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Effects of a Buteyko breathing programme on reducing anxiety sensitivity and perceived stress in a sample of university students

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Abstract
This study analysed the effects of a Buteyko breathing programme (BBP) on anxiety sensitivity and perceived stress in a sample of university students. Forty-one students from the Faculty of Education at the University of Almería took part, randomly assigned to an experimental group (n = 21) and a control group (n = 20). A quasi-experimental design with pre-test and post-test measurements was used, employing the Anxiety Sensitivity Index (ASI-3) and the Perceived Stress Scale (PSS). The intervention programme lasted ten weeks and included theoretical and practical sessions on respiratory re-education, with guided exercises in nasal breathing, reduction of tidal volume and control of breathing pauses.
The results showed statistically significant reductions in anxiety sensitivity (particularly in its physical and cognitive dimensions) and in perceived stress in the experimental group, whilst the control group showed no significant changes. Effect sizes were high for cognitive worry (d = 1.34) and total anxiety sensitivity (d = 1.22), and moderate for perceived stress (d = 0.821). These findings confirm the efficacy of Buteyko breathing as a strategy for emotional self-regulation and the reduction of psychological distress in educational contexts.
From an educational perspective, the study highlights the value of integrating structured breathing practices as pedagogical tools for wellbeing and emotional learning in higher education. Buteyko breathing is presented as a brief, accessible and low-cost intervention, capable of promoting self-regulation, body awareness and adaptive coping with academic stress. Future research is proposed, focusing on its institutional implementation and the evaluation of its long-term impact.

Keywords: Buteyko breathing; anxiety; perceived stress; emotional self-regulation; student wellbeing; higher education

Introduction

University life is a period of profound personal, social and academic changes that can significantly increase vulnerability to stress and anxiety disorders. Various studies have shown that university students experience high levels of anxiety and perceived stress, attributable to academic pressure, career uncertainty, changes in support networks and, more recently, the psychological aftermath of the COVID-19 pandemic (Dresen et al., 2025). A global review conducted by Tan et al. (2023) estimated that the average prevalence of anxiety amongst university students is 32 per cent, ranging from 7.4 per cent to 55 per cent, highlighting a mental health issue of considerable magnitude. Similarly, Barbayannis et al. (2022) observed that high academic stress is associated with higher levels of psychological

distress and a significant deterioration in general well-being. Pérez-Jorge et al. (2025) confirmed that task overload, peer competition and a lack of effective coping strategies are factors that contribute to perceived stress, affecting both academic performance and mental health.

Perceived stress is defined as the subjective assessment of environmental demands as unpredictable, uncontrollable or overwhelming (Cohen et al., 1994). High levels of perceived stress have been linked to sleep disorders, risk-taking behaviours and a higher incidence of anxiety and depressive symptoms among students (Fruehwirth et al., 2023). These findings highlight the need for interventions that reduce physiological and emotional reactivity to stress, thereby promoting autonomic regulation and emotional self-regulation.

At the same time, anxiety is one of the most common psychological problems amongst university students. Anxiety is not only expressed as excessive worry or anticipatory fear, but also involves a range of physiological symptoms related to autonomic arousal, such as tachycardia, shortness of breath, dizziness and a feeling of tightness in the chest. In this context, a particularly relevant construct is anxiety sensitivity, defined as the fear of sensations associated with anxiety, based on the belief that these sensations may have dangerous or negative consequences (Taylor, 1995).

Anxiety sensitivity is closely linked to the perception of interoceptive signals, particularly those related to breathing and the concentration of carbon dioxide (CO_2) in the blood. People with high anxiety sensitivity tend to interpret normal physiological sensations (such as a slight increase in respiratory rate or palpitations) as danger signals, which perpetuates the cycle of anxiety and fear. This phenomenon has been extensively described in the context of panic and functional respiratory disorders (Leyro et al., 2021). In this regard, breath control and improved CO_2 tolerance emerge as potentially effective strategies for reducing interoceptive hypervigilance and the anxiety response.

