

# Exam Anxiety in Adolescents and the Efficacy of its Interventions

## – A Systematic Review

Kabir Dhawan<sup>1</sup>

<sup>1</sup> American Embassy School, New Delhi, India

Correspondence: Kabir Dhawan, American Embassy School, New Delhi, India.

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### Abstract

This systematic review evaluates interventions aimed at reducing exam anxiety in adolescents, revealing that various methods, such as Cognitive Behavioural Therapy (CBT), mindfulness, emotional self-regulation, expressive writing, attention training, multimodal cognitive-behavioural approaches, hypnosis, and working memory training, significantly lower anxiety levels. By thorough quality assessment and data extraction from ten included studies, this paper highlights the effective interventions, urging future research to refine these interventions and explore their long-term benefits. Educators and practitioners are recommended to adopt these evidence-based strategies to enhance students' academic performance and psychological health.

**Keywords:** exam anxiety, exam stress, high school student, interventions, cognitive behaviour therapy, hypnosis, meditation

### 1. Introduction

In the contemporary educational landscape, the experience of stress among teenagers, particularly in the context of examinations, has become a subject of paramount concern. The prevalence of exam stress in teenagers has been a growing area of research and discussion, as the academic demands on adolescents continue to rise. The impact of exam stress is not confined to the academic domain; it extends to affect various facets of teenagers' lives, including their mental well-being, emotional stability, and overall quality of life.

Secondary or high school students, defined here as junior/lower secondary education and senior/upper secondary education (UNESCO, 2012) and tertiary students, defined as post-secondary education (UNESCO, 2012), have commonly reported stress relating to their education or academic-related stress, such as pressure to achieve high marks and concerns about receiving poor grades. A survey conducted by Organisation for Economic Co-operation and Development (OECD) in 2017, which included 540,000 student respondents in the age bracket of 15 to 16 years and spread over 72 countries, found that 66% are students felt stressed about poor grades, 59% reported worry on difficulty of tests, 55% reported feeling anxious about school testing despite being prepared well and 37% felt tense while studying. Girls consistently reported greater anxiety relating to schoolwork than boys.

Exam or test anxiety refers to the response triggered by stimuli encountered in testing or evaluation scenarios (Sieber 1980). The phenomenon of test anxiety has frequently been studied within the framework of overanxious disorder and social phobia in children (Beidel, 1991); however, it does not currently meet the criteria for a "diagnosable" disorder by ICD 11 or DSM V. Nevertheless, many children experience symptoms associated with it. Various reviews indicate a wide range of prevalence rates for test anxiety, spanning from 15% to 60% among students (Cassady 2010) (Huberty 2009). Evidence suggests that the incidence rates and the impact on outcomes of test anxiety tend to rise from elementary school to university enrolment. (Ergene, 2003) (Putwain & Daly, 2014) (von der Embse et al., 2012).

Exam anxiety encompasses two aspects: trait, which remains relatively constant, while test anxiety state can vary over time (Spielberg 1975). One of the most prominent features of state anxiety is anticipatory anxiety, which progresses downwards as the exam proceeds, without resurging. Ping et al (2008) showed that anticipatory anxiety has no association with anxiety traits but students with high test anxiety trait scores had significantly more symptoms of anxiety during the exam. They also observed that individuals exhibiting high levels of test anxiety trait tended to express greater satisfaction with their exam outcomes, probably due to reduced

self-imposed performance standards. Conversely, it is plausible that individuals with high levels of test anxiety trait engage in earlier and more effective exam preparation strategies.

Research on test anxiety has consistently supported a model that identifies two main components: "physiological" and "cognitive" (Liebert & Morris, 1967)(Cassady 2023). The physiological component involves physical responses to stress like a faster heartbeat or nausea ( see table 1), while the cognitive component includes worrying thoughts and distractions during tests. Some researchers suggest a third component called "social derogation," associated with the concern of social deprecation following failure on a test, but its distinctness is debated (John et al. 2008) (Bodas & Ollendick, 2005).

