomes particularly relevant when acclimatization opportunities are inadequate.

Conversely, routine prophylaxis is not warranted in low-risk individuals who ascend gradually and can adhere to standard acclimatization recommendations. In such settings, non-pharmacological prevention remains sufficient and avoids unnecessary exposure to adverse effects.

5.3. Mountaineers versus high-altitude athletes

Mountaineers and athletes differ in both exposure pattern and clinical priorities. Mountaineers are more often exposed to progressive altitude gain over several days, although summit attempts or compressed itineraries may still create high-risk phases.[4] Athletes more commonly face short-term or intermittent exposure combined with an immediate need to train or compete, which may magnify the practical consequences of even mild AMS.[7]

These differences influence prophylactic decision-making. In mountaineers, medication is typically reserved for high-risk individuals or specific rapid-ascent phases. In athletes, prophylaxis may be considered more proactively when performance is time-sensitive and acclimatization cannot be optimized. Even so, pharmacological prevention is best viewed as a complement to acclimatization rather than a replacement for appropriate ascent planning.

6. Acetazolamide as first-line pharmacological prophylaxis

6.1. Mechanism of action

Acetazolamide is the best-established first-line pharmacological option for AMS prevention. Its principal mechanism is inhibition of carbonic anhydrase, which promotes renal bicarbonate excretion and induces a mild metabolic acidosis.[8,10] This effect offsets altitude-related respiratory alkalosis, supports central respiratory drive, facilitates sustained hyperventilation, and improves oxygenation.[8,9]

Although acetazolamide may also exert minor effects on cerebrospinal fluid dynamics, its main clinical value lies in accelerating acclimatization rather than merely suppressing symptoms.[8,10]

6.2. Evidence of efficacy

The efficacy of acetazolamide is supported by randomized trials spanning several decades.[11,12] More recent systematic reviews and meta-analyses have confirmed that it significantly reduces AMS incidence across a range of ascent profiles and populations.[13,14,15] This consistency, combined with a strong physiological rationale, explains why current guidelines continue to recommend it as the preferred prophylactic agent in moderate- and high-risk settings.[2]

6.3. Dosage and timing

The most commonly recommended regimen is 125 mg twice daily, initiated one day before ascent and continued during ascent.[2,14] This dose generally provides effective prophylaxis while minimizing adverse effects. Higher doses, such as 250 mg twice daily, are also effective but are associated with more frequent paresthesias, dysgeusia, and diuresis, without clear evidence of superior clinical benefit.[14]

Initiation approximately 24 hours before ascent allows time for acid-base effects and ventilatory adaptation to develop. In most practical scenarios, treatment is continued during ascent and for at least 48 hours after arrival at the target altitude, particularly if further ascent is planned.[2]

6.4. Safety profile and adverse effects

Acetazolamide is generally well tolerated in prophylactic doses. The most common adverse effects include paresthesias, increased diuresis, nocturia, mild gastrointestinal symptoms, and altered taste perception, particularly with carbonated beverages.[10,14] These effects are usually mild and dose dependent.

Caution is warranted in individuals with renal impairment, electrolyte abnormalities, or clinically relevant acid-base disorders. Although acetazolamide is a sulfonamide derivative, clinically significant cross-reactivity with sulfonamide antibiotics appears to be low; however, caution remains appropriate in patients with a history of severe hypersensitivity reactions.

6.5. Use in athletes: benefits and limitations

In athletes, acetazolamide may help reduce AMS-related impairment during early high-altitude exposure and may improve tolerance of rapid ascent when acclimatization time is limited.[7] However, its use requires careful balancing of preventive benefit against potential performance-related drawbacks.

Its diuretic effect may complicate hydration management during intense training or competition, and the induced metabolic acidosis may impair buffering capacity during high-intensity exercise. Available evidence suggests that the overall effect on exercise performance is context dependent and may be unfavorable in some settings, particularly when maximal or repeated high-intensity efforts are required.[16,17] Because direct athlete-specific evidence remains limited, firm conclusions about performance benefit should be avoided.

This issue is especially relevant because athletic exposure to altitude is often compressed in time and embedded within highly structured training or competition schedules. In such settings, the clinical threshold for intervention may be lower than in recreational populations, as even minor decrements in well-being or training tolerance may have disproportionate practical consequences. However, this does not necessarily justify broader prophylactic use. Rather, it highlights the need for careful case-by-case assessment, since the same drug that reduces AMS risk may also introduce physiological or perceptual effects that are undesirable in performance-sensitive environments.[7,16,17]

7. Dexamethasone and corticosteroids

7.1. Mechanism of action

Dexamethasone is an effective alternative prophylactic agent, but its clinical role differs fundamentally from that of acetazolamide. Rather than promoting acclimatization, it acts primarily through anti-inflammatory mechanisms and stabilization of the blood-brain barrier, thereby limiting cerebral fluid shifts associated with AMS symptoms.[4,6]

Because dexamethasone does not improve ventilatory adaptation, its prophylactic effect is mainly symptomatic. This distinction is important when considering prolonged exposure or ongoing ascent.[2,4]

7.2. Evidence for prophylactic use

Randomized trials have shown that dexamethasone reduces the incidence and severity of AMS, particularly during rapid ascent and in high-risk scenarios.[18,19] Its efficacy is therefore clinically meaningful, especially when acetazolamide cannot be used.