From a physiological perspective, hyperventilation (whether episodic or chronic) can lower the partial pressure of CO_2 in the blood, leading to respiratory alkalosis and causing symptoms such as dizziness, tingling, muscle stiffness, a feeling of shortness of breath or depersonalisation. These symptoms, in turn, may be interpreted in a catastrophic manner, fuelling anxiety and the perception of a loss of control (Boulding et al., 2016; Vidotto et al., 2019). Hypocapnia is also associated with alterations in cerebral blood flow and increased neuronal excitability, which can intensify emotional reactivity. Therefore, normalising ventilation and increasing CO_2 tolerance can have a significant impact on reducing anxiety and perceived stress.

Experimental evidence has shown that Capnometry-Assisted Respiratory Training (CART), a technique based on biofeedback of exhaled CO_2 ($ETCO_2$), is effective in reducing panic attacks and fear of bodily sensations (Meuret et al., 2010; Jamison et al., 2019). In these studies, training to gradually increase exhaled CO_2 led to significant improvements in anxiety symptoms and in sensitivity to interoceptive sensations. These findings support the hypothesis that increasing CO_2 tolerance acts as a form of controlled interoceptive exposure, desensitising individuals to the physiological signals they normally interpret as dangerous.

It is within this framework that the Buteyko breathing technique, developed by Konstantin Buteyko in the 1950s, is situated. This technique posits that many respiratory conditions and anxiety symptoms are linked to chronic, unconscious hyperventilation and a consequent relative deficiency of CO_2 in the body. Consequently, the breathing method aims to reduce minute ventilation, slow the respiratory rate, promote nasal breathing and incorporate gentle breathing pauses in order to restore adequate CO_2 levels and optimise respiratory efficiency (Slader et al., 2006; Vagedes et al., 2024). Systematic practice involves breathing control exercises, gently holding the breath after exhalation, and paying conscious attention to the

sensation of ‘air hunger’, which is interpreted as a way of training the body’s physiological tolerance to CO_2.

The scientific literature on the Buteyko method has traditionally focused on its application in bronchial asthma, where numerous clinical trials have demonstrated improvements in symptom control, a reduction in the use of bronchodilator medication, and an improvement in patients’ quality of life (Slader et al., 2006; Vagedes et al., 2024). Although the primary mechanism in these studies is attributed to a reduction in hyperventilation and improved gas exchange, some authors have suggested that part of the benefits may also be due to a regulatory effect on the autonomic nervous system, by reducing the sympathetic hyperactivation characteristic of anxious states.

More recently, scientific interest in the Buteyko breathing method has extended into the field of mental health. Some clinical trials and quasi-experimental studies have shown reductions in anxiety and stress following breathing training programmes based on the Buteyko principles (Eghbali et al., 2025; Gopakumar & Mathew, 2022). However, an official review by the Australian Department of Health (2025) concluded that the evidence regarding the effects of this technique on emotional functioning and mental health remains uncertain and of low certainty, due to the limited number of controlled studies and small sample sizes. Nevertheless, these reports acknowledge the physiological plausibility of the method and its potential therapeutic value in complementary respiratory regulation interventions.

From the perspective of the mechanisms involved, Buteyko breathing may influence anxiety and perceived stress through various physiological and psychological pathways. Firstly, by reducing respiratory volume and prolonging exhalations, there is a gradual increase in arterial CO_2, which corrects hypocapnia and reduces the somatic symptoms resulting from respiratory alkalosis. This restoration of chemical homeostasis may reduce the perception of bodily threat and, consequently, sensitivity to anxiety (Boulding et al., 2016; Leyro et al., 2021). Secondly, the slower, more regular breathing pattern characteristic of the method may increase heart rate variability (HRV), a marker of vagal tone and autonomic flexibility. Slow, controlled breathing (regardless of the specific technique) has been shown to enhance cardiorespiratory synchronisation and improve emotional regulation (Blum et al., 2019; Wells et al., 2012). This autonomic modulation is associated with an increased capacity to recover from stress and a reduction in generalised anxiety.

Another important aspect of the Buteyko technique is the promotion of nasal breathing over mouth breathing. Nasal breathing increases the availability of nitric oxide (NO), a molecule with vasodilatory, bronchodilatory and antimicrobial effects, which also helps to improve oxygenation and the efficiency of gas exchange (Eser et al., 2024; Watso et al., 2023). These physiological changes may reduce the subjective sensation of respiratory effort and promote a calmer bodily experience, which could indirectly influence a reduction in anxiety and perceived stress. Nasal breathing also helps to maintain the humidity and temperature of the inhaled air, reducing irritation of the airways – a factor which, in anxious individuals, may lessen the perception of breathlessness or chest tightness.

