Breath-based interventions in elite athletes and coaches

Theoretical foundations and applied considerations for mental well-being and performance

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Abstract: *Background:* This narrative review discusses the historical development of the scientific and psychophysiological foundations of neurovisceral integration and the key role that breath-based interventions can play in the regulation of mind-body interactions ultimately impacting well-being and performance in elite athletes and coaches. *Methods:* A literature review was conducted for articles published from 2000 to 2025 using the key words: neurovisceral integration, breathing techniques, autonomic regulation, sports performance, life balance, mental well-being, elite athletes, elite coaches. The historical underpinnings of a neurovisceral integration framework and current concepts of autonomic regulation for guiding breath-base interventions and their impact are reviewed. *Results:* By translating autonomic regulation theory into breath-based interventions, we describe their impact on the regulation of cognition, emotion, attention, autonomic arousal, neuromuscular efficiency, and somatic/kinetic chain activation domains. Five specific breathing techniques are described and their application to these six domains are elucidated. Four anonymized case illustrations from the first author's practice from different sports are presented and the integration strategies of these breath-based in each are discussed in detail. *Conclusion:* Breath-based interventions within a neurovisceral integration framework provide sports mental health providers with guidance to their use for autonomic regulation, performance consistency, stress control, mental well-being and restorative sleep.

Keywords: breathing, neurovisceral integration, heart rate variability, elite athletes, performance

Introduction

Breathing is among the most efficient and evolutionarily conserved behavioral mechanisms for regulating the physiological and psychological demands of life and sport. Breath-based interventions have gained increasing attention in elite sport as accessible strategies for influencing emotional regulation, attentional control, and performance readiness, yet their integration into practice has often outpaced clear articulation of their theoretical and psychophysiological foundations. This paper examines the historical lineage, psychophysiological mechanisms, and applied considerations of breath-based interventions as they relate to mental well-being and performance in elite athletes and coaches.

The scientific foundations of this understanding extend back to the mid-19th century, when Claude Bernard established that health depends on the nervous system's capacity to actively regulate the internal physiological environment, a concept he termed the *milieu intérieur* (later foundational to the concept of homeostasis). Bernard demonstrated that circulation and cardiac function are not autonomous processes but are dynamically modulated by neural mechanisms in response to environmental, emotional, and metabolic demands [1]. This principle – that adaptive stability reflects flexible neural regulation rather than fixed equilibrium – provides the earliest physiological foundation for contemporary concepts of autonomic regulation and stress physiology.

Building upon this physiological framework, William James, in parallel with Carl Lange, extended these ideas into the psychological domain. The James–Lange theory proposed that emotional experience arises from the perception of bodily changes rather than preceding them,

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What is already known on this topic
Neurovisceral Integration is a useful theoretical framework for understanding mind-body interactions in elite athletes and coaches

What this study adds
Breath-based breathing interventions can up- or down-regulate central and peripheral autonomic nervous system activation levels allowing for neurovisceral integration.

How this study may affect sports psychiatry practice
Breath-based interventions can be used to influence cognitive, emotional, attentional, autonomic, neuromuscular, and muscular (kinetic) chain domains that are key to performance consistency and mental well-being.

positioning cardiorespiratory and visceral signals as integral components of emotion, attention, and volitional action [2,3,4]. In this view, bodily rhythms, including respiration, are not merely expressions of mental states, but active contributors to conscious experience and behavioral control [2,3,4]. This insight laid the conceptual groundwork for modern psychophysiology and embodied cognition.

These physiological and psychological perspectives were subsequently synthesized and formalized by Walter Cannon, who introduced the concept of homeostasis and described coordinated autonomic responses to stress [5,6]. Cannon's work unified Bernard's emphasis on internal regulation with James's focus on bodily contributions to emotion, establishing a systems-level framework in which the brain orchestrates cardiovascular, respiratory, and metabolic processes to maintain adaptive stability under challenge [5,6].

Contemporary models of neurovisceral integration (see Figure 1), articulated by Julian F. Thayer and operationalized in sport and performance contexts by Stefan Laborde, build directly upon this lineage. Within this framework, vagally mediated heart rate variability (HRV) is conceptualized as an index of the functional integration between central regulatory networks and cardiac control, reflecting autonomic flexibility, emotional regulation, and attentional capacity. Breathing occupies a unique position within this model, as it is both autonomically regulated and voluntarily modifiable, providing a direct behavioral pathway for influencing neurovisceral function [7,8,9,10].

Two broad patterns of respiration – often described as stress-related and relaxation-related – are embedded within the autonomic nervous system regulation and operate largely outside conscious awareness. Stress breathing is typically activated by adversity, threat, or competitive demand and is characterized by rapid, shallow, and often noisy airflow, frequently mouth-dominant, with increased recruitment of accessory muscles of the neck and chest and heightened inspiratory effort. By contrast, relaxation-related breathing is slower, quieter, and more rhythmical,

