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The A52 Breath Method: A Narrative Review of Breathwork for Mental Health and Stress Resilience

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ABSTRACT

Breathwork - deliberately altering the way one breathes - has gained growing attention as an emerging non-pharmacological intervention for mental health and stress regulation. A novel yet ancient method that remains largely underexplored in the literature, breathwork requires structured, evidence-based investigation to optimize its application. This review analyses the existing literature on slow, diaphragmatic, nasal breathing and breath-holding techniques, to propose the A52 Breath Method—a theoretically grounded approach for enhancing stress resilience. A narrative review of breathwork literature was conducted that focused on the physiological and psychological mechanisms underpinning stress reduction. Medical databases were searched: 465 articles were screened and 30 studies underwent full-text review. Studies examining slow breathing ($\leq$ 6 breaths per minute), diaphragmatic activation, nasal breathing, and breath holds were analyzed for their effects on autonomic nervous system regulation, heart rate variability (HRV), and psychological resilience. The findings indicate that slow, nasal, diaphragmatic breathing significantly improves vagal tone, HRV, parasympathetic activity, and emotional control, while reducing cortisol, anxiety, stress, and PTSD. The integration of these elements in the 5-s inhale, 5-s exhale, 2-s hold pattern (A52 Breath Method) provides a structured approach to breathwork with potential applications in high-stress professions, including emergency responders, military personnel, healthcare workers, and everyday life. The A52 Breath Method represents a novel, evidence-informed breathwork framework designed to optimize stress regulation. Future research should validate its efficacy through randomised controlled trials, particularly in populations exposed to chronic and acute stress. This conceptual model has the potential to inform clinical and occupational interventions for mental health and stress resilience.

1 | Introduction

Breathing is one of the few physiological processes that is both automatic and consciously voluntary, aligning it uniquely at the crossroads of mind and body. Across history, intentional breathing techniques or "breathwork" have been used throughout cultures to promote spirituality, emotional balance, and wellbeing. Recently, modern researchers have begun systematically analyzing the psychophysiological effects of breathing techniques and the consequent effects on stress, mental health, and autonomic regulation. Emerging evidence suggests that slow, intentional breathing can influence the autonomic nervous system through vagal innervation that leads to fluctuations in heart rate variability (HRV), cortisol, and emotional states. Breathwork has also shown clinical improvements mediated from both the "top down" (e.g. frontal cortex) and "bottom up" (e.g. physiological autonomic processes and hypothalamic-pituitary-adrenal (HPA) axis) (Wahbeh et al. 2016). However breathing techniques vary

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widely in duration, pacing, ratios, and delivery method, making it hard to distinguish which aspects are the most effective and why.

A breathing technique that is widely researched and uses the measurement of HRV is heart rate variability biofeedback (HRV–BF), which targets individual resonance frequency (around six-breaths-per-minute (bpm) pacing or 0.1 Hz) and results in increased respiratory sinus arrythmia (RSA).

RSA encompasses the short-term suppression of parasympathetic activity during inhalation as the heart rate increases, and restoration of the vagal response during exhalation and heart rate decrease (Schleicher et al. 2024). Heart rate variability is a biological marker of the autonomic nervous system and a measure of the variation in beat-to-beat cardiac intervals. HRV provides helpful insight into the balance between the sympathetic ("fight or flight") and parasympathetic ("rest and digest") nervous systems.

Frequency-domain analysis of HRV provides further insight into autonomic functioning. The high-frequency (HF) band reflects parasympathetic activity, while the low-frequency to high-frequency (LF/HF) ratio indicates sympathetic-parasympathetic balance (Malhotra et al. 2024). Increased HF-HRV has been associated with greater emotional regulation, resilience, and wellbeing, while elevated LF/HF ratios may indicate sympathetic dominance, linked to prolonged stress and mental health conditions (Jung et al. 2024; Kavitha et al. 2024).

Vagally mediated heart rate variability (vmHRV) is a measure of cardiac vagal activity and indicates good autonomic control. Further parameters include the root mean square of successive differences (RMSSD), a time-domain parameter that resembles parasympathetic activity, and HF, a frequency-domain parameter that also reflects parasympathetic activity and cardiac vagal control (Jung et al. 2024; Saito et al. 2024). The neurovisceral integration model describes the connection between HRV and emotion, and how HF-HRV indicates capacity for emotional regulation. Key brain–body networks involving the brain's prefrontal cortex (PFC), anterior cingulate cortex, insula, and amygdala work together to regulate the autonomic output via brainstem connections. The PFC, in particular, is responsible for dampening the amygdala or "fear/emotion reactivity center," inhibits medulla sympathetic arousal, and stimulates parasympathetic vagal pathways. When the PFC is functioning well, elevated HF-HRV produces improved regulation, stress resilience, and psychological flexibility (Jung et al. 2024; Smith et al. 2017; Thayer and Lane 2000).

This narrative review aims to synthesize current empirical evidence on slow breathing techniques and introduce the A52 Breath Method, a structured, evidence-informed protocol warranting future testing. As a non-pharmacological and cost-effective strategy, breathwork is promising for stress management. Yet the field remains diverse methodologically with no standardised breathing framework for optimizing outcomes. A narrative review was the chosen methodology for this paper due to the ability to synthesize broad and diverse literature on breathwork. Given that breathwork techniques differ across multiple disciplines such as psychology, physiology, holistic alternatives, and neuroscience, a narrative approach enables a subjective examination and discussion of key mechanisms and applications (Sukhera 2022). As this review introduces and evaluates the A52 Breath Method, a narrative format supports a broad, flexible, and critical analysis of existing findings while highlighting areas for future research (Baethge et al. 2019; Snyder 2019). By thematically analyzing outcomes, this review highlights gaps in the literature and evaluates the degree to which existing evidence supports the ideologies of the A52 Breath Method.

1.1 | Introducing the A52 Breath Method

The A52 Breath Method is a new unvalidated breathing protocol developed by the author, Abbie Little, through theoretical and practitioner insights while being specifically designed for mental resilience and stress reduction. It is grounded in existing physiological theory and informed by empirical research on slow breathing, vagal activation, and psychophysiological variation. The method involves a 5-s nasal inhalation, 5-s nasal or mouth exhalation, and a 2-s post-exhalation hold—repeated for 10 min to achieve five-breaths-per-minute (5-5-2 configuration).