An additional element of the Buteyko method involves mindful attention to the act of breathing. Regular practice involves observing one’s breathing without forcing it, introducing gentle pauses and focusing on the sensation of calm. This approach can be regarded as a form of attentional training or respiratory mindfulness, which has been shown to have beneficial effects in reducing anxiety and stress. According to Leyro et al. (2021), repeated exposure to physiological sensations (such as increased CO_2 or a mild sensation of ‘shortness of breath’) without negative consequences triggers a process of interoceptive desensitisation, in which bodily signals are no longer interpreted as threats. In this way, breathing practice could specifically reduce the physical dimension of anxiety sensitivity by altering the cognitive interpretation of bodily sensations.

The overall evidence on breathing interventions supports the effectiveness of practices that promote slow, controlled breathing. Bentley et al. (2023) conducted a systematic review which found that breathing training programmes involving at least five minutes of practice per session, multiple sessions, and exercises focusing on nasal and diaphragmatic breathing produced significant reductions in stress and anxiety, with moderate effect sizes. Similarly, Fincham et al. (2023) found that interventions based on slow, diaphragmatic breathing have an overall beneficial effect on levels of perceived stress and symptoms of anxiety, particularly when participants practise regularly. These findings are consistent with the hypothesis that the Buteyko breathing method, by sharing common principles with other forms of slow breathing, may generate similar psychological effects, enhanced by its emphasis on reducing ventilation and increasing CO_2 tolerance.

The literature on respiratory dysfunction in individuals with anxiety also supports the therapeutic potential of ventilatory correction techniques. Boulding et al. (2016) and Vidotto et al. (2019) proposed that many symptoms attributed to anxiety (such as the sensation of 'being unable to breathe deeply' or 'chest tightness') are in fact manifestations of inefficient breathing patterns, characterised by mild and sustained hyperventilation. Respiratory re-education, aimed at restoring nasal breathing and reducing respiratory rate, has been associated with improvements in gas exchange efficiency and in the perception of bodily control. In the university setting, where anxiety is often accompanied by muscle tension and thoracic breathing patterns, practising the Buteyko method could help to re-establish a more functional and relaxed breathing pattern, with both physiological and psychological benefits.

Furthermore, studies on heart rate variability (HRV) biofeedback and slow breathing show that the regular practice of controlled breathing increases parasympathetic activity and cardiorespiratory coherence, which translates into a greater sense of calm and emotional control (Van der Zwan et al., 2015; Wells et al., 2012). Blum et al. (2019) observed that guided slow breathing exercises improve affective regulation and reduce levels of anxiety and subjective stress, reinforcing the idea that breath-mediated autonomic modulation is a key mechanism in reducing psychological distress.

Present study

In this context, the Buteyko breathing method could act as a form of physiological training in emotional regulation, combining elements of interoceptive exposure, mindfulness and autonomic rebalancing. By promoting tolerance to normal levels of CO_2 and reducing hyperventilation, this technique may diminish the bodily sensations that typically trigger alarm responses, thereby reducing sensitivity to anxiety. At the same time, the slow, nasal breathing practice may induce sustained parasympathetic activation, alleviating perceived stress and improving resilience to academic or social demands.

Therefore, the aim of this study is to test the effectiveness of a Buteyko breathing training programme on levels of anxiety sensitivity and perceived stress in a sample of university students. Specifically, it is expected that students participating in the Buteyko breathing programme (experimental group) will show significant reductions in their anxiety sensitivity and perceived stress scores compared with students not participating in the programme (control group).

Method

Participants

The sample for this study consisted of 41 students from the Faculty of Education at the University of Almería, aged between 18 and 36 (M=22.32; SD=3.67). The experimental group comprised 21 participants (6 men and 15 women), whilst the control group comprised the remaining 20 participants (5 men and 15 women). Subjects were randomly assigned to one group or the other, with the gender variable controlled to ensure a similar number of men and women in both groups, thereby preventing this variable from interfering with the study's results. Statistical analysis showed no statistically significant differences between the control and experimental groups in terms of age ($z=2.10$; $p=.834$).