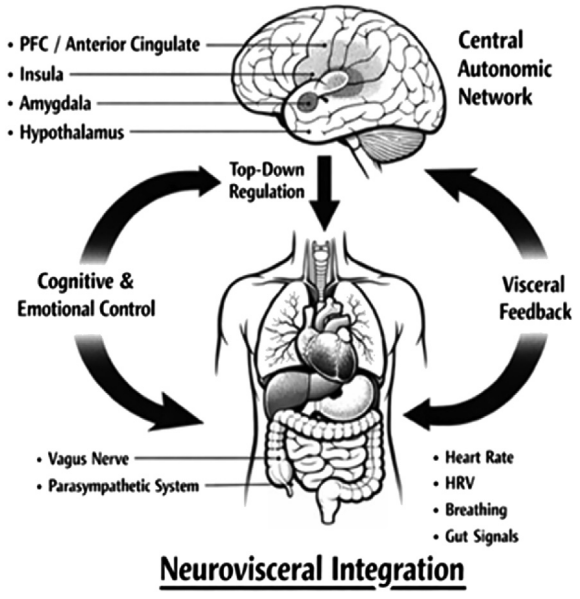


Figure 1. Neurovisceral integration demonstrates the bidirectional relationship between brain and body. Illustration generated by AI; not reproduced from a published source.

typically involving nasal inhalation, prolonged exhalation, and predominant diaphragmatic engagement, with greater expiratory control and release of somatic and emotional tension. These patterns reflect core principles of autonomic regulation and neurovisceral integration, linking respiration with emotional state, attentional control, and bodily readiness for action [1,5,6,11,12,13]. Although both patterns are adaptive, sustained dominance of stress-related breathing is common among athletes and coaches and may contribute to dysregulated arousal and impaired recovery [9,10,14,15,16,17,18].

Translating autonomic regulation theory into breath-based interventions

The breath-based interventions outlined below are presented as a small set of structured exemplars through which the broader regulatory framework depicted in Figure 2 can be operationalized in practice. These interventions are presented as clinically informed, context-dependent tools that allow athletes to modulate autonomic arousal, cognitive-emotional state, and somatic regulation across training and competition and are adaptations of approaches described by Weil [19]. Collectively, these interventions illustrate how intentional modulation of respiration can support cognitive–emotional regulation (including cognitive

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interference reduction, attentional control, and emotional regulation) as well as somatic–physiologic regulation (including autonomic arousal modulation, somatic relaxation, and neuromuscular efficiency) [7,8,9,10,11,12]. The first four interventions are primarily oriented toward down-regulation of autonomic arousal and enhancement of attentional and emotional control, and may be flexibly integrated into preparation, competition, recovery, and rehabilitation contexts, depending on individual needs and situational demands [9,10,12,15,16,18]. Highlighting the bidirectional nature of breath-based regulation, the final intervention emphasizes transient up-regulation of physiological activation and alertness, and can be integrated into awakening routines, during energy dips, and pre-competition preparation [7,8,14]. The first four down-regulatory breathing interventions begin with a full clearing exhale, and the bellows breath up-regulation breathing intervention begins with rapid nasal breathing. Summaries of each intervention, their impact and applications for each of these in sport and life are included in Table 1.

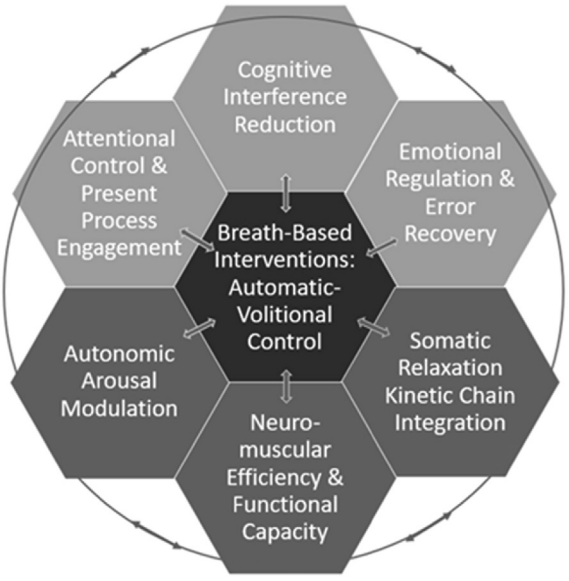


Figure 2. Functional framework for neurovisceral integration illustrating breath-based interventions as a bidirectional regulatory mechanism linking cognitive, emotional, autonomic, somatic, attentional, and neuromuscular domains.

Down-regulatory breath-based interventions

Clearing breath

The clearing breath is a foundational breath-based intervention that supports cognitive interference reduction, emotional regulation, and somatic relaxation, and may be flexibly integrated into training, competition, and pre-performance routines [6,7,9,10,11,12].

Instruction

After a clearing exhale, breathe in through the nose evenly and smoothly to a four-count (filling just to the collarbone), followed by a smooth, complete exhalation through lightly pursed lips, without straining, for a six- or eight-count, depending on age and lung capacity. For maximal effect, the breath may be synchronized with simple rhythmic movement (e.g., counting, gentle rocking of the head, neck, or torso, or finger or foot tapping on each count during exhalation). When rhythmic breathing is paired with rhythmic movement, lower-level automatic neural circuits are preferentially engaged, reducing excessive cortical cognitive activity and stress-related emotional activation.

Impact and strength of evidence

Prolonged, controlled exhalation facilitates autonomic down-regulation by increasing parasympathetic influence and reducing sympathetic arousal [9,10,11,14]. Nasal inhalation further modulates respiratory airflow and supports vagally mediated autonomic regulation [11,12], while synchronization with rhythmic movement enhances somatic integration and attentional stabilization [7,8]. Collectively, these effects support cognitive interference reduction, emotional regulation, and release of excess musculoskeletal tension [12,15,16,17,18]. The strength of evidence is moderate. This was determined for this technique and the others that follow by examining the risk of bias and methodological quality assessments from several systematic reviews.