Nevertheless, dexamethasone is generally considered second-line prophylaxis because it does not facilitate acclimatization and may suppress symptoms without reducing the underlying physiological stress of altitude exposure.[2]

7.3. Comparison with acetazolamide

Although both agents reduce AMS incidence, they are not interchangeable. Acetazolamide promotes physiological adaptation, whereas dexamethasone primarily reduces symptom

expression.[8] Acetazolamide is therefore generally preferred for most preventive situations, while dexamethasone is better reserved for selected cases involving contraindication, poor tolerance, or a need for short-term protection.[2]

7.4. Risks and limitations

The main concern with dexamethasone is the possibility of masking worsening altitude illness, thereby encouraging continued ascent despite inadequate acclimatization.[2,4] Short-term use is often well tolerated, but potential adverse effects include insomnia, mood changes, hyperglycemia, and gastrointestinal symptoms. Accordingly, dexamethasone should be used selectively and should not replace appropriate ascent strategy.

8. Other pharmacological agents with limited or emerging evidence

8.1. Nonsteroidal anti-inflammatory drugs

Ibuprofen and other nonsteroidal anti-inflammatory drugs have been evaluated as possible alternatives for AMS prevention. Their effect appears to result mainly from symptomatic reduction of headache and inflammation rather than from any meaningful influence on acclimatization. Randomized data suggest that ibuprofen may reduce AMS incidence compared with placebo, but the effect is less consistent and less robust than that observed with acetazolamide.[20]

For this reason, NSAIDs should not be considered first-line prophylaxis.[2] Their role is better viewed as adjunctive or situational, particularly when standard prophylactic agents are not suitable.

8.2. Other agents

Other candidate agents, including ginkgo biloba, have produced inconsistent results. Early studies suggested possible benefit, but subsequent trials failed to confirm a reliable preventive effect.[21,22] At present, these alternatives cannot be recommended as substitutes for established strategies.

9. Pharmacological prophylaxis in high-altitude athletes

9.1. Impact on physical performance

Altitude exposure is associated with a progressive decline in maximal oxygen uptake, and this reduction is an important determinant of impaired endurance performance.[16] However, the physiological and practical implications of AMS prophylaxis in athletes remain incompletely defined. Most available evidence derives from general high-altitude populations rather than from competitive athletes, and direct data linking prophylactic treatment to performance outcomes are limited.

Acetazolamide may improve oxygenation and reduce AMS-related impairment during early high-altitude exposure, but its overall effect on exercise performance remains uncertain. Potential benefits related to improved tolerance of hypoxia must be balanced against possible disadvantages, including altered acid-base balance, increased diuresis, and reduced buffering capacity during high-intensity efforts.[17,23] In athletes, the net effect is therefore best understood as a potential trade-off rather than a predictable performance advantage.

9.2. Timing relative to training and competition

Timing is particularly important in athletes, who often ascend rapidly and must perform soon after arrival. Starting acetazolamide approximately 24 hours before ascent is consistent with current recommendations, but in performance settings, this should be weighed against the possibility that early adverse effects may interfere with key training sessions or competition.[2] Whenever feasible, gradual acclimatization and preacclimatization strategies remain preferable to routine pharmacological prevention in athletes.[24] Medication is most justified when exposure cannot be modified and the expected risk of AMS clearly outweighs potential performance-related drawbacks.

9.3. Practical considerations in sports settings

In sports settings, practical decision-making should account for sport discipline, altitude profile, expected duration of exposure, prior AMS history, and the consequences of even mild adverse effects. Hydration is a particular concern with acetazolamide, especially during prolonged or intense exercise. Likewise, small decrements in comfort or buffering capacity may be clinically relevant in elite or highly competitive athletes.

Accordingly, pharmacological prophylaxis in athletes should be selective, individualized, and integrated into broader altitude-planning strategies rather than used routinely.

Another important issue is that athletes are not a uniform population. The balance between possible benefit and potential drawback may differ substantially between endurance athletes, who may prioritize sustained tolerance of hypoxic exposure, and athletes participating in disciplines with a greater anaerobic component, in whom even small disturbances in buffering capacity or perceived exertion may be more consequential. Similarly, the practical value of prophylaxis may differ between preplanned altitude camps, where gradual acclimatization strategies can often be built into the schedule, and competition-related travel, where ascent is rapid, and flexibility is limited.[16,17,23,24] These differences reinforce the need for individualized interpretation rather than blanket recommendations.