Design

To analyse the effects of the Buteyko breathing programme (independent variable) on levels of perceived stress and anxiety sensitivity (dependent variables), a quasi-experimental longitudinal design was used, involving a pre-test–post-test comparison of groups, with an experimental group and a control group on a waiting list.

Measurements

ASI-3 Scale. Anxiety Sensitivity Index (Peterson & Reiss, 1992; Taylor et al., 2007). The Spanish version (Altungy et al., 2023) was administered; like the original version, it consists of 18 items and retains the same general structure and response format. Participants are asked to indicate the extent to which they experience each of the 18 statements on a Likert-type scale, ranging from 'Not at all' (0) to 'Very much' (4). The items refer to fear/anxiety reactions to the experience of somatic symptoms (e.g., 'I get scared when my heart beats quickly'), social symptoms ('It is important to me not to give the impression of being nervous'), and symptoms of cognitive disorganisation (e.g., 'I get scared when I am unable to keep my mind focused on a task'). In addition to a total score, three subscales are derived, each comprising 6 items: physical concern, cognitive concern, and social concern. The Spanish version exhibits high reliability (total $\alpha = .90$; subscales between .81 and .88).

Perceived Stress Scale (PSS; Cohen et al. 1983; Cohen et al., 1994). This scale assesses the extent to which the subject perceives and evaluates life situations as stressful. The scale consists of 14 items on which participants must self-assess using a 0–4-point Likert-type scale, rating their level of perceived stress over the past month; thus, the raw score obtained indicates that a higher score corresponds to a higher level of perceived stress, as the items on the scale assess the extent to which people find their lives to be unpredictable, uncontrollable or overloaded – all of which are central components of stress (Remor & Carrobles, 2001). This questionnaire has an internal consistency of .81 and a test-retest reliability of .73 for the Spanish population (Remor, 2006).

Procedure

Firstly, the study sample was recruited. To this end, a course entitled 'Buteyko Breathing Training and Practice' was offered to first-year students on the Bachelor's Degree in Primary Education at the University of Almería, for which a total of X students enrolled. The participants were then randomly assigned to the control and experimental groups, with gender controlled to ensure there were equal numbers of men and women in both groups.

Once the sample had been selected, a pre-test assessment was carried out on all research participants; they were asked to complete the ASI scale and the Perceived Stress Scale in order to determine the baseline levels of each participant in the study for these variables. This pre-test assessment was conducted during the first week of October 2025.

Once the pre-test scores for the study variables had been obtained, the Buteyko breathing training programme was launched for the experimental group, whilst the participants in the control group were informed that, due to space constraints, the group had to be split and that the course would be delivered in two sessions, with them being assigned to the second session. The programme lasted a total of 10 hours, delivered over 10 weeks with each session lasting approximately one hour. The intervention programme ran from 9 October to 11 December 2025.

The intervention programme lasted a total of 10 weeks, with one 60-minute session per week, combining theoretical and practical content on the Buteyko method with guided exercises and short home-based tasks (10–15 minutes daily). The overall aim was to reduce stress and anxiety sensitivity through respiratory re-education and the strengthening of physiological self-regulation.

In week 1, the fundamentals of breathing and its relationship with the autonomic nervous system were introduced. The students assessed their baseline breathing pattern using the control pause (the length of time one can hold one's breath after exhaling until the first urge to breathe again is felt), and performed conscious nasal breathing exercises.

Week 2 focused on the principles of the Buteyko method, addressing the reduction of respiratory volume and the importance of CO_2 as a modulator of physiological balance. Participants practised reduced nasal breathing and recorded their control pauses.

During the third week, dedicated to functional nasal breathing, the emphasis was on inhaling and exhaling exclusively through the nose, alongside nasal decongestion techniques. A 4:4 breathing rhythm was practised, and daily nasal breathing with a gradual reduction in volume was recommended.