Reset breath

The reset breath is a variant of the clearing breath specifically oriented toward rapid error recovery following mistakes or emotionally salient disruptions during performance. It incorporates a deeper inhalation and brief inspiratory hold to facilitate conscious release of cognitive-emotional and somatic activation [7,8,15,16,20].

Instruction

After a clearing exhale, breathe in through the nose to a four-count while progressively tightening the muscles of the face, neck, shoulders, back, core, hips, legs, and feet. Hold for a five-count, then exhale forcefully through the mouth to a six-count, releasing muscular tension and residual cognitive-emotional activation.

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Table 1. Breath-based interventions used to modulate autonomic, cognitive/emotional, and somatic functioning in sport

Breathing Technique/ Regulatory Orientation	Defining Features	Impact	Representative Applications*
Clearing Breath *Down-regulatory*	Nasal inhalation followed by prolonged, controlled oral exhalation through pursed lips (in 4; out 6-8), optionally synchronized with rhythmic body movement	• Parasympathetic activation • Reduced cognitive interference • Emotional regulation • Somatic relaxation	• Pre-performance routine • Performance anxiety • Visual focus • Injury rehabilitation • Stretching
Reset Breath *Down-regulatory*	Deeper nasal inhalation with brief inspiratory hold, whole-body muscular engagement, followed by forceful oral exhalation through pursed lips with kinetic chain release	• Rapid attentional reset • Emotional regulation • Kinetic chain release	• Move past mistakes • Re-center after poor play • Reduce rumination
Triple Clear *Down-regulatory*	Three sequential nasal inhalations with progressively prolonged oral exhalations (e.g., 4/4, 4/5, 4/6), optionally synchronized with rhythmic body movement.	• Autonomic down-regulation • Sustained attentional control • Restored somatic integration	• Pre-competition regulation • Stress control • Mental rehearsal/ visualization • Recovery breaks • End-of-day unwinding
4-5-6 Patterned Breath *Down-regulatory*	Structured nasal breathing with post-inspiratory hold and prolonged oral exhalation through pursed lips repeated 4-8 times (1-2 minutes)	• Slowed respiratory cadence • Attentional and emotional stabilization • Somatic anchoring under pressure	• High-pressure competition • Visualization • Recovery breaks • Sleep preparation • Sustained attentional focus
Nasal Hyperventilation (Bellows Breath) *Up-regulatory*	Rapid, rhythmic diaphragmatic movement followed by several long clearing breaths in brief (20 sec) sets and repeated 3-5 times	• Transient sympathetic activation • Increased alertness • Neuromuscular readiness • Partial autonomic rebalancing	• Morning activation • Circadian dip • Pre-training activation • Low-energy training sessions • Fatigue countermeasure

Notes: *Representative applications are informed by the mechanisms and evidence summarized in the accompanying "Impact and Strength of Evidence" sections and should be interpreted within the overall strength of evidence described for each intervention.

Impact and strength of evidence

The deeper nasal inhalation and brief inspiratory hold increase interoceptive awareness and engage central regulatory networks involved in emotional and attentional control [6,7]. The tightening of the entire kinetic chain of muscles allows trapped kinetic energy to be temporarily raised, set in motion, and released. The subsequent forceful exhalation promotes parasympathetic re-engagement and rapid autonomic down-regulation, supported by increased intra-abdominal pressure and vagal modulation [9,10,11,14,15,16]. Together, these processes facilitate emotional regulation, attentional reset, and somatic release within the kinetic chain following performance-disruptive errors [20]. The strength of evidence is moderate.

Triple clear

The triple clear is a structured breath-based intervention that reinforces autonomic down-regulation and supports cognitive interference reduction, emotional regulation, and somatic relaxation in situations of heightened stress or arousal [7,8,9,10,12,14,15,16,20].

Instruction

After a clearing exhale, breathe in through the nose smoothly and rhythmically for a four-count using primarily diaphragmatic movement (i.e. belly breathing; to facilitate this, place a hand on the abdomen and allow it to rise during inhalation and fall during exhalation, see Figure 3), followed by a four-count exhale through pursed lips, synchronized with rhythmic movement (e.g., rocking or tapping). The second breath follows the same four-count nasal inhalation with a five-count exhalation, and the third breath a four-count inhalation with a six-count exhalation. A brief pause is introduced at the end of the third breath cycle. With practice over time, individuals with larger lung capacities may progressively extend the exhalation phase (e.g., 4/4, 4/6, 4/8).

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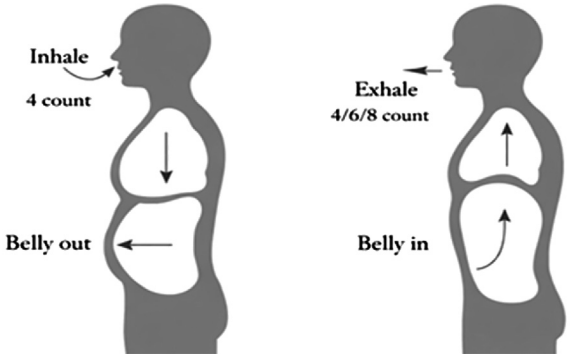


Figure 3. The triple clear breath involves diaphragmatic breathing. As air enters the nose, the belly rises allowing the lungs to fill with air for a count of 4. On the exhale the belly falls as air exits the mouth for the count of 4/5/6 on progressive breaths. Illustration generated by AI; not reproduced from a published source.