The cognitive and physiological aspects of test anxiety are closely linked, but it's unclear which one triggers the other. Some believe that physical symptoms can lead to worrying thoughts, while others think worrying thoughts can cause physical symptoms (Hembree, 1988). Cognitive test anxiety tends to remain stable over time, like a personality trait, while physiological symptoms can change depending on the situation (Cassady, 2004).

In less stressful situations, both components of test anxiety are manageable, but they become more severe in high-pressure testing environments (Tempel & Neumann, 2014).

## 2. Outcomes of Test Anxiety

Research consistently shows a clear link between test anxiety and academic performance, although it's important to note that this relationship is not necessarily causal. This connection holds true across different types of tests, including high-stakes exams (DeCaro et al. 2011), classroom tests (Zeidner & Matthews 2005), overall course performance (Heller & Cassady 2017), and even in experimental settings without external pressure (Cassady 2004).

Table 1. Symptoms that may be associated with Exam Anxiety

Physical Symptoms	Behavioural Symptoms	Affective Symptoms
<ul style="list-style-type: none"> <li>• Profuse Sweating</li> <li>• Clammy/sweaty palms</li> <li>• Headache (unexplained)</li> <li>• Stomach ache (unexplained)</li> <li>• Nausea</li> <li>• Trembling</li> <li>• Palpitations</li> <li>• Dizziness or light headedness</li> <li>• Muscle tension or tics</li> <li>• Flushed skin color</li> <li>• Difficulty sleeping /poor sleep</li> <li>• Difficulty sleeping /poor sleep</li> <li>• Poor eating</li> <li>• Diarrhoea (unexplained)</li> <li>• Using the toilet before the test</li> </ul>	<p>Difficulties arise with concentration, attention, and memory, impacting various aspects such as:</p> <ul style="list-style-type: none"> <li>○ comprehending test instructions and questions</li> <li>○ recalling information</li> <li>○ organizing thoughts and responses</li> <li>○ poor performance on exams, despite mastery of the content evidenced in non- testing assessments.</li> </ul> <p>Off-task behaviors :</p> <ul style="list-style-type: none"> <li>○ making inappropriate comments</li> <li>○ fidgeting</li> <li>○ pacing</li> <li>○ tapping</li> <li>○ staring</li> <li>○ crying</li> <li>○ speaking rapidly in tests</li> </ul> <p>Other behaviors</p> <ul style="list-style-type: none"> <li>○ asking excessive unnecessary questions about the test</li> <li>○ experiencing repeated mental blocks and memory lapses,</li> <li>○ feeling overwhelmed,</li> <li>○ expressing dissatisfaction with test items,</li> <li>○ seeking unnecessary help from others,</li> <li>○ resorting to cheating</li> <li>○ pretending to be ill or absent on test days.</li> </ul>	<ul style="list-style-type: none"> <li>• Engaging in self-defeating statements with pessimistic predictions (e.g., "I'll fail this test")</li> <li>• displaying apathy and lack of motivation</li> <li>• comparing oneself unfavorably to others (e.g., "I'm not as intelligent as them")</li> <li>• providing excuses for subpar test results (e.g., "I perform poorly due to test anxiety")</li> <li>• expressing avoidance and apprehension towards testing situations.</li> </ul>

Sources: (Salend 2011) ;(Heiman & Precel, 2003) ; Cizek & Burg (2006); Dorland ( 2009); Cassady (2010)

When looking at how different aspects of test anxiety affect performance, both physiological and cognitive components play a role in lowering performance. However, cognitive test anxiety tends to have a stronger predictive power in determining how well students perform (Cassady & Johnson 2002).