In the fourth week, work focused on controlling the breathing rhythm and the maximum pause (the length of time one can hold one's breath after exhaling until a strong urge to breathe again is felt), with the aim of increasing CO_2 tolerance and stabilising the respiratory rate (6–8 breaths per minute).

Week 5 focused on relaxed breathing and emotional self-regulation, linking slow diaphragmatic breathing to the activation of the parasympathetic nervous system. Gentle breathing exercises and brief controlled apnoeas were practised to increase CO_2 levels.

In week 6, the Buteyko technique was applied to stressful situations related to the students' academic activities, identifying triggers for hyperventilation and practising reduced breathing during stress simulations.

Week 7 delved into silent, nasal breathing at night, aimed at establishing a gentle and continuous breathing pattern. It was recommended to practise slow breathing before bed and, optionally, to seal the mouth with medical tape to prevent mouth breathing.

Week 8 incorporated breathing whilst moving, combining nasal breathing and brief pauses during slow walks, thereby reinforcing body awareness and active respiratory control.

Week 9 focused on consolidating the practice, integrating the main components of the method (nasal breathing, ventilatory reduction, control pause and silent breathing) into a single daily sequence lasting 10–15 minutes.

Finally, week 10 was devoted to the final assessment and conclusion, comparing initial and final control pauses, reflecting on individual progress and carrying out a group Buteyko breathing integration session.

Overall, the programme promoted breath awareness, reduced hyperventilation and strengthened emotional and physiological self-regulation, making it a tool that can be applied in an educational context to reduce stress and anxiety.

Once the intervention programme had been completed in the experimental group, the post-test assessment was carried out. To this end, all participants in both the control and experimental groups were administered the same questionnaires used in the pre-test phase, in

order to ascertain whether there had been any significant changes in the study variables. This post-test assessment took place during the week of 15 December 2025.

Finally, all participants were informed of the research objectives, gave their written consent, and the confidentiality and anonymity of the data were guaranteed at all times.

Once the research had been completed, the Buteyko breathing course was delivered to the participants in the control group.

Ethical considerations

All participants provided their informed consent and the study was approved by the Bioethics Committee of the University of Almería, Spain. The data recorded from each of the instruments were coded alphanumerically, ensuring confidentiality and anonymity, in order to comply with the Personal Data Protection Act established by the Ethics Committee for Research Involving Human Subjects (CEISH). The international guidelines for studies involving human subjects, as set out in the Nuremberg Code and the Declaration of Helsinki, were applied. The research was approved by the Bioethics Committee of the University of Almería (UALBIO2024/007)

Data analysis

To test for statistically significant differences between the mean scores of the control and experimental groups at each stage of the study for the different dimensions of the variables impulsivity, aggression and emotional regulation, the non-parametric Mann–Whitney U test for independent samples was used, as the data did not follow a normal probability distribution. Subsequently, to test for statistically significant differences between the mean scores for the different dimensions of the variables impulsivity, aggression and emotional regulation at each stage of the study in both the control and experimental groups, the non-parametric Wilcoxon signed-rank test for paired samples was used.

To assess the magnitude of the change observed following the implementation of the intervention programme across the different dimensions of the study variables in the experimental group, Cohen's d and the percentage change between pre-test and post-test scores were used.

All statistical analyses were carried out using the SPSS statistical package, version 29.0.

Results

Firstly, the means and standard deviations of the study variables for the control and experimental groups were calculated for each phase of the research (see Table 1).

Table 1. Means and standard deviations for the pre-test and post-test in the control and experimental groups for the variables anxiety sensitivity and perceived stress

	PRETEST				POSTEST			
Group	Control		Experimental		Control		Experimental	
Factors	*M*	*DT*	*M*	*DT*	*M*	*DT*	*M*	*DT*
Asi-Physics	13.40	3.37	13.10	2.56	13.10	3.48	10.95	2.31
Asi-Cognitive	12.90	2.61	14.00	2.41	12.70	2.72	11.05	1.94

Asi-Social	12.10	2.34	11.52	2.44	12.30	2.59	11.05	2.73
Asi-Total	38.40	4.93	38.62	4.71	38.10	4.74	33.05	4.42
Perceived stress	36.70	4.13	36.52	5.57	36.75	4.29	32.10	5.18

When performing the Mann-Whitney U test for independent samples on the pre-test scores, it can be seen that there are no statistically significant differences at the outset between the mean scores of the control and experimental groups for the study variables. In contrast, statistically significant differences did emerge between the control and experimental groups in their post-test scores for the variables physical worry ($z=2.88$; $p<.01$), cognitive worry ($z=3.19$; $p<.05$), anxiety sensitivity ($z=3.19$; $p=.001$), and perceived stress ($z=2.80$; $p<.01$) (see Table 2).