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Impact and strength of evidence

Progressive slowing of the breath and extension of the exhalation phase enhances parasympathetic influence and supports autonomic down-regulation by reducing sympathetic arousal [9,10,11,14,15,16]. Sustained attentional focus on the sensory qualities of exhalation (auditory and proprioceptive cues) facilitates cognitive interference reduction by decreasing excessive cortical engagement and stress-related emotional activation [7,8]. Diaphragmatic breathing promotes efficient lung filling and augments vagally mediated autonomic regulation [10,11,12], while the introduction of a brief post-exhalation pause further stabilizes attentional control and somatic relaxation [12,14]. Together, these processes support emotional regulation, release of excess musculoskeletal tension within the kinetic chain, and restoration of regulatory balance under conditions of stress [15,16,20]. The strength of evidence is moderate.

4-5-6 patterned breath

The 4-5-6 patterned breath is a structured down-regulatory breath-based intervention that facilitates autonomic down-regulation and stabilizes attentional and emotional responses during high-value competitive moments by introducing a brief post-inspiratory hold that deliberately slows respiratory cadence [7,8,9,10,11,12].

Instruction

After a clearing exhale, allow the air to flow smoothly through the nose to four-count, filling the lungs from the lower thorax upward toward the collarbone while permitting abdominal expansion. Once the lungs are filled, hold for a count of five while engaging light rhythmic movement (e.g., gentle rocking or tapping). As the hold concludes, exhale smoothly for a six-count, maintaining rhythmic movement throughout. Repeat for four breath cycles (approximately one minute), then transition to easy breathing (nose-nose, nose-mouth, or mouth-mouth). For each cycle, the breath may be internally counted as: In-2,3,4; Hold-2,3,4,5; Out-2,3,4,5,6. With practice, individuals with greater lung capacity may progress to longer patterns (e.g., 4-7-8).

Impact and strength of evidence

The insertion of a brief post-inspiratory hold slows respiratory rhythm and promotes autonomic down-regulation by attenuating sympathetic arousal during periods of competitive stress [9,14,15,16]. This deliberate pacing counteracts stress-related temporal acceleration, supporting stabilization of attentional focus and emotional responses under pressure [7,8]. Prolonged, controlled exhalation further enhances parasympathetic influence [10,11,12], while rhythmic movement reinforces somatic integration and attentional anchoring [7,8]. Together, these effects support cognitive–emotional regulation and performance readiness during high-value moments [14]. The strength of evidence is moderate.

Nasal hyperventilation/bellows breath (up-regulatory breath-based intervention)

In contrast to the preceding interventions, which emphasize autonomic down-regulation and cognitive-emotional stabilization, nasal hyperventilation/bellows breath is oriented toward transient up-regulation of physiological activation and alertness when greater arousal is required [7,8,14]. This intervention may be used strategically to enhance arousal, attentional readiness, and neuromuscular activation during periods of low energy or reduced alertness, such as upon awakening, during circadian dips, or prior to competition when increased arousal is desired [7,8,14,18].

Instruction

Begin by breathing rapidly out and then in through the nose using primarily diaphragmatic movement (allowing the abdomen to rise and fall with each breath). Initial emphasis should be placed on establishing a smooth, rhythmic pattern rather than maximal speed. The exhalation should feel actively driven by diaphragmatic release and rise, with inhalation occurring reflexively as the diaphragm contracts (sniffing has the opposite pattern and uses many accessory breathing muscles). Utilizing this breathing strategy, a sequence of 3 sets is conducted. Each set consists of approximately 50 breath cycles, counted in groups of tens, with gradual acceleration and deepening of the breaths toward the end of the set. Each set ends with two prolonged

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exhalations (8-10 counts) followed by a 1-2 minute recovery (easy breathing) to allow breath to return to baseline (see Figure 4).

Impact and strength of evidence

Rapid, rhythmical nasal breathing transiently increases sympathetic activation and central arousal by augmenting respiratory-driven afferent signaling to brainstem and subcortical alertness networks [14,16]. This up-regulatory effect supports increased attentional readiness and neuromuscular activation when baseline arousal is low [21,22,23,24]. Subsequent prolonged exhalations facilitate partial autonomic rebalancing, helping to dissipate excess anxious activation while maintaining functional alertness [9,10,11]. In this way, nasal hyperventilation exemplifies the bidirectional capacity of breath-based interventions to modulate autonomic arousal in a context-dependent manner [7,8]. The strength of evidence is limited as there are few controlled studies.

General applications of breath-based interventions

The breath-based interventions described above can be flexibly embedded across a range of performance, training, recovery, and injury rehabilitation contexts by targeting specific regulatory domains outlined in Figure 2. Rather than being tied to discrete techniques, these applications reflect common psychophysiological challenges encountered by athletes and coaches, including cognitive interference, somatic tension, attentional instability, emotional carryover from error, and dysregulated arousal across the circadian cycle [7,8,10,12,18].