High Uncertainty Intolerance (UI)- a belief that unpredictable situations are threatening, even when the chances of something bad happening are low (Huntley et al., 2020), is associated with poor academic performance. Learners with high UI often lack confidence in their abilities, which affects their academic success. They may have trouble persisting through challenges, using effective learning strategies, or setting goals for themselves. Uncertainty intolerance (UI) is linked to lower academic achievement and well-being. Uzun and Karatas (2020) found a significant negative relationship between self-efficacy and UI, indicating that individuals who have difficulty dealing with uncertainty also lack confidence in their own abilities.

Students with Test Anxiety have also been seen to utilize Academic self-handicapping -intentionally creating obstacles for important tasks to avoid doing well (Urdu & Midgley 2001). By setting up these barriers, they can blame external factors for their poor performance instead of taking responsibility themselves. This strategy is often used to protect self-esteem when failure is expected or feared (Gadbois & Sturgeon 2011) (Schwinger et al.2021). However, using academic self-handicapping can lead to negative outcomes like lower confidence, worse academic performance, higher anxiety about tests, and struggling to adjust academically. People who expect to do poorly may use this strategy to have a ready excuse for their performance. This helps them feel better about themselves by shifting the blame away from their abilities(Chorba et al.2012).

A multifaceted phenomenon, exam anxiety is influenced by an intricate interplay of academic, familial, and societal factors. As adolescents navigate the challenging terrain of educational expectations, the pressure to perform well in exams can induce stress and anxiety, potentially leading to adverse consequences for their mental health. The significance of understanding the construct of exam stress lies not only in recognizing its ubiquity but also in devising effective interventions to alleviate its detrimental effects on the well-being of teenagers.

### **3. Rationale for the Study**

Researchers have performed studies around the factors implicated in exam anxiety and have studied some of the interventions used to address exam anxiety and ameliorate the impact of its symptoms. By synthesizing and critically evaluating existing literature, this study aims to provide a comprehensive overview of the current state of knowledge regarding exam stress in teenagers and the effectiveness of interventions designed to mitigate its consequences.

This systematic review delves into the various factors contributing to exam stress, encompassing academic pressures, parental expectations, and individual coping mechanisms. Additionally, it scrutinizes a diverse array of interventions, with the goal of discerning the most efficacious methods in addressing exam stress among teenagers.

In sum, this research seeks to illuminate the intricate dynamics of exam stress in teenagers, offering valuable insights that can inform educators, parents, and mental health professionals in developing targeted interventions to support the well-being of adolescents facing the challenges of high-stakes examinations. Through a rigorous examination of existing literature and a synthesis of empirical evidence, this study aims to contribute to the ongoing dialogue surrounding adolescent mental health and the optimization of strategies to foster resilience in the face of academic pressures.

#### **3.1 Primary Objective**

To ascertain beneficial interventions for exam anxiety in adolescents by analysing the existing literature with an aim to explore the potential for creating an app/platform tailored to high school students, incorporating the most beneficial interventions identified in the study thereby providing accessible support for teenagers worldwide.

#### **3.2 Secondary Objectives**

- (1) To critically evaluate interventions aimed at addressing exam stress.
- (2) To identify and analyse the factors contributing to exam stress in teenagers.
- (3) To determine the overall effectiveness of interventions in reducing exam stress among teenagers.
- (4) To provide evidence based research for informing educators, parents, mental health professionals, and policymakers.

#### 4. Methods

The PICOS (population, intervention, comparator, outcome, setting and study design) framework was used to formulate the question addressed by this systematic review (Boland, Cherry and Dickson 2014, p27).

##### 4.1 Study Design

All published and unpublished Randomised Controlled Trials (RCT) were sought for this systematic review and meta-analysis. Because one of the aims of this study is to provide evidence to policy makers for making informed choices, RCTs were the best option for inclusion as they provide the necessary background essential to the practice of evidence-based medicine (Bulpitt 1996). RCTs are also the best kind of study to gather data for estimating the beneficial effects of a particular treatment or intervention (Howard & Thornicroft 2006), which is the primary aim of this study. The process of randomisation reduces bias and provides rigorous analysis for the study of a cause-and-effect relationship between an intervention and an outcome (Hariton & Locascio 2018). The power calculation of the number of participants, concealment process and blinding are inherent to any RCT, further minimizing bias and making it a strong research and statistical tool. However, the study includes experimental clinical trials, pre-test /post-test study design research as well.