Table 2. Mann-Whitney U test for independent samples of the pre-test and post-test differences between the control and experimental groups for the variables anxiety sensitivity and perceived stress

	PRETEST		POSTEST	
Factors	*z*	*p*	*z*	*p*
Asi-Physics	.682	.495	2.88	.004**
Asi-Cognitive	1.62	.105	2.19	.028***
Asi-Social	.739	.460	1.51	.131
Asi-Total	.367	.713	3.19	.001*
Perceived stress	.144	.885	2.80	.005**

Note: ***$p=.001$;**$p<.01$;*$p<.05$

When the Wilcoxon test for paired samples was carried out on the scores of the experimental group, statistically significant differences were found when comparing their post-test and pre-test scores across all variables, except for social anxiety. However, when this test was carried out on the control group, no statistically significant differences were found in any of the study variables (see Table 3).

Table 3. Wilcoxon test for paired samples of pre-test–post-test differences in the control and experimental groups for the variables of growth, sensitivity to anxiety and perceived stress

Group	Control		Experimental	
Factors	*z*	*p*	*z*	*p*
Asi-Physics	.818	.413	3.67	.000*
Asi-Cognitive	.607	.544	4.05	.000*
Asi-Social	.836	.403	1.62	.104
Asi-Total	.669	.504	3.98	.000*
Perceived stress	.095	.924	4.04	.000*

Note:*p<.001

In order to assess the magnitude of the change observed in the experimental group between their pre-test and post-test scores, Cohen's d (1988) was used, where values above 1.5 indicate very large effects, between 1.5 and 1 indicate large effects, and between 1 and 0.5 indicate medium effects. Table 4 shows that the Cohen's d scores in the experimental group indicate significant changes in the variables cognitive worry (d = 1.34) and anxiety sensitivity (d = 1.22), whilst moderate changes are observed in the variables physical worry (d = 0.885) and perceived stress (d = 0.821).

Finally, the percentage change between the pre-test and post-test scores in the experimental group was calculated for the various variables in the study. Table 4 shows that this percentage indicates reductions of more than 20 per cent in the cognitive worry dimension (-21.07), and of around 15 per cent in physical worry (-16.41), anxiety sensitivity (-14.42) and perceived stress (-12.10).

Table 4. Cohen's d and the percentage change from pre-test to post-test in the experimental group for the variables anxiety sensitivity and perceived stress

Factors	*d* Pre-Post	%Pre-Post
Asi-Physics	.885	-16.41
Asi-Cognitive	1.34	-21.07
Asi-Social	.181	-4.08
Asi-Total	1.22	-14.42
Perceived stress	.821	-12.10

Discussion

The results of this study provide solid empirical evidence regarding the effectiveness of a Buteyko breathing programme in reducing anxiety sensitivity and perceived stress among university students. After ten weeks of intervention, the experimental group showed statistically significant reductions in the physical and cognitive dimensions of anxiety sensitivity, as well as in perceived stress, whilst the control group showed no significant changes in any of the variables assessed. This pattern of results suggests that the systematic practice of the Buteyko breathing method may constitute a viable and pedagogically meaningful strategy for emotional self-regulation and psychological well-being in the university context.

One of the most notable findings of this study is that the control group, having not participated in the intervention, not only maintained their levels of anxiety and stress but also showed a tendency towards a slight worsening in these variables compared with the experimental group. This result reinforces existing evidence indicating that, in the absence of specific interventions, levels of anxiety and stress amongst the university population tend to increase over time due to the accumulation of academic, social and personal demands (Dresen et al., 2025; Fruehwirth et al., 2023; Pérez-Jorge et al., 2025). Therefore, the data obtained in this study highlight the urgency of incorporating preventive and educational strategies that

promote emotional self-regulation before psychological distress becomes chronic or interferes with academic performance and retention at university.