Cognitive interference reduction

Athletes and coaches frequently report patterns of excessive cognitive activity, including worry about evaluation or outcomes, ruminations following errors, or conscious monitoring of technical execution. When conscious thought intrudes upon the execution of previously learned motor skills, attentional resources are divided, execution speed is reduced, and error likelihood increases. Conscious thought processes are relatively slow (0.4 seconds longer than subcortical activity) and depend on higher cortical engagement, whereas well-learned motor sequences are executed more rapidly via subcortical brain structures, including the basal ganglia and cerebellum.

Breath-based interventions that combine rhythmic respiration with rhythmic movement provide a practical means of shifting regulatory control away from excessive cortical monitoring toward lower-level automatic motor systems. By engaging these subcortical pathways, these interventions reduce cognitive interference and suppress the reciprocal amplification of negative affect and overthinking that can disrupt automatic movement execution [7,8,9, 18,20].

Somatic relaxation and kinetic chain integration

Movement preparation and stretching are common components of training and competition routines, yet many athletes report breath-holding or shallow inhalation during these activities. All musculotendinous units contain mechanoreceptors that modulate stretch sensitivity to protect against injury. Prolonged exhalation during static or dynamic stretching enhances parasympathetic influence,

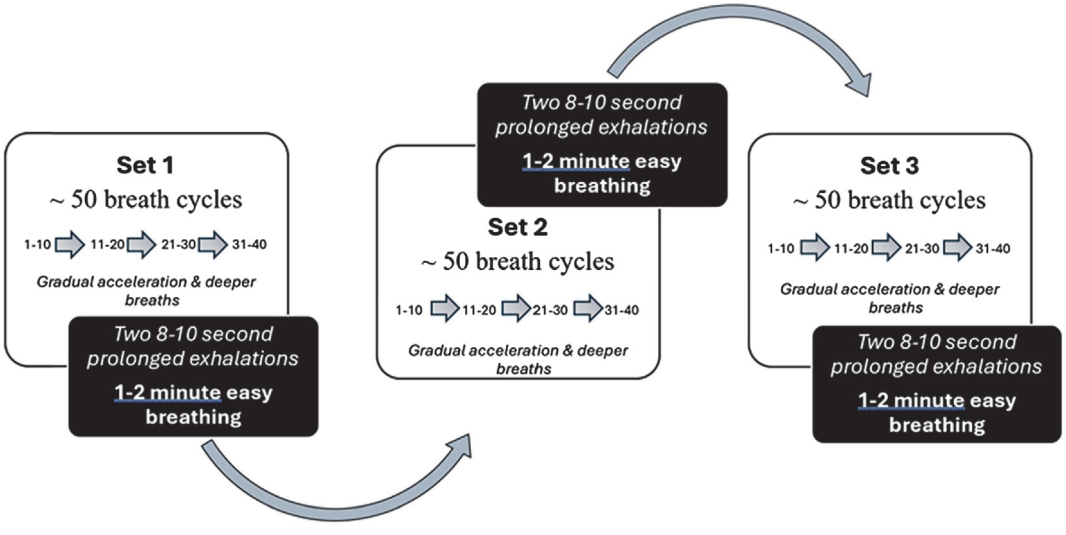


Figure 4. Nasal hyperventilation breathing sequence.

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reduces gamma motor neuron activity, and lowers muscle spindle sensitivity, thereby facilitating more effective and safer tissue elongation [11,12,24,26].

Across long training and competition days, cumulative mechanical strain from sitting, standing, repetitive movement, travel, and prolonged meetings can contribute to myofascial tension and myofascial pain, vertebral discomfort, and sleep disturbance. When unaddressed, this excess somatic load can exacerbate cognitive overactivity, emotional reactivity, motor restlessness, and make sleep more difficult. Incorporating brief recovery breaks using breath-based interventions with movement (e.g. dynamic stretching, manual therapy) throughout the day can reverse the patterns of mechanical strain and facilitate the release of excess myofascial tension, diminish pain perception, and promote kinetic chain integration [13,16,22,24,26].

Neuromuscular efficiency and functional capacity

In the context of injury rehabilitation, fear of reinjury is a common psychological barrier to return to sport and can be associated with myofascial and/or nociplastic (altered central processing) pain [24]. This fear often manifests as excessive internal attentional focus on the injured region, guarding, increased pain perception, and increased proximal and distal muscle tension. For example, following anterior cruciate ligament reconstruction, exercises such as leg raising with weights, single and double leg squats, and jumping/landing are common, but often lead to asymmetrical and dysrhythmic movement patterns. Integrating clearing or down-regulatory breaths into each rehabilitation exercise, while directing attention away from the injured site, can reduce somatic guarding and fear of reinjury while reducing pain perception, and supporting more confident, coordinated movement patterns during recovery [7,8,9,10,24,26,27].

Attentional control and present process engagement

In sports requiring precise visual targeting or anticipatory tracking (e.g., archery, tennis, baseball), attentional control is closely linked to respiratory phase. During inhalation, generally, gaze naturally broadens and visual focus softens, whereas slow exhalation is associated with narrowing and stabilization of gaze and enhanced visual acuity. When respiration is intentionally aligned with task demands, coordination among psychophysiological and motor systems improves [7,8,911,18]. Therefore, breath-based interventions may be used strategically to support present-process engagement by coupling exhalation with moments requiring visual precision and attentional stability, and inhalation with moments of environmental scanning or transition [7,8,12,20].