What differentiates A52 from other methods is its even slower pacing, nasal emphasis, and brief post-exhalation hold—an aspect supported by research suggesting that post-exhalation holds may enhance relaxation and further reduce sympathetic drive (Bourdas and Geladas 2025; Zaccaro et al. 2018). While the optimal pattern and frequency of slow paced breathing remains undecided, and limited studies have isolated the effects of a 2-s pause, researchers have suggested that a delay of greater than 1 s may optimize the mitigation of stress (Sevoz-Couche and Laborde 2022). The distinctively deliberate pause in the A52 Breath Method on the exhale serves several neurophysiological functions, namely increased end-tidal carbon dioxide (CO_2), a mild controlled physiological signal that activates central chemoreceptors. This causes a parasympathetic response and supports chemoreflex resetting (a realignment to favor slower breathing and sympathovagal balance), resulting in a more stable autonomic state and enhanced interoceptive awareness (Russo et al. 2017; Zaccaro et al. 2018). Moreover, singularly using nasal breathing for the inhalation is intentional. Nasal inhalation results in greater nitric oxide (NO) delivery which positively affects vasodilation, oxygen uptake, inflammation, and autonomic regulation. Contrastingly, these effects bypass mouth breathing which results in shallow, thoracic, and sympathetic dominance, in turn exacerbating the stress response (Brems 2024).

The A52 rhythm aligns with several researched breathing techniques including slow breathing, resonance or coherence breathing, and HRV–BF which has been shown to optimize parasympathetic activity, vagal tone, baroreflex sensitivity, HRV, mental health, and stress resilience (Banushi et al. 2023; Fincham et al. 2023; Kavitha et al. 2024; Saito et al. 2024; Schleicher et al. 2024; Zhang et al. 2024). Although the literature reports variations in the inhalation and exhalation ratio (I:E), and breath hold durations, the A52 pacing provides a pragmatic yet simplified synthesis of core components repeatedly validated in the literature (Banushi et al. 2023; Fincham et al. 2023; Van Diest et al. 2014; Zaccaro et al. 2018).

While no studies to date have directly tested the 5-5-2 breathing sequence, converging evidence from slow, paced breathing, extended exhalation, nasal inhalation, and rhythm consistency protocols, including those incorporating brief pauses (e.g. Sevoz-Couche and Laborde 2022), suggests this sequence may have advantageous effects. The A52 Breath Method offers a theoretically grounded model which aims to synthesize these elements into a consistent, accessible protocol warranting further exploration.

1.2 | Research Questions

Two research questions were developed:

What is the psychophysiological effect of breathwork techniques for both the prevention and treatment of stress-related disorders?

What slow, nasal, diaphragmatic breathing methods support the development of the A52 Breath Method?

2 | Methodology

This narrative review investigates the physiological and psychological mechanisms underlying slow, nasal diaphragmatic breathing (the A52 Breath Method) and its role in stress prevention and treatment, as well as mental resilience. A structured approach using Covidence review software was employed to identify and analyze the relevant literature.

Several different collections of keywords and MeSH headings including Boolean operators ("AND" and "OR"), were used to search four medical databases on March 20, 2025 (see Table 1). The medical databases included PsycINFO (American Psychological Association), Scopus (Elsevier), CINAHL (EBSCO Information Services), and PubMed (National Library of Medicine). Manual searches and saved searches on Google Scholar were also imputed for analysis. All empirical literature across time were included to broaden the scope of literature collection and facilitate a more comprehensive understanding of breathwork.

Inclusions criteria (all must be met):

- Studies examining breathwork interventions related to stress, anxiety, PTSD, or resilience;
- Research focusing on physiological and psychological mechanisms of slow breathing for example HRV, cortisol levels, subjective stress scores, mental health improvements; and
- Peer-reviewed clinical trials, meta-analyses, and systematic reviews.

Exclusion criteria:

- Studies focusing exclusively on breathing techniques unrelated to stress regulation;
- Research on non-respiratory meditation or relaxation techniques without controlled breathing for example progressive muscle relaxation;
- Articles lacking full-text availability or published in non-English languages;
- Opinion pieces or non-empirical studies without scientific backing; or
- Studies lacking strong methodological rigor.

The search identification query returned 465 articles: 196 of these were removed as duplicates and 269 studies were independently screened based on titles and abstracts. From these, 174 studies were marked irrelevant and 93 full-text studies were screened for eligibility; then, 63 studies were further excluded as they did not meet all of the inclusion criteria, leaving 30 studies to undergo analysis (see Figure 1).

3 | Results and Overview of Included Studies

The empirical literature on breathwork techniques was reviewed. The studies included were published between 2012 and 2025, highlighting the novel resurgence of breathwork as it becomes increasingly popular. Evidently, the number of scientific studies reporting on breathing techniques has surged recently, as shown in Figure 2. Table 2 summarizes the breathwork techniques along

TABLE 1 | Concepts and keywords used in the narrative review.

Concept	Keywords/Synonyms
Breathwork	("Breathing techniques" OR "breath control" OR "diaphragmatic breathing" OR "nasal breathing" OR "slow breathing" OR "conscious breathing" OR "5–5–2 breathing" OR "breath retention" OR breathwork OR "performance breathing" OR pranayama OR "mindful breathing" OR "paced breathing" OR "controlled breathing")
Mechanisms	("Physiological effects" OR "psychological effects" OR "autonomic nervous system" OR "vagal tone" OR "heart rate variability" OR "cortisol regulation")
Stress and mental health	("Stress reduction" OR "anxiety" OR PTSD OR "burnout" OR "resilience" OR "mental wellbeing" OR "psychological stress" OR "preventive health" OR "stress prevention" OR "early intervention" OR "stress management" OR "therapeutic effects" OR "mind–body interventions" OR "stress disorders" OR "panic disorder" OR "post-traumatic stress disorder")