The significant reduction in anxiety sensitivity, particularly in its physical and cognitive components, suggests that the Buteyko breathing programme not only lowers overall arousal levels but also alters students' relationship with their own bodily sensations and thoughts under pressure. Sensitivity to anxiety, understood as the fear of physical or cognitive sensations associated with anxiety (Taylor, 1995), is a key predictor of emotional vulnerability. Its reduction implies greater tolerance of physiological states of arousal, an essential trait for the adaptive coping with academic challenges. From an educational psychology perspective, this finding can be interpreted as an improvement in students' functional interoception, as they learn to recognise and reinterpret bodily signals of arousal not as a threat, but as a natural part of cognitive effort or performance under pressure (Leyro et al., 2021; Jardin et al., 2018).

The greater decreases on the cognitive worry subscale of the ASI-3 are particularly relevant in the university context, as they reflect a reduction in thoughts such as 'I'm going to lose control' or 'I won't be able to concentrate', which are common during exams or oral presentations. These results are consistent with the literature indicating that structured breathing practice promotes attentional control and reduces negative self-talk (Fincham et al., 2023; Bentley et al., 2023). Thus, the Buteyko breathing method appears to influence not only the physiological dimension of anxiety, but also the cognitive interpretation of internal sensations, providing a specific resource for cognitive-emotional self-regulation that students can apply independently in assessment or presentation situations.

In educational terms, this ability to modulate internal arousal has a dual value: on the one hand, it helps to improve students' subjective well-being, and on the other, it optimises the cognitive conditions for learning. In this regard, research in neuroeducation has shown that high levels of stress and anxiety interfere with attention, working memory and cognitive flexibility – all of which are crucial functions for academic performance (Tan et al., 2023). Conversely, the practice of slow, mindful breathing helps to restore a balance between arousal and calm, which promotes concentration and the retention of information (Blum et al., 2019; Wells et al., 2012). Therefore, the Buteyko breathing method can be understood as a pedagogical tool for psychophysiological regulation, with benefits that go beyond emotional health to have a direct impact on the quality of learning.

The fact that the physical and cognitive dimensions of anxiety sensitivity responded positively to the intervention, whilst the social dimension remained stable, is consistent with the nature of the training provided. The programme focused on internal regulation and did not include components of social exposure or communication skills, which would be more effective in reducing anxiety linked to interpersonal evaluation (Jardin et al., 2018; Taylor et al., 2007). This differential pattern reinforces the idea that interventions should be designed in a multi-component and context-specific manner, addressing both the interoceptive and social factors of university-related distress. In this case, the Buteyko breathing technique proves to be particularly effective for the dimensions of anxiety related to the interpretation of internal sensations, making it an excellent starting point within broader university wellbeing and emotional education programmes.

With regard to the reduction in perceived stress observed in the experimental group, the results are consistent with research linking slow breathing practices to increased emotional control and a reduced perception of overwhelm (Bentley et al., 2023; Fincham et al., 2023; Van der Zwan et al., 2015). Thus, the perception of control (a central element of Lazarus and Folkman's stress model) acts as a buffer against academic demands and is associated with greater psychological resilience. In this regard, Bueyko breathing can be considered a means of strengthening this perception of control through a concrete, body-based practice. The daily

practice of mindful, slow breathing offers students a simple tool to regulate their emotional state in real time, reducing reactivity to stressors and fostering a sense of personal competence in the face of the demands of the academic environment.

The effect sizes obtained in this study (large for cognitive worry and anxiety sensitivity, and medium for perceived stress) are comparable to those observed in mindfulness or biofeedback interventions among university students (Blum et al., 2019; Van der Zwan et al., 2015). However, the Buteyko breathing method offers notable advantages in terms of simplicity, accessibility and cost, as it requires neither specialised equipment nor lengthy training sessions, which facilitates its incorporation into institutional student wellbeing programmes. Furthermore, its format of ten weekly sessions and brief home-based exercises is well suited to the university routine and allows for independent mastery of the technique, ensuring its sustainability in the medium term.