##### 4.2 Eligibility Criteria

Studies published in English language that met the following criteria were included in this systematic review.

##### 4.3 Study Characteristics

Only published Randomised Controlled trials with quantitative data, clinical trials and Randomised experiment trials with pre-test/post-test design were included to provide the best evidence-base for effectiveness of interventions. Case studies, Cohort studies, reviews and opinions have not been included. Grey literature was not searched and search is limited to research papers published in the English language only.

##### 4.4 Participant Characteristics

The participants in this systematic review include adolescents between 11 to 19 years of age, enrolled in high school or equivalent educational institutions worldwide, and have a diagnosis of test anxiety. A list of participant inclusion and exclusion criteria is provided in Table 2.

Table 2. Eligibility Criteria

Study title/author /year		
Participant population	Include	Exclude
	<ul style="list-style-type: none"> <li>• High school students</li> <li>• Identified with high test anxiety</li> <li>• Any geographical location</li> <li>• Age – between 11-19 years</li> </ul>	<ul style="list-style-type: none"> <li>• Elementary students</li> <li>• Middle school students</li> <li>• University students</li> <li>• Not identified as test anxious</li> <li>• Diagnosed other mental disorder like depression/anxiety/psychosis</li> </ul>
Intervention with baseline and post intervention assessment	Include	Exclude
	Studies investigating interventions aimed at reducing exam anxiety, such as ( but not restricted to): <ul style="list-style-type: none"> <li>• Cognitive Behavioral Therapy (CBT)</li> <li>• Mindfulness-based interventions</li> <li>• Emotional self-regulation techniques</li> <li>• Attention training techniques</li> <li>• Multimodal interventions combining cognitive and behavioral approaches</li> <li>• Hypnosis</li> <li>• Working memory training</li> <li>• Music therapy</li> <li>• Pet therapy</li> </ul>	Studies that do not involve interventions aimed at reducing exam anxiety (e.g., general stress management without a focus on exam anxiety).
Comparator	Include	Exclude
	<ul style="list-style-type: none"> <li>• Placebo</li> <li>• Waitlist control</li> <li>• No intervention</li> </ul>	<ul style="list-style-type: none"> <li>• Another form of intervention</li> <li>• On Pharmacotherapy for any mental disorder</li> </ul>
Outcomes	Include	Exclude
	Assessment for exam anxiety as primary or secondary outcome measure	No tool used to measure exam anxiety
Study Design	Include	Exclude
	<ul style="list-style-type: none"> <li>• Randomised controlled trial.</li> <li>• Pilot trial</li> <li>• Pre-test /post test experimental study</li> </ul>	<ul style="list-style-type: none"> <li>• Narrative review</li> <li>• Cohort study</li> <li>• Cross sectional study</li> <li>• Case studies</li> <li>• Reviews or meta analysis</li> <li>• opinions</li> </ul>
Decision	Eligible	Not Eligible

#### 4.5 Intervention Characteristics

##### 4.5.1 CBT

According to APA (2017), cognitive behavioural therapy (CBT) is based on three main ideas. It tries to fix incorrect or unhealthy ways of thinking and patterns of behaviour and teaches better ways to handle mental problems. CBT programs often use strategies to change thinking and behaviour. Thinking strategies involve learning to recognize distorted thinking and matching it with reality, adopting helpful behaviours and motivation, solving problems, handling exam-related stress, and building confidence. Meanwhile, behaviour change

strategies include confronting fears instead of avoiding them, practising role-playing for difficult interactions, and learning to form realistic and therapeutic relationships with others (APA, 2017).