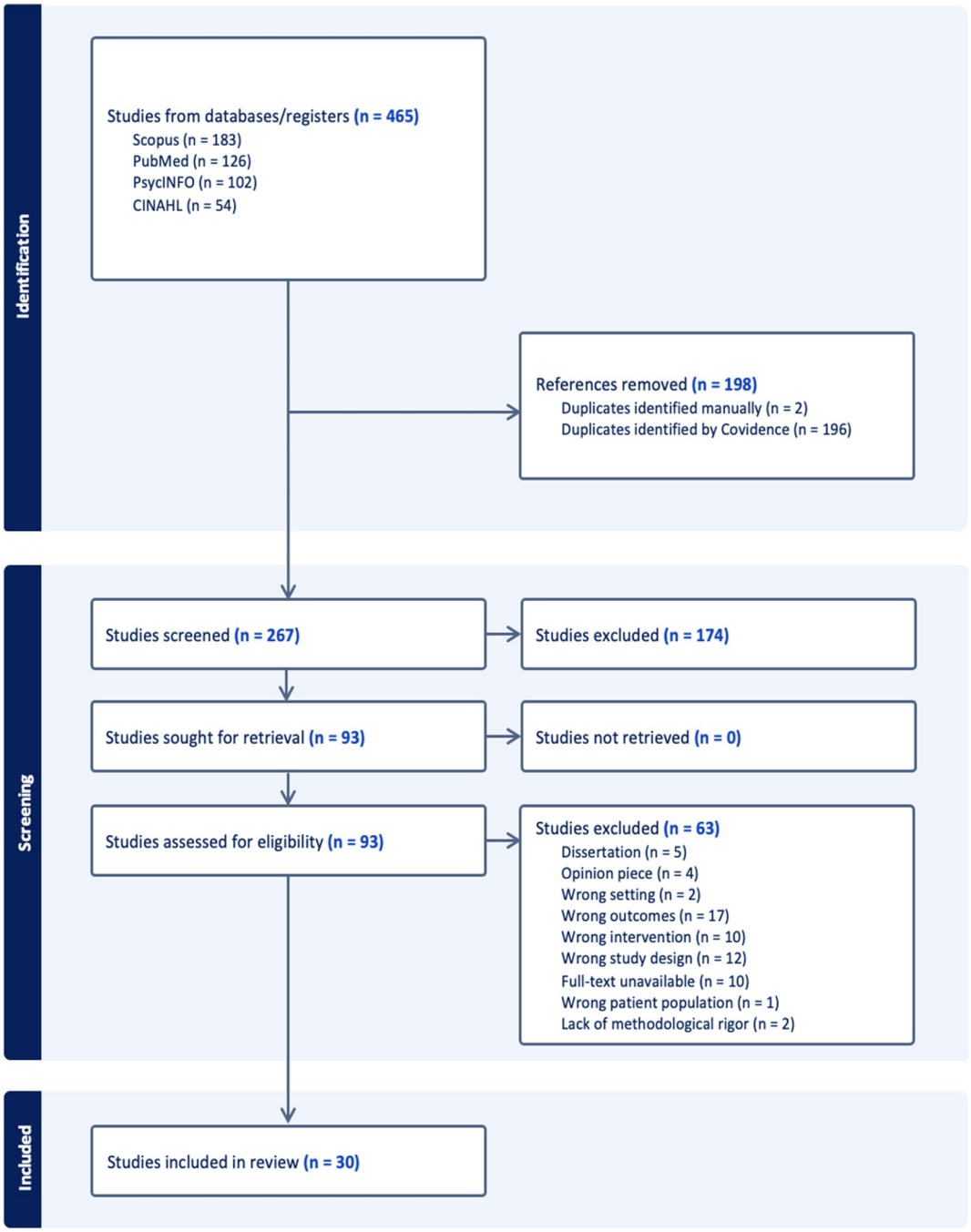


FIGURE 1 | PRISMA flow diagram for the literature selection process.

with the associated physiological and psychological effects reported across the included studies.

From the 30 articles included in the analysis, most of the experimental literature focused on slow paced breathing (12), followed by HRV–BF (6), see Figure 3.

The studies included in this review demonstrate a consistent pattern of psychophysiological benefits associated with slow and structured breathing techniques. Across the 30 included studies, HRV emerged as the most frequently reported physiological outcome, with 23 studies noting significant improvements in at least one HRV parameter (e.g. RMSSD, HF-HRV, LF/HF ratio). Decreased heart rate and respiration rate were also commonly observed, indicating parasympathetic activation. Psychologically, anxiety reduction was reported in 10 studies. Additionally, decreased perceived stress ($n = 9$), PTSD ($n = 2$), and enhanced emotional regulation ($n = 2$) was reported across clinical and healthy populations.

Several studies also reported improvements in baroreflex sensitivity, salivary cortisol, cognitive flexibility, increased brainwave frequencies, and subjective wellbeing. Breathing techniques that combined slow breathing with guided delivery or additional physiological cues such as visual pacing, yielded stronger and more consistent results. However, the degree of benefit varied, with some studies finding no significant changes in certain psychological or physiological markers, particularly

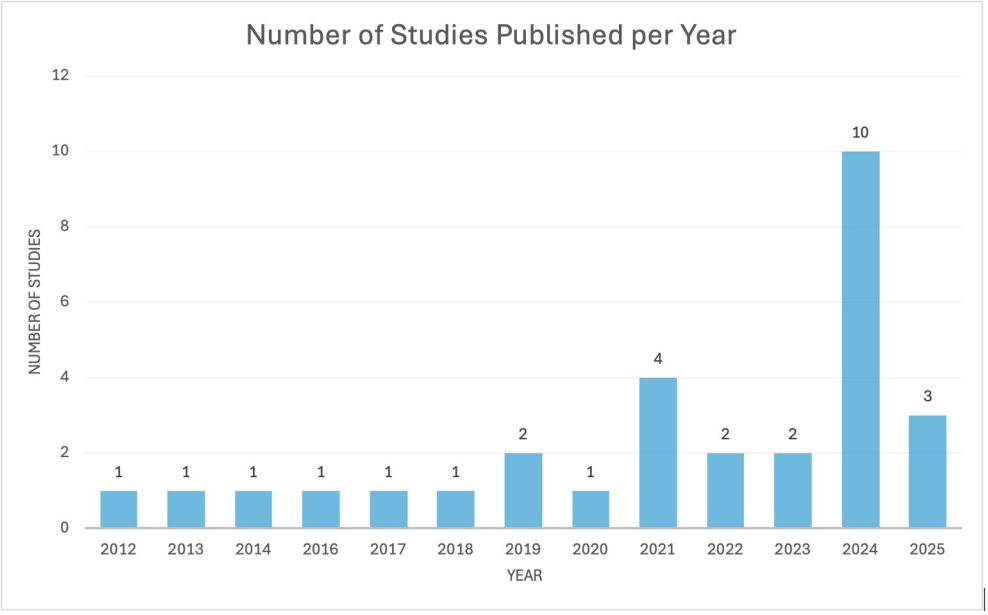


FIGURE 2 | The number of included breathwork studies published by year.

when intervention fidelity was low. Despite these generally positive trends, the methodological diversity among these studies, such as differences in breathing rates (ranging from 4 to 6.5bpm), breathing ratios (e.g. 4-2-4, 5-5, 6-0-6), and delivery methods (e.g. self-guided apps, instructor-led sessions, biofeedback tools), highlighted the challenge of drawing standardized conclusions. Moreover, measurement tools varied, including both physiological (i.e. HRV, EEG, and cortisol) and psychological instruments (i.e. PSS and STAI). This variability reinforces the need for structured protocols like the A52 Breath Method, which aims to unify pacing, breathing pattern, and delivery for consistent replication.