A highly significant pedagogical element is the learnable and transferable nature of the Buteyko breathing technique. Unlike purely therapeutic interventions, this programme is designed as an active learning process in which students become aware of their breathing, experience its influence on their emotional state and apply it in everyday contexts (Eghbali et al., 2025; Gopakumar & Mathew, 2022). Furthermore, by developing autonomous emotional regulation skills, the Buteyko breathing method can contribute to the development of students who are more resilient and competent in managing their own wellbeing—a fundamental cross-cutting competence in contemporary higher education.

The significance of the findings is further emphasised when considered within the current global context. Recent literature has highlighted a sustained increase in anxiety and stress amongst university students, exacerbated by the COVID-19 pandemic (Liyanage et al., 2021; Dresen et al., 2025). Without structured interventions, these levels of distress tend to persist or even worsen throughout students' time at university (Fruehwirth et al., 2023). Therefore, the data from this study not only demonstrate the effectiveness of Bueyko Breathing, but also highlight the risks of institutional inaction regarding psychological wellbeing in higher education. Universities cannot limit themselves to addressing the consequences of psychological distress; rather, they must actively promote primary prevention strategies that strengthen students' self-regulation and emotional health.

The preventative nature of Bueyko breathing makes it particularly suitable for integration into academic life. Rather than being a treatment for clinical cases, it is presented as a resource for emotional and physical literacy that is accessible to all students. This approach is in line with current frameworks for healthy universities, which promote the inclusion of wellbeing practices within the curriculum and institutional culture (Pérez-Jorge et al., 2025). In this regard, Buteyko breathing could be incorporated into workshops on cross-curricular skills, guidance programmes or tutoring activities, constituting a low-cost intervention with potential benefits for mental health and academic performance.

Practical implications

The findings have potential implications for student well-being initiatives in higher education. Universities could consider offering breathing-awareness workshops or optional skills sessions as part of broader health promotion, tutoring, or student-support programmes. The programme's weekly format and brief home practice may make it relatively straightforward to implement. It should, however, be presented as a complementary self-regulation resource rather than a substitute for professional assessment or treatment when students experience clinically significant anxiety or stress. Any implementation should also monitor participation, acceptability, adherence, and possible adverse experiences.

Limitations

However, the study has limitations that must be acknowledged. Firstly, the sample size is small, which suggests that the design should be replicated with larger and more heterogeneous samples. Secondly, the use of self-reports may have introduced social desirability bias; it would therefore be advisable to include physiological measures (such as heart rate variability or capnometry) and observational measures in future research. Thirdly, although the intervention was effective in addressing the internal and cognitive dimensions of anxiety, it would be useful to combine the Buteyko breathing technique with social exposure or communication skills modules to address the social dimension of the ASI-3. Finally, there is no longitudinal follow-up, so the duration of the effects beyond the immediate post-intervention period remains unknown. The findings should therefore be interpreted cautiously, and the study should be regarded as preliminary evidence rather than definitive proof of efficacy. In addition, the intervention and outcomes were assessed over a limited period, so the persistence of the observed changes remains unknown. The results may not generalise beyond the population and educational setting examined.

Future research

Future studies should recruit larger samples from multiple universities and degree programmes, include more diverse student populations, and use adequately powered randomised controlled designs. Active comparison groups would help establish whether the effects are specific to the Buteyko method or reflect factors such as instructor attention, group support, expectations, or regular practice. Researchers should also include follow-up assessments to determine whether benefits are maintained, record adherence to home exercises, and assess acceptability and feasibility. Combining self-report measures with physiological indicators—such as heart-rate variability or capnometry—and relevant educational outcomes could help clarify possible mechanisms and the practical significance of the intervention.

Conclusion

The findings suggest that a 10-week Buteyko breathing programme may help reduce perceived stress and selected dimensions of anxiety sensitivity among university students. The experimental group showed statistically significant improvements in physical and cognitive anxiety sensitivity and perceived stress, whereas the control group showed no significant pre–post changes. The largest change was observed in cognitive anxiety sensitivity, while the social dimension did not improve significantly. These results support the potential value of structured breathing practice as an accessible educational and preventive resource, although further research is needed before firm conclusions about its effectiveness or wider applicability can be drawn.

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