Emotional regulation and error recovery

Errors during competition commonly trigger attention to non-performance-enhancing bottom-up stimuli and solicit stress-related emotional responses, including frustration, doubt, embarrassment, or worry, which can persist beyond the initial mistake and impair subsequent performance. Early competition errors (e.g., foul, missed shot) are particularly disruptive, as they may precipitate cascading loss of confidence and altered decision-making [7,8,20].

Down-regulatory breath-based interventions (e.g. reset breath) provide a practical mechanism for interrupting this carryover by facilitating rapid emotional regulation and attentional reset following mistakes. By modulating autonomic arousal and reducing cognitive–emotional activation, these interventions support recovery of performance readiness and reduce the likelihood of repeated errors driven by unresolved affective responses [7,8,9,10,12,20].

Autonomic arousal modulation across the circadian cycle

Awakening and energy mobilization

Circadian rhythm is the body's internal, light-triggered, 24-hour clock that regulates reoccurring patterns of sleep and wakefulness [30]. The first hour following awakening represents a window for strategic arousal modulation, coinciding with the cortisol awakening response and increased sympathetic readiness. Breath-based interventions, including up-regulatory strategies such as nasal hyperventilation, can be used to augment alertness and support energy mobilization during this period, particularly when sleep quality or duration has been suboptimal [6,7,8,14,18,30].

Rapid, rhythmical nasal breathing, as well as breath-coupled cardiovascular activation, enhances central arousal signaling and supports metabolic readiness. These approaches may also be reintroduced later in the day during predictable circadian dips in alertness [14,18,22,23,24].

Unwinding and recovery

A substantial percentage of elite competitions occur in the evening, contributing to circadian phase shifts that delay sleep onset and impair recovery. For example, approximately 80-90% of the 82 regular season games in the National Basketball Association and 80% of the 162 regular season games in Major League Baseball are played in the evening or night to accommodate viewing schedules. This late competition activation is associated with delayed sleep timing, prolonged physiological arousal, and impaired recovery processes [6,7,8,18,30]. Many athletes report persistent activation and difficulty transitioning to sleep following competition.

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Formal unwinding routines that incorporate down-regulatory breath-based interventions can facilitate autonomic rebalancing, reduce residual sympathetic activation, and shorten sleep latency. Approaches such as progressive muscle relaxation combined with prolonged exhalation, or structured 4-5-6 breathing patterns, support gradual reduction of arousal and restoration of recovery processes [9,10,11,12,28,30].

Specific sports applications

Tennis: using breath for emotional regulation, attentional stability, and somatic coordination

Tennis is a high-velocity, point-to-point sport requiring precise integration of visual processing, response time, hand–eye coordination, neuromuscular power, and attentional control. For many players, serving performance is a critical determinant of match success. Kovacs and Ellenbecker [31] describe a multi-phase, biomechanically sequenced approach to the tennis serve – encompassing stance, bounce, toss, load, coil, acceleration, contact, and deceleration/finish – highlighting the importance of timing, kinetic chain efficiency, and neuromuscular coordination across phases.

Within this framework, breath-based interventions may be strategically embedded at multiple points in the service cycle to support emotional regulation, attentional stability, and somatic coordination. Elite first-serve percentage typically ranges from approximately 58–63%, with the highest performers achieving rates closer to 65–68%, while high-velocity servers often accept slightly lower percentages (≈55–60%) as a trade-off for pace and placement [32]. Persistently low first-serve percentages (<55%) are commonly associated with increased frustration, altered decision-making, and reduced second-serve effectiveness, underscoring the interaction between emotional regulation and serve execution.

Case illustration: first-serve inconsistency in an elite professional player

A professional power-based tennis player presented with marked first-serve inconsistency (48% first-serve rate) and reduced first-serve points won (55%), which he attributed to persistent frustration and diminished confidence surrounding this aspect of his game. To address emotional carryover and kinetic chain tension, an enhanced pre-serve routine incorporating a reset breath was introduced at the start of each service game.

The reset breath was paired with bilateral gripping of the racquet (right hand on the handle, left hand stabilizing the throat, reverse hands for left-handed player), followed by a deep nasal inhalation combined with isometric torque generation (clockwise rotation of the right hand and counter-clockwise rotation of the left hand without racquet displacement). At peak muscular engagement, a brief inspiratory hold was introduced, followed by a forceful exhalation coinciding with release of the non-dominant hand and dissipation of excess upper-body tension and emotional activation.

As the pre-serve routine progressed, easy nasal breathing was synchronized with ball bouncing and stance adjustment (rhythmic movement), during which the serving target was selected. During the toss, load, and coil phases, inhalation through the nose was followed by a forceful, pursed-lip exhalation during acceleration and contact, facilitating coordinated kinetic chain release and supporting power and accuracy. Deceleration and follow-through occurred naturally as exhalation was completed, reinforcing somatic integration and attentional closure. This breath-integrated routine was associated with improved emotional composure, more consistent serve mechanics, and progressive improvement in first-serve performance metrics over subsequent matches.

Consistent with the conceptual model presented in Figure 1, this case highlights how breath-based interventions can be flexibly embedded within complex sport-specific routines to support simultaneous regulation of emotion, attention, arousal, and neuromuscular execution.