4 | Discussion

4.1 | Physiological Effects of Breathwork

Many studies focusing on slow, nasal and/or diaphragmatic breathing consistently demonstrated enhanced autonomic regulation via vagal innervation. Increases in HF-HRV, standard deviation of normal-to-normal heartbeats (SDNN; overall variability in heart beats, indicating cardiovascular health and stress management), RMSSD (a marker of parasympathetic activity), and reduction in the LF/HF ratio (a measure of balance between sympathetic and parasympathetic nervous systems) were found across long and short study durations (De Couck et al. 2019; Prinsloo et al. 2013; Saito et al. 2024; Schleicher et al. 2024; Van Diest et al. 2014; Yetwin et al. 2022). These increases in parasympathetic tone were replicated still in single 2-min and 5-min breathing sessions (Magnon et al. 2021; Pozzato et al. 2025). Longitudinal studies, while few, showed sustained improvements in resting HRV, parasympathetic dominance, and baroreflex sensitivity, indicating a lasting effect (Jung et al. 2024; Kavitha et al. 2024). Slow breathing and deep diaphragmatic breathing was also shown to reduce cortisol levels (Maniaci et al. 2024), especially when paired with touch (Dada et al. 2024). Many of these changes occurred across healthy, clinical, and trauma-affected populations, suggesting broad therapeutic relevance, from corporate industries to emergency responders. While the majority of studies administered breathing rates at 6 bpm or 0.1 Hz, one study demonstrated that the greatest increase in LF-HRV was found at 5.5 bpm (You et al. 2024).

Slow breathing practices resulted in reduced resting respiratory rate, trending toward spending more time in the parasympathetic nervous state which is unakin to modern society's increasing respiration (Balban et al. 2023; Daniel-Watanabe et al. 2025; Wahbeh et al. 2016). Moreover, greater physiological and psychological gains were found in those with higher resting respiratory rates and psychological distress, as well as those who practiced their technique more frequently (Balban et al. 2023; Pozzato et al. 2025). There is much debate regarding the inhalation/exhalation ratio, stating that prolonging the exhale is superior. When directly compared, the RCT by Birdee et al. (2023) showed no significant differences found in measures of HRV between inhalation = exhalation and inhalation < exhalation slow breathing. Additionally, reductions in RSA occurred during slow rhythmic breathing practices (Van Diest et al. 2014); however, they did not occur during box breathing or prolonged exhalation (2:8 ratio).

Regarding neurology, increases were found in delta, theta, alpha, and beta EEG power during slow breathing when compared to fast breathing. This suggests a uniquely induced globally integrative dual brain state that is both calm but awake (Luo et al. 2025); moreover, it implies decreased overactivation (i.e. stress), calm focus, relaxation, and enhanced parasympathetic tone. Slow breathing also enhances top-down emotional regulation by improving amygdala (fear and reactivity center) and medial prefrontal cortex connectivity (regulatory center) in the brain (Jung et al. 2024) Interestingly, larger effects were found in older adults and women who practiced slow breathing (Jung et al. 2024; Magnon et al. 2021).

TABLE 2 | Study identification, breathing technique, characteristics, psychophysiological effects, and key findings.

Study	Breathing technique	Study characteristics	Physiological effects	Psychological effects	Key findings
Balban et al. (2023)	Cyclic sighing (prolonged exhale), box breathing (equal ratio), cyclic hyperventilation w/ retention; 5 min/day for 28 days delivered remotely	Design: RCT Population: Healthy adults Duration: 28 days Sample Size: 114	• Decreased respiratory rate (most in cyclic sighing); no significant change in HRV or resting heart rate	• Increased positive affect (especially in cyclic sighing group) • Decreased state anxiety and negative affect in all groups	Breathwork is more effective than mindfulness meditation for improving mood and reducing respiratory rate; cyclic sighing was most effective. No changes in sleep were observed in any group. Greater adherence led to greater benefit.
Birdee et al. (2023)	Slow breathing: Exhale (E) = inhale (I) versus E > I. 12 weekly 45 min instructed classes + daily at home practice. Respiratory rate not set	Design: RCT Population: adults Duration: 12 weeks Sample Size: 100	• No significant difference in HF-HRV or RMSSD between $E = I$ and $E > I$ • Both groups trended upwards in vagal HRV but not statistically significant	• Decreased anxiety scores in both groups; small, non-significant further decreased in $E > I$ group (−5.37 vs. −4.30, $p = 0.350$)	Slow breathing (regardless of ratio) significantly reduced anxiety; $E > I$ did not significantly outperform $E = I$ for either physiological or psychological stress.
Chin and Kales (2019)	Paced breathing (5s inhale, 5s exhale; 0.1 Hz) versus rhythmic muscle contraction versus combined breathing + contraction; single 5-min session; 6bpm	Design: Pilot RCT Population: Healthy males Duration: single session Sample Size: 48	• Increased HF-HRV (parasympathetic) in combined group (150% > control, 45.9% > contraction alone) • Decreased LF and LF/HF in contraction and combined groups	• No significant mood or engagement changes • Cognitive performance unaffected	Synchronised breathing + contraction produced the strongest parasympathetic response under stress. Breathing alone not significantly better than control. Suggests breathing alone may not be enough for pre-stress vagal priming.
Dada et al. (2024)	"365 breathing:" 6 bpm for 5 min, three times daily	Design: RCT Population: Glaucoma patients Duration: 6 weeks Sample Size: 80	• Decreased Serum cortisol • Increased RMSSD • Decreased LF/HF ratio • Increased delta HR and E:I ratio	• N/a	365 breathing significantly improved parasympathetic tone, and cortisol, and enhanced autonomic function.
Daniel-Watanabe et al. (2025)	Paced breathing (5s inhale, 5s hold, 5s exhale) taught via VR game; 4bpm	Design: RCT Population: Healthy participants Duration: days Sample Size: 71	• Increased HRV under stress • Decreased respiration rate	• N/a	VR breath training improved HRV and respiration under stress; strongest HRV gains seen in those most adherent to breathing.