The National Health Service-UK (2019) described CBT as a therapeutic approach aimed at assisting individuals in managing their issues by modifying their thought processes and behavioural patterns. Similarly, Graham (2005) defined cognitive behavioural therapy as any intervention based on the premise that an individual's thoughts are directly linked to their emotions and actions.

#### 4.5.2 Self-hypnosis

Hypnosis is akin to meditation, in which individuals can learn to enter consciously and purposefully for therapeutic purposes. During this state, suggestions are communicated verbally or through imagery to achieve the desired outcome (Valentine et al., 2018). These suggestions may seek to alleviate anxiety by promoting calmness and relaxation. However, the primary value of hypnosis lies in its ability to enhance the effectiveness of suggestion and access unconscious processes or mind-body connections. Our brain has two parts called cerebral hemispheres. When awake, the left side usually takes charge, acting like our 'conscious mind'. It is the logical, verbal part that thinks and communicates logically. However, the right side takes over when we relax or get deeply into something. This is our 'unconscious mind', known for emotions, creativity, and imagery. It doesn't speak in words like the left side does. So, when we want to calm down or ease anxiety, just saying "relax" might not work. Instead, we can use pictures or stories to help our mind understand and feel better. When students experience exam anxiety, they're mostly feeling emotions rather than thinking clearly. At this point, guiding their creative imagination towards positive outcomes is helpful. Anxiousness makes imagination often jump to worst-case scenarios, fuelling more anxiety and adrenaline and leading to potential panic (Williamson, 2019).

#### 4.5.3 Mindfulness Training

Mindfulness, a meditation method incorporating breathing exercises and guided imagery, serves to calm both body and mind (Hooker & Fodor, 2008; Scott, 2013). It encourages self-awareness, self-regulation and acceptance, which leads to better memory and learning outcomes because of the lowering of tension and anxiety (Keller et al., 2019).

Implementing mindfulness practices in classrooms has been shown to be effective in reducing the anxious thoughts in the minds of students, which impede cognitive functions, such as working memory (Bellinger et al., 2015). Mindfulness is being looked at as an alternate coping mechanism before or during exams for students with exam anxiety (Hjeltne et al., 2015).

#### 4.5.4 Progressive Muscle Relaxation

Progressive Muscle Relaxation (PMR) therapy, particularly targeted at adolescents, seeks to lower test anxiety levels by intentionally inducing muscle relaxation. This approach involves deliberately tensing and then relaxing specific muscle groups throughout the body, fostering a profound sense of calm.

Initially developed by Jacobson (1938), PMR involves the systematic tensing and releasing of muscle groups, often accompanied by focused breathing to reduce overall muscle tension. While Jacobson's original method required numerous sessions to address 30 different muscle groups, subsequent research by others streamlined the technique to just 16 muscle groups, yielding comparable results.

Furthermore, studies have suggested that PMR can induce physiological changes, such as reducing metabolic rate, lowering blood pressure, and decreasing blood flow in the middle cerebral artery (Conrad and Roth 2007).

#### 4.5.5 Animal Assisted Therapy

One notable form of social support during stressful situations is pet therapy, which has gained traction in various colleges and universities across the United States. Known as Animal-Assisted Therapy (AAT), these programs encompass animal visitation initiatives and activities aimed at reducing student anxiety (Adamle et al., 2009; Barker et al., 2016; Bell, 2013; Crump & Derting, 2015; Daltry & Mehr, 2015; Stewart et al., 2014; Young, 2012).

Feedback from students who have participated in AAT sessions during stressful periods, such as finals week, has been overwhelmingly positive. They describe the experience as excellent, noting significant stress reduction and a feeling of support (Bell, 2013; Binfet & Passmore, 2016; Young, 2012).