Track and field: using breath for autonomic arousal regulation, kinetic chain integration and attentional control

At race pace sprinting, middle-distance, and long-distance running place substantial metabolic demands on the athlete, primarily drawing on glycogen stored in muscle and liver. Oxidative metabolism of these substrates generates carbon dioxide (CO_2) as a principal by-product [14]. Because ventilation is driven more strongly by rising CO_2 than by declining oxygen levels, ineffective CO_2 clearance during high-intensity running can precipitate maladaptive breathing responses [11,17].

When CO_2 clearance becomes inefficient, runners may shift toward a stress-related breathing pattern characterized by rapid, inspiratory-focused, mouth-dominant breathing with excessive recruitment of accessory neck and chest wall musculature [17,33]. This is associated with increased laryngeal and upper airway tension, drying of the airways, and global kinetic chain stiffening. Clinically, these changes may manifest as muscle heaviness, reduced running economy, declining speed, and, in some athletes, exercise-induced laryngeal obstruction (EILO),

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accompanied by inspiratory stridor and acute respiratory distress [17,33,34].

Case illustration: respiratory distress and rhythm disruption in an elite high school distance runner

An elite high school distance runner competing in cross-country, the mile, and the two-mile events sought evaluation for recurrent episodes of respiratory distress and inspiratory stridor occurring at peak exertion during regional and state championship races. These episodes resulted in marked performance impairment, including forced deceleration and, in one instance, withdrawal from a championship 5-kilometer race.

During clinical discussion, the athlete reported minimal attention to breathing during competition unless she became markedly fatigued, at which point she abruptly shifted to an inspiratory-dominant stress breathing pattern accompanied by panic and escalating respiratory distress. This pattern appeared to reinforce a vicious cycle of rising CO_2, airway tension, and cognitive-emotional dysregulation.

Intervention focused on restoring rhythmic CO_2 clearance and somatic integration during running. During initial training runs, the athlete was instructed to adopt a mouth–mouth breathing pattern while jogging, emphasizing a segmented three-count exhalation ("out–2–3") followed by a largely passive three-count inhalation ("in–2–3"), synchronized with stride cadence such that each breath segment corresponded to a single step. This breath–stride coupling promoted attentional anchoring and reinforced diaphragmatic engagement.

As running speed increased toward race pace, the athlete transitioned to a simplified pattern: one stride dedicated to a focused, audible exhalation, followed by one stride allowing a largely passive inhalation. By consciously directing attention to the sound and somatic sensation of the exhale—and learning to "let go" of the inhalation—she reliably triggered diaphragmatic contraction, created a negative intrathoracic pressure gradient, and allowed air to flow passively through the oral cavity. This approach reduced laryngeal friction and airway drying while preserving rhythmic efficiency.

With repeated practice during sprint intervals, tempo runs, and variable-pace training, the athlete demonstrated improved tolerance of high-speed running without respiratory distress, even at maximal effort. Central to this adaptation was maintaining effective CO_2 clearance during exhalation, thereby preventing the threshold shift toward inspiratory-dominant stress breathing. Over time, this breath-based strategy supported restoration of running rhythm, reduced anxiety at peak exertion, and improved competitive performance consistency.

Consistent with the framework illustrated in Figure 2, this case demonstrates how breath-based interventions can be used to stabilize autonomic state, support neuromuscular efficiency and kinetic chain integration, and preserve attentional control under extreme metabolic and psychological load.

American football (special teams): using breath for cognitive interference reduction, somatic relaxation, and neuromuscular efficiency

American football special teams demand execution of highly precise motor sequences under time-pressured and high-consequence conditions. For long snappers, performance hinges on the rapid and accurate delivery of the football to a holder or punter while simultaneously preparing for immediate contact from a defensive rusher. Performance is typically evaluated using two primary metrics: snap time (center release to holder or punter catch interval) and accuracy, both of which are vulnerable to disruption under conditions of heightened arousal and global kinetic chain tension.

Long snapping represents a closed-skill motor task that is particularly sensitive to perturbations across cognitive, autonomic, and somatic regulatory domains. Elevated sympathetic activation may manifest as excessive grip pressure, altered proprioceptive feedback, and disrupted temporal sequencing, resulting in early ball release, inconsistent velocity, or loss of directional accuracy. These performance degradations reflect breakdowns in regulatory efficiency rather than deficits in technical skill.

Case illustration: inconsistent snap quality in a NCAA Division I long snapper

A second-year Division I long snapper with a history of competitive-related performance disruption presented with inconsistent snap time and accuracy during games despite stable practice performance. Video review revealed two undesirable and unintentional recurrent patterns during pressurized situations: (1) dropping the head during the pre-snap stance to visually confirm the holder or punter, and (2) excessive grip pressure immediately prior to release. Both behaviors are consistent with stress-related sympathetic dominance and impaired proprioceptive sequencing.

To address these regulatory disruptions, intentional breathing was systematically embedded within the athlete's established nine-step motor sequence (align, stance, grip, lock-in, trigger, accelerate, release, follow-through, protect). Three clearing breaths were integrated at specific transition points rather than introduced as a separate pre-snap routine.

The first breath was introduced during the transition from alignment (standing) into stance, pairing a slow nasal

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inhalation while upright followed by a controlled clearing breath through pursed lips with descent into the snapping position. This phase supported autonomic down-regulation, reduced anticipatory cognitive interference, and facilitated global kinetic chain relaxation, establishing a stable baseline for execution.