(Continues)

TABLE 2 | (Continued)

Study	Breathing technique	Study characteristics	Physiological effects	Psychological effects	Key findings
De Couck et al. (2019)	Paced breathing (5–2–5 symmetric vs. 5–2–7 skewed); guided by Biotrace device; single 5-min session	Design: Study 1—within-subjects ($n = 30$) Study 2—RCT ($n = 56$) Population: students Duration: single sessions	• Increase SDNN, RMSSD, LF power • Skewed breathing (5–2–7) trended higher but not significantly better than symmetric • No HF changes	• Decreased perceived stress post-task in breathing group versus. increased in controls • Breathing group performed 47% better on decision-making task	Both breathing patterns increased vagal HRV; skewed exhale breathing before stress improved decision accuracy under pressure. Larger exhale leads to improved decision-making under pressure.
de Wit and Moraes Cruz (2021)	Extended connected breathing (no pauses between breath); 8 sessions at avg. 54.6 min	Design: Clinical case study Population: fire fighter Duration: 7 months Sample Size: 1	• Decreased HRV (parasympathetic markers), hypothesized release from fear-based immobility and dissociation • Restoration of natural autonomic balance as trauma was processed	• Decreased PTSD, anxiety, depression	The participant's PTSD symptoms went into full remission. Anxiety and depression symptoms decreased significantly. There was a decrease in parasympathetic activity (decreased RMSSD, decreased HF) —indicating the participant was emerging from a trauma-induced freeze state, not becoming more stressed.
Fonkoue et al. (2020)	Device guided slow breathing ~ 5bpm; 15 min per day. Sham group at 14 bpm	Design: RCT Population: Veterans with PTSD Duration: 8 weeks Sample Size: 29	• Decreased muscle sympathetic nerve activity reactivity to stress • No change in resting BP, HR, HRV, or baroreflex sensitivity	• No significant changes in PTSD symptom scores	Device guided slow breathing significantly reduced sympathetic nerve activity response to acute mental stress without changing resting measures.
Herhaus et al. (2022)	HRV–BF (0.1-Hz breathing); 20 min twice daily. Sham group had no specific pacing	Design: RCT Population: Individuals with panic disorder Duration: 4 weeks Sample Size: 52	• Increased HRV • Decreased HR	• Decreased panic and agoraphobia symptoms	Supports HRV–BF as a non-invasive and nonpharmacological treatment to improve reduced HRV and decrease panic symptoms in those with panic disorder. Comparable to slow breathing (5-6 bpm). HRV–BF Sham group showed no effect.

(Continues)

TABLE 2 | (Continued)

Study	Breathing technique	Study characteristics	Physiological effects	Psychological effects	Key findings
Jung et al. (2024)	HRV–BF (~6bpm); 10–20 min twice daily and 10 sessions at a medical facility	Design: RCT Population: Young and old adults Duration: 5 weeks Sample Size: 165	• Increased RMSSD • Increased LF-HRV • Increased resonance frequency power (0.063–0.125 Hz) • Increased resting HRV and vagal tone mediated improvements	• Decreased negative emotions	Breathwork improved baseline nervous system regulation (resting HRV) and negative emotions. Breathing group also improved amygdala–medial prefrontal cortex connectivity suggesting neural emotion regulation pathways.
Kavitha et al. (2024)	Pranayama (supine) for 30–35 min daily; pacing unspecified	Design: RCT Population: Anxiety disorder patients Duration: 8 weeks Sample Size: 140	• Increased HRV • Increased parasympathetic dominance • Increased baroreflex sensitivity	• N/a	Pranayama improves cardiac autonomic function while shifting toward parasympathetic predominance and increasing HRV.
Laborde et al. (2017)	Slow-paced breathing at 6bpm (4.5s inhale, 5.5s exhale) using visual pacer; single 17-min session	Design: Within-subject experimental Population: Adolescents with intellectual disabilities Duration: single session Sample Size: 14	• Increased RMSSD during cognitive stress task versus Control (audiobook) • Indicates increased vagal tone	• N/a	Slow-paced breathing led to significantly higher vagal tone during stress.
Luo et al. (2025)	Slow breathing: 6s inhale, 6s exhale (5 bpm); compared to fast breathing (2s in, 2s out); 30s sessions during threat uncertainty task	Design: Within-subject Population: Female university students Duration: single sessions Sample Size: 25	• Decreased HR during slow breathing • Increased delta, theta, alpha, and beta EEG power during slow breathing • Decreased beta power during anticipatory anxiety (uncertain threat) during slow breathing	• Decreased valence and arousal ratings (reduced emotional intensity) during slow breathing across certain and uncertain conditions	Slow breathing reduced subjective and physiological anxiety responses. Beta desynchronization linked to reduced cognitive effort under uncertainty, suggesting slow breathing preconditions the brain to regulate uncertainty better.
Magnon et al. (2021)	Deep and slow breathing; 4s inhale, 6s exhale (5bpm); guided by visual pacer; single 5-min session	Design: Within-subject Population: Young and old adults Duration: single session Sample Size: 47	• Increased HF-HRV (increased vagal tone) (larger effect in older adults) • No change in RMSSD	• Decreased state anxiety in both young and older adults • Anxiety reduction correlated with increased HF-HRV	A 5-min deep slow breathing session effectively boosted vagal tone and reduced anxiety in both age groups, with greater HF-HRV gains in older adults.

(Continues)

TABLE 2 | (Continued)

Study	Breathing technique	Study characteristics	Physiological effects	Psychological effects	Key findings
Malhotra et al. (2024)	Kapalbhati pranayama (5 min of forceful exhalations with diaphragmatic and abdominal muscle engagement); > 30bpm	Design: Prospective intervention study Population: Healthy adults Duration: 8 weeks Sample Size: 20	• Decreased RMSSD • Increased LF/HF ratio during Kapalbhati (suggests increased SNS activity) • Decreased HR versus Baseline	• Increased beta and gamma EEG activity • Decreased delta and theta waves after Kapalbhati indicating increased brain stimulation and alertness	Kapalbhati mildly reduced HRV but strongly increased EEG beta/gamma activity, suggesting cognitive arousal without significant sympathetic overload.
Maniaci et al. (2024)	Neo-functional deep breathing (NDB); diaphragmatic breathing at ~6 bpm with physical touch; 30 min, single session	Design: Pilot RCT Population: Healthy adults Duration: single session Sample Size: 40	• Increased RMSSD • Increased abdominal respiratory amplitude • Decreased bpm • Decreased cortisol • Decreased inflammatory cytokines	• Decreased state anxiety and perceived stress post-intervention in both groups (not group-specific)	NDB group showed significant parasympathetic activation and anti-inflammatory effects post-stress.
Palve and Nithiya Devi (2018)	Pranayama; 5-min sessions, four cycles (2:1:2:1 ratio—pacing unspecified)	Design: Quasi-experimental Population: medical undergraduates Duration: 2 h Sample Size: 250	• N/a	• Decreased stress • Decreased anxiety (did not reach significance)	Pranayama can immediately reduce stress and anxiety.
Park et al. (2024)	HRV–BF (~6 bpm); 20 min twice daily	Design: Single-arm proof-of-concept trial Population: Adults with psoriasis Duration: 7 weeks Sample Size: 5	• N/a	• Decreased anxiety • Increased quality of life • No significant change in depression	HRV–BF reduced anxiety and improved quality of life.
Pozzato et al. (2025)	Slow-paced breathing (6 bpm, 5:5 I:E ratio); single 2-min session; visual pacing	Design: Controlled cohort study Population: Injured and non-injured adults Duration: single session Sample Size: 232	• Increased RMSSD, HF, SDNN, LF, total power • Greater gains in those with higher psychological distress or higher resting respiratory rate	• N/a	Slow-paced breathing enhanced vagal HRV and parasympathetic activity across all groups. Individuals with high distress or faster resting respiratory rate showed the largest HRV gains.