10. Discussion

This narrative review indicates that pharmacological prophylaxis has a clear but circumscribed role in the prevention of AMS. The available evidence most strongly supports acetazolamide as the preferred first-line agent because it combines consistent clinical efficacy with a mechanism that directly facilitates acclimatization.[13,14,15] Dexamethasone is also effective, but its role is narrower because it reduces symptom expression without meaningfully improving physiological adaptation to altitude.[2,18,19]

These distinctions are relatively well supported in general high-altitude populations, particularly among trekkers and mixed cohorts. By contrast, the evidence base in athletes is considerably more limited. Many practical considerations relevant to sports settings—including effects on training quality, hydration, repeated high-intensity efforts, and competitive performance—are inferred from broader altitude literature rather than from athlete-specific clinical studies. For that reason, recommendations for athletes should be interpreted more cautiously than those for general mountaineering populations.

This distinction between mountaineers and athletes also underscores a broader interpretive challenge in the literature. Studies conducted in general high-altitude populations often provide robust information on AMS prevention as a clinical endpoint, but they do not always capture the practical outcomes most relevant to sport, such as training quality, session completion, perceived exertion, recovery, or competition readiness. As a result, the evidence may be sufficient to support cautious clinical reasoning, yet still fall short of allowing strong performance-specific recommendations. This gap helps explain why athlete-focused decision-making in this area remains partly inferential rather than strictly evidence-based.[16,17,23,24]

This need for sport-oriented synthesis is also reflected in recent review articles published in Quality in Sport, which have revisited both AMS-specific prevention and the broader clinical framework of high-altitude disease.[25,26]

The current evidence base also has broader limitations. An additional limitation is the narrative design of the present review, which involved expert-driven study selection without a formal risk-of-bias assessment and may therefore have limited the completeness and reproducibility of the synthesis. Considerable heterogeneity exists across studies with regard to ascent rate, altitude reached, outcome definitions, and participant characteristics. This makes direct comparison between trials difficult and limits precision when translating pooled findings into specific real-world scenarios.[27] In addition, a substantial proportion of the literature derives

from recreational trekkers or mixed populations rather than from groups with clearly defined performance demands.

Another unresolved area concerns repeated exposure and retention of acclimatization. Many athletes and expedition participants encounter altitude in recurrent cycles rather than as a single ascent, yet the interaction between repeated exposure, residual acclimatization, and pharmacological prophylaxis remains incompletely understood.[28] Future research should therefore prioritize athlete-specific studies, more standardized AMS endpoints, and outcomes that better reflect real-world performance and field conditions.

Overall, current evidence supports a risk-stratified approach. Pharmacological prophylaxis is most appropriate when AMS risk is clearly elevated, and acclimatization cannot be optimized. In contrast, routine prophylaxis in low-risk situations is not supported by either physiology or clinical evidence.

11. Practical implications

Pharmacological prophylaxis should be used selectively and primarily in moderate- and high-risk exposure scenarios, especially in individuals with a prior history of AMS or in those undertaking rapid ascent without adequate acclimatization.[2] In such situations, acetazolamide should be considered the default pharmacological option because it reduces AMS incidence while facilitating acclimatization.[8,10]

Dexamethasone should be reserved for selected cases in which acetazolamide is contraindicated, poorly tolerated, or impractical, particularly when short-term protection is required.[2] Because it may mask evolving illness, it should not be used as a substitute for appropriate ascent planning.

Routine pharmacological prophylaxis is not indicated in low-risk individuals who ascend gradually and can follow standard acclimatization recommendations. In athletes, prophylaxis requires individualized decision-making because potential benefits in symptom reduction must be balanced against possible performance-related trade-offs and the limited availability of direct athlete-specific evidence.

12. Conclusions

Pharmacological prophylaxis is an effective adjunct in the prevention of AMS in clearly defined moderate- and high-risk scenarios. Acetazolamide remains the preferred first-line agent because it has the strongest evidence base and promotes physiological acclimatization in addition to reducing symptom burden.[2,13,14,15]

Dexamethasone is an effective second-line option, but its role is narrower because it does not facilitate acclimatization and may mask deterioration.[2,18,19] Evidence supporting ibuprofen and other alternative agents remains insufficient for routine use.[2,20,21,22]

Taken together, the available literature supports a pragmatic hierarchy of preventive decision-making. First, acclimatization remains fundamental whenever feasible. Second, acetazolamide is the most rational pharmacological option when the risk is meaningfully elevated. Third, dexamethasone retains a role in selected circumstances but should be used with greater caution because its benefits are not linked to improved adaptation. Finally, athlete-specific applications require particular restraint, as direct evidence remains limited and practical trade-offs may be more relevant than in general mountaineering populations.[2,13,14,15,18,19]

Overall, pharmacological strategies should complement, not replace, appropriate acclimatization. The most appropriate preventive approach remains individualized and should account for ascent profile, prior AMS history, logistical constraints, and the distinct demands of mountaineering versus athletic performance. More recent comparative syntheses and head-to-head data continue to support acetazolamide as the preferred first-line option, while ibuprofen appears potentially useful in selected contexts but without clear superiority over acetazolamide.[29,30,31]

Disclosure

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During the preparation of this work, the authors used ChatGPT (OpenAI) exclusively for linguistic refinement, grammar correction, and structural editing of the manuscript. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the scientific content, interpretation of the data, and final version of the manuscript.

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