The second breath spanned stance through lock-in, with nasal inhalation during stance followed by gradual exhalation as grip was set and lock-in established. This segment specifically targeted attentional stabilization and calibration of grip pressure, counteracting the tendency toward excessive grip force in the hands and forearms under pressure. The pause at the end of this exhale triggered the snap.

During the acceleration and release phase, residual air was expelled to support coordinated force transmission and timing. Exhalation volume was modulated based on task demands, with minimal residual air release used for shorter snaps (point-after-touchdown and field-goal) requiring maximal precision, and greater airflow employed for longer snaps (punt) requiring increased velocity and distance.

By threading breath through the motor sequence itself, rather than treating it as an isolated preparatory behavior, the intervention became integral to effective skill execution. Consistent with Figure 2, this case demonstrates how breath-based strategies can be embedded within complex, sport-specific motor patterns to simultaneously support cognitive interference reduction, somatic relaxation, and neuromuscular efficiency, addressing performance degradation at the level of regulatory integration rather than conceptualizing "anxiety" as a discrete psychological state.

American football coach: using breath for autonomic arousal modulation (circadian rhythm), neuromuscular efficiency and somatic relaxation

Although the above examples focus primarily on athlete performance, the same neurovisceral integration principles apply to coaches, whose cognitive demands, postural loading, and recovery constraints similarly influence autonomic regulation and downstream recovery processes, including sleep.

Coaching at collegiate and professional levels places physiological demands on individuals whose workload is rarely recognized as physically taxing. For instance, daily, coaches may watch 3-4 hours of film in a prolonged seated posture with a forward head position, thoracic kyphosis, and sustained rotational strain. Over the course of a competitive season, cumulative mechanical loads contribute to myofascial tension, axial discomfort, and disruption of sleep architecture [27,30,35,36].

Somatic tension, moreover, maintains low-grade sympathetic activation, elevating baseline arousal and constraining the autonomic down-regulation necessary for sleep initiation and continuity [35,37]. Such phenomena are expressed by coaches who typically describe difficulty "turning off" at night because of cognitive rumination or replaying of game scenarios when unresolved musculoskeletal loading is the main problem.

Case illustration: fragmented sleep in a Division I football coach

A veteran defensive coordinator with chronic cervical and thoracolumbar pain reported recurrent nocturnal awakenings following games or especially long days in the office. Direct observation of his film study routine revealed prolonged somatic strain from seated flexion with constant rotational movement to view three screens. Hourly, one-minute exhalation-enhanced stretch recovery breaks paired with postural unloading between film sessions were introduced. Adjunctively, a home-based neck and back massager was introduced as part of an evening unwinding routine, providing additional myofascial release and signaling the autonomic transition toward sleep readiness. These micro-interventions support vagal engagement, reduce myofascial tone, and restore autonomic flexibility, promoting recovery and restorative sleep through enhanced unwinding routines (Figure 2), without adding additional time constraints to the coaching day.

Discussion

The breath-based interventions described in this paper are applied expressions of long-standing psychophysiological principles that intentionally employ neurovisceral and autonomic regulation models to optimize the individual's task-performance as portrayed in Figure 2. By elegantly linking respiration and attention, emotional regulation and performance readiness may be enhanced immediately by the individual performer [2,6,7,8,11,12]. Accordingly, breath-based interventions offer sports mental health and performance professionals theoretically grounded means of supporting self-regulatory capacity in elite athletes and coaches across training, competition, recovery and injury rehabilitation contexts [7,8,9,10,12,29]. The interventions' clinical value lies in their flexibility as context-sensitive tools that adapt to individual needs and complex situational demands required to achieve high performance [7,8,9,10,18].

Limitations and future directions

While the breath-based interventions described here are grounded in well-established psychophysiological theory and supported by growing empirical literature, much of

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the existing evidence is derived from laboratory-based studies, short-term interventions, or heterogeneous athletic samples [9,10,12]. As such, the efficacy of specific breath-based interventions across different sports, competitive levels, and clinical profiles remains incompletely characterized. Though the interventions presented are intentionally flexible and context-sensitive rather than protocolized, suggesting broad ecological validity, limited standardization complicates direct comparison among studies and participant samples. Lastly, although mechanisms are framed through neurovisceral integration and autonomic regulation models, direct neurobiological or longitudinal clinical outcome data in elite athlete populations remain limited [7,8,15,16,25].

Future research should prioritize methodologically rigorous studies that examine breath-based interventions as regulatory processes rather than isolated techniques, with explicit attention to dose, timing, and contextual embedding across training, competition, recovery, and rehabilitation settings [9,10,15,16,18,29]. Longitudinal designs incorporating psychophysiological markers (e.g., heart rate variability), behavioral performance metrics, and clinically relevant mental health outcomes such as depression, performance anxiety and insomnia would help clarify both mechanisms and durability of effects [7,8,11]. Additionally, greater attention is needed to individual differences, including prior trauma exposure, injury history, baseline anxiety, and autonomic reactivity, that may moderate responsiveness to breath-based regulation. Finally, integration of breath-based interventions within broader interprofessional models of athlete mental health and performance represent an important translational opportunity for sports medicine teams [12,18].

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