(Continues)

TABLE 2 | (Continued)

Study	Breathing technique	Study characteristics	Physiological effects	Psychological effects	Key findings
Prinsloo et al. (2013)	HRV–BF -induced deep breathing at ~0.1 Hz (6 bpm) for 10 min; single session	Design: Pilot RCT Population: Stressed males Duration: single session Sample Size: 18	• Increased LF power, SDNN during breathing • Increased RMSSD and HF power maintained during stress (post-intervention) • Decreased HR response to stress	• Increased relaxation decreased anxiety • Increased cognitive performance (faster, more accurate)	Single HRV-biofeedback session improved HRV and stress response during subsequent rest and cognitive stress; better performance and relaxation.
Röttger et al. (2021)	Combat Tactical breathing (TB) (4:4:4:4 ratio with breath holds) versus Prolonged exhalation (2:8 ratio)	Design: Within-subject experimental Population: Military students Duration: days Sample Size: 30	• TB decreased HR and skin conductance more than prolonged exhalation during stress • No significant changes in HRV (RMSSD/RSA) for either	• No significant differences between TB and prolonged exhalation on subjective mood/strain	TB more effective at lowering physiological stress (HR, skin conductance level). Prolonged exhalation led to faster and more accurate task performance.
Saito et al. (2024)	HRV–BF (4.5 bpm - 6.5 bpm) versus sham group (10-14 bpm); 10 x 20-min sessions	Design: RCT Population: students Duration: 3 weeks Sample Size: 40	• Increased vagally mediated HRV	• There was no significant difference in anxiety between groups. They both decreased.	The results indicate increased resting vagally mediated HRV after HRV–BF training. There was no difference in anxiety symptoms between the intervention and active control group who practiced alternate paced abdominal nasal breathing. They both decreased. This suggests HRV feedback is not necessary and nasal, abdominal and paced breathing is inherently beneficial.
Schleicher et al. (2024)	App-guided heart coherence breathing (5s inhale, 5s exhale, no pause); 5 min session after Trier Social stress test; 6bpm	Design: RCT Population: Adolescents Duration: single session Sample Size: 73	• Increased LF and LF/HF HRV during relaxation (indicating vagal/baroreflex engagement) • No change in RMSSD or HF	• Decreased cortisol recovery and subjective stress higher in breathing versus No breathing groups • App group showed less subjective improvement than natural breathing	App-guided slow breathing elevated LF-HRV and LF/HF ratio post-stress; may aid stress recovery via vagal modulation, though perceived as less pleasant than natural breathing.

(Continues)

TABLE 2 | (Continued)

Study	Breathing technique	Study characteristics	Physiological effects	Psychological effects	Key findings
Solarikova et al. (2021)	Controlled slow breathing at 6 bpm (with no feedback) versus HRV–BF	Design: RCT Population: Healthy young adults Duration: 10 weeks Sample Size: 75	• Decreased HR and increased LF/HF ratio in post-intervention stage (within-subject) • No significant HRV parameter changes between groups	• No significant change in perceived stress scores between or within groups	Neither biofeedback nor slow breathing produced significant improvements in HRV or stress scores versus Control.
Van Diest et al. (2014)	Slow breathing (6 bpm) versus normal rate (12 bpm) with low versus high inhalation/exhalation (I/E) ratio	Design: Quasi-experimental Population: students Duration: single sessions Sample Size: 23	• Increased RSA and HF-HRV at 6 bpm with low I/E ratio • Increased LF-HRV at 6 bpm • Increased HR with low I/E ratio	• Increased relaxation, mindfulness, positive energy, stress reduction with low I/E ratio • Increased positive energy at 6 bpm	Low I/E ratio was the strongest predictor of improved relaxation and HRV effects; slow breathing alone had modest impact unless paired with low I/E.
Wahbeh et al. (2016)	Slow breathing (SB) with device; MM + SB (mindful awareness + intention to slow breath); MM (mindful meditation) body scan	Design: RCT Population: Veterans Duration: 6 weeks Sample Size: 102	• Decreased resting respiration (MM, MM + SB vs. Control) • No change in HR or HRV between groups • MM decreased cortisol within-group	• Decreased PTSD symptoms (MM and MM + SB)	Modest but clinically relevant PTSD symptom reductions in MM arms; most benefits seen in MM alone; SB less effective alone. Having intention behind the breath boosts effectiveness.
Wells et al. (2012)	Slow breathing (6 bpm) with and without HRV–BF; 5-min session	Design: RCT Population: Musicians Duration: single session Sample Size: 46	• Increased HF-HRV and decreased LF/HF ratio during anxious anticipation post-intervention (in intervention group only)	• Decreased state anxiety (STAI-S) in high-anxious individuals following intervention	One session of slow breathing (with or without biofeedback) increased HRV and reduced anxiety in high-anxious individuals.
Yetwin et al. (2022)	HRV–BF; 30–60-min treatment sessions; 10 min per day at home sessions	Design: RCT Population: Children Duration: 4 weeks Sample Size: 21	• Increased HRV	• Decreased chronic pain	Participants experience increased HRV and decreased pain.
You et al. (2024)	Slow-paced breathing at 5, 5.5, 6, 6.5, and 7 cycles per minute (cpm); 5-min sessions; nasal inhale, mouth exhale	Design: Within-subject experimental Population: athletes Duration: single sessions Sample Size: 75	• Increased cardiac vagal activity (CVA) across all slow breathing conditions • Greatest increased in LF-HRV at 5.5 cpm	• N/a	All SPB frequencies significantly increased CVA compared to control, however 5.5cpm showed the greater increase in LF-HRV.

(Continues)

TABLE 2 | (Continued)

Study	Breathing technique	Study characteristics	Physiological effects	Psychological effects	Key findings
Zhang et al. (2024)	Quick coherence technique (QCT) with HRV–BF; 6–10cpm	Design: Quasi-experimental Population: Commercial pilots Duration: 4 weeks Sample Size: 44	• Decreased stress Index (in day-to-day life and in-flight) increased LF/HF ratio no significant change in RMSSD	• Increased stress resilience, emotional regulation, potential cognitive enhancement	QCT significantly lowered stress and increased sympathetic activation (LF/HF), promoting resilience and cognitive readiness.

Abbreviations: Bpm = breaths per minute; cpm = cycles per minute; CVA = cardiac vagal activity; HF = high frequency (in relation to HRV); HF-HRV = high frequency heart rate variability; HR = heart rate; HRV = heart rate variability; HRV–BF = heart rate variability bio-feedback; LF = low frequency (in relation to HRV); LF/HF = low frequency/high frequency ratio; LF-HRV = low frequency heart rate variability; PTSD = post-traumatic stress disorder; RCT = randomised controlled trial; RMSSD = root mean square of successive differences; RSA = respiratory sinus arrhythmia; SDNN = Standard Deviation of Normal-to-Normal interbeat intervals; SPB = slow paced breathing; vm-HRV = vagally-mediated HRV.

4.2 | Psychological Effects of Breathwork

Across the empirical literature, slow and deep breathing were associated with several significant psychological improvements, such as anxiety, perceived stress, positive affect, and mood regulation (Birdee et al. 2023; De Couck et al. 2019). In particular, HRV–BF at 6 bpm resulted in decreased panic symptoms, negative emotions, anxiety, and chronic pain while increasing quality of life, relaxation, stress resilience, and cognitive performance (Herhaus et al. 2022; Jung et al. 2024; Park et al. 2024; Prinsloo et al. 2013; Yetwin et al. 2022; Zhang et al. 2024). Interventions ranging from 2-min sessions (Pozzato et al. 2025) to longitudinal 12 weeks (Birdee et al. 2023) produced reductions in state anxiety, depression, negative affect, and even resulted in complete remission of PTSD symptoms (de Wit and Moraes Cruz 2021). These effects were often facilitated by changes in vagally mediated HRV, linking physiological mechanisms with psychological benefit, further supporting the growing body of evidence that breathing is an effective and accessible tool for mental wellbeing and stress resilience (Jung et al. 2024). However, while some studies found robust benefits to mental wellbeing, others reported only modest changes, indicating variability based on session frequency and level of instruction (Fonkoue et al. 2020).

4.3 | The A52 Breath Method

After synthesizing the literature, a wide variety of empirical studies provide compelling support for the A52 Breath Method, which consists of a 5-s inhale, 5-s exhale, and 2-s post-exhalation hold, with this structure mirrored in several effective breathing techniques. As shown in Figure 4, 67% of breathing techniques, including slow breathing techniques, resonant/coherence breathing, and HRV–BF, strongly align with the A52 Breath Method. Despite their varied design, several studies using slow-paced breathing such as 6 bpm, all demonstrate significant improvements in HRV, RMSSD, HF-HRV, vagal tone, cortisol, inflammation, and emotional regulation under stress (Daniel-Watanabe et al. 2025; Maniaci et al. 2024; Pozzato et al. 2025; You et al. 2024). Numerous HRV–BF studies have confirmed that even without technology, slow, nasal, diaphragmatic breathing can produce measurable physiological benefits objectively aligned with A52 Breath Method, as well as psychological such as agoraphobia and negative emotions (Herhaus et al. 2022; Jung et al. 2024; Saito et al. 2024).

Complementary evidence from studies using resonance or coherence breathing (Schleicher et al. 2024; Zhang et al. 2024) and pranayama (Kavitha et al. 2024; Palve and Nithiya Devi 2018) have further underscored the significance of breath pacing and nasal flow—hallmarks of A52. Interestingly, even single sessions of as low as 2-min of slow breathing resulted in increased HRV, suggesting breathwork is accessible, cost-effective, and convenient (Magnon et al. 2021; Pozzato et al. 2025; Wells et al. 2012). Overall, the A52 Breath Method offers a promising framework for future research and application with a structure validated by experimental literature. This practical and standardised self-regulation tool that may be suitable for both clinical and self-guided digital applications in households and high-performance fields.

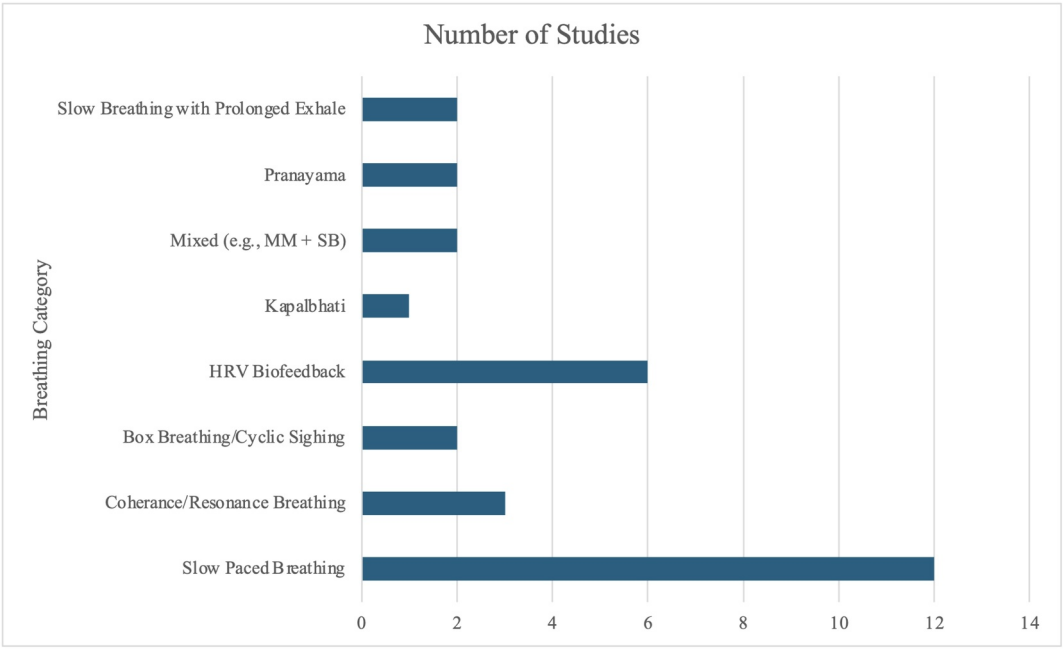


FIGURE 3 | The number of studies categorized by breathing technique.

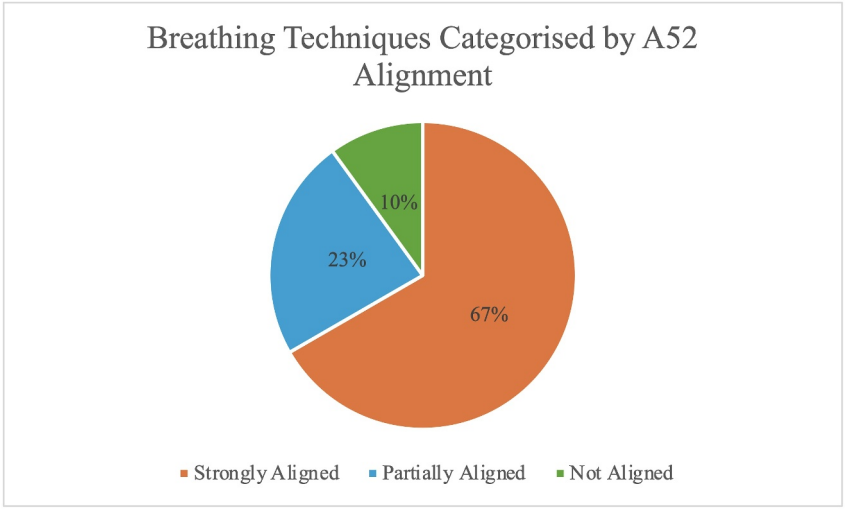


FIGURE 4 | Breathing techniques included in the analysis as categorized by A52 alignment Figure 4 classifications were determined on the degree of similarity to the novel A52 breath method, which emphasizes slow nasal diaphragmatic breathing (5-s inhale, 5-s exhale), with a post-exhalation hold and a focus on simple, repeatable daily practice. Techniques were categorized as "Strongly Aligned" if they met most of these criteria. This included nearly all slow-paced breathing techniques at 5:5 ratios, as well as HRV biofeedback. Techniques with a prolonged exhale (e.g. 4:6 ratio), or that were derived from other traditions but partly overlapped with A52 (e.g. Pranayama), were considered "Partially Aligned". Hyperventilation based methods (e.g. Kapalbahti), box breathing, and techniques that lacked a physiological or theoretical resemblance to A52 were categorized as "Not Aligned". Alignment ratings were based on an internal analysis table developed to systematically assess consistency across protocol structure, breathing category, and underlying mechanisms.

4.4 | Trends

Large discrepancies can be found across the literature, often reporting conflicting results. Some say that certain breathing practices are largely beneficial, and others say they do not reach significance; therefore, the method of delivery, instruction, and intervention adherence should be assessed and analyzed to achieve congruency. Interestingly, practices involving HRV–BF resulted in significant positive results 100% of the time. Yet, when compared directly with slow breathing interventions without HRV–BF they did not outperform, leading A.Little to recommend that feedback devices may not be necessary (Saito et al. 2024; Wells et al. 2012). This is ironic when in other studies some "subjective" slow breathing results did not reach significance (Chin and Kales 2019). This suggests that perhaps a proper hands-on approach to instruction and sufficient training

intensity can elicit greater effect, and alternatively leaving participants to learn from digital means may not (Solarikova et al. 2021). This requires further exploration.

One of the most prominent limitations observed across the reviewed studies is the lack of standardization in breathing instruction. Although slow breathing consistently yielded beneficial outcomes, that variation in pacing which ranged from 4 to 7 breaths per minute, inhale/exhale ratios, and presence or absence of breath holds contributed to methodological inconsistency. Some studies used audio or visual pacing aids, whereas others relied on self-guided pacing, in person instruction, VR, app-based or didn't report the specific breathing pattern at all. This inconsistency reduces the replicability and cross-study comparisons. These issues highlight the need for replicable, theory-derived breathing protocols, such as the A52 Breath Method, which offers a clearly defined pattern (5-s inhale, 5-s exhale, 2-s post-exhalation hold), nasal emphasis, and consistent pacing at 5 breaths per minute. By offering a standardized yet physiologically grounded framework, A52 helps address the current fragmentation in breathing research whilst laying the foundation for robust future trials and meta-analyses.

5 | Gaps and Future Research Directions

Overall, research into breathwork is in its infancy yet increasing markedly. Breathwork encompasses hundreds of different techniques, which may be its Achilles heel. A lack of standardization exists in breathing protocols, from timings and ratios to session length and delivery method. This makes it difficult to isolate which breathing features are most effective and for researchers to replicate and refine outcomes. Limited research exists on brief breath hold retention, especially following the exhalation. A lack of direct comparison between nasal breathing and mouth breathing, as well as directly comparing upper chest breathing and diaphragmatic breathing, also demonstrates a gap in comparative studies.

Single-session studies dominate: the literature lacks high-quality, longitudinal, randomised controlled trials with active control groups. In an unregulated and fast-growing industry, defined breathwork techniques require more stringent high-powered investigations to determine the most effective techniques to be recommended to companies and individuals to help combat stress. Breathwork is clearly beneficial, and further high-quality designs with clinical trials and physiological monitoring are required to help promote breathwork as a cost-effective, upstream, top-down and bottom-up approach to mental health and stress resilience. As for the novel A52 technique, this will require adequately powered randomised controlled trials to test its efficacy subjectively and objectively before being implemented as a tool to combat mental health and increase resilience.

Future research should standardize and report breathing protocols in full (including I:E ratio, BPM, nasal vs. mouth breathing, use of breath holds, etc.), compare multiple breath styles head-to-head, use diverse samples to enhance generalizability, be longitudinal to track cumulative effect, incorporate objective measures (e.g. HRV, EEG, cortisol, amygdala activity), and test structured models like the A52 Breath Method.

5.1 | Conclusion

While the existing literature on the psychophysiological effectiveness of breathwork is in its infancy, the current results are promising. This review highlights the growing consensus that slow, nasal, diaphragmatic breathing is a powerful tool for regulating stress and enhancing autonomic balance, while having consistent associations with improved HRV, vagal tone, and reduced stress and mental illness.

The A52 Breath Method, with its 5-5-2 pacing, bridges theory with real-world applicability, aligning closely with the most effective protocols in the literature. It is an accessible and cost-effective tool for personal and clinical use, particularly in high-stress industries. Future research should validate the A52 Breath Method through longitudinal and rigorous research, while utilizing head-to-head comparisons with other breathing protocols, in order to investigate its objective and subjective effects on psychological and physiological outcomes.

Author Contributions

Abbie L. Little: conceptualization, methodology, data curation, formal analysis, investigation, writing – original draft, and writing – review and editing.

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Consent

The author has nothing to report.

Conflicts of Interest

The author declares no conflicts of interest.

Data Availability Statement

The original analysis table generated and/or analysed during the current study are available from the corresponding author on reasonable request.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

During the preparation of this work, the author AL used AI to assist with structuring sections and other non-intellectual aspects of

manuscript preparation. The use of this tool was confined to language support only. All intellectual content, study design, analysis, interpretation, and conclusions were generated and verified by the author. The author takes full responsibility for the integrity and originality of the work presented.

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