#### 4.5.6 Music Therapy

Previous research suggests that music influences health through changes in various neurochemical systems, including dopamine, opioids, cortisol, CRH, ACTH, serotonin, POMC derivatives, and oxytocin. A systematic review of 44 studies examined the biological impact of music in both clinical and nonclinical settings, finding that 13 out of 33 biomarkers were significantly affected by music compared to controls (Finn & Fancourt, 2018). Cortisol was the most frequently analysed biomarker, with 14 studies showing music either decreased cortisol more or increased it less than the control. Although music is widely used to reduce stress, its application in academic settings needs further exploration. Lilley et al. (2014) found that listening to calm music while studying lowered systolic blood pressure and heart rate and improved test scores, particularly for students whose course credit was at risk due to test performance.

#### 4.6 Outcome Indicators

The included studies utilized various validated instruments to measure exam anxiety. The Revised Test Anxiety Scale (RTA) evaluates worrying, distraction, tension, and physical symptoms during tests, with higher scores indicating greater anxiety. The School-Related Well-being Scale (SWBS) measures overall well-being in the school setting, with higher scores reflecting better well-being. The Revised Children's Anxiety and Depression Scale (RCADS) assesses generalized anxiety and panic, with higher scores indicating higher anxiety levels. Lastly, the Friedben Test Anxiety Scale (FTAS) evaluates social derogation, cognitive obstruction, and physiological elements, with higher scores indicating lower test anxiety. These tools are reliable and provide consistent results in measuring exam anxiety and related well-being.

### 5. Literature Search

Online databases searched for literature relevant to this systematic review included Medline, Embase, Prospero, PubMed, Web of Science, Cochrane library and Clinical trials.gov website. Attempt was also made to search grey literature through ethos.bl.uk for studies that have not been published and dissertations or thesis in the area, however, no literature relevant to this review was found. A list of keywords for each of the search items was made using synonyms for exam anxiety. Table 2 lists the various words used as search keywords in online databases. Outcome terms were not used as keywords for the search to increase sensitivity of the search. Search was limited to research papers in English language published because of lack of resources to interpret literature in any other language. The time limitation was set to gather literature from 2010 to present to be able to gather data from recent studies that have more probability of utilizing newer methods of cognitive training, especially digital based, ensuring that the analysis is on the most up-to-date intervention styles. This time limitation also limited the search to articles that followed the CONSORT 2010 statement by default. CONSORT 2010 is a 25-item checklist on guidance for reporting RCTs, adherence to which facilitates clarity, transparency of reporting and completeness, highlighting deficiencies in research which in turn results in improved designing and conduction of further research (Schulz et al. 2010).

Table 3. Search words used for online databases

Search Item	Words used
Population	Student (s), high school, college, school going, college* going, adolescents, teenager
Exam Anxiety	Exam anxiety, exam pressure, panic, test anxiety
Intervention	CBT, Meditation, music therapy, counselling, therapy, hypnosis, animal assisted intervention, pet therapy, exercise, relaxation techniques, intervention, <u>calming</u> , EFT, art therapy

\*high school is called college in some countries and curriculums

### 6. Data Extraction and Quality Assessment

The risk of bias in the included studies was critically appraised using the checklist provided by (Boland et al. 2014, p72) which is simple, comprehensive and based on the CRD (Centre for Reviews and Dissemination 2009) critical appraisal criteria. However, with this tool the judgements are not validated with quotes and comments as

is necessary with the Cochrane Risk of Bias Tool (Higgins and Green 2008, p194-202). Additionally, each study was rated using the Jadad Scale (Jadad et al. 1996). The Jadad Scale is a five point scale. High quality is designated by a score of  $\geq 3$  points; low quality attributed when the score is  $\leq 2$  points. The Jadad Scale (for RCTs) was chosen because of its brevity and simplicity. It assesses items that are clearly related to bias; its external validity and reliability has been substantiated (Halpern and Douglas, 2005). According to Clark et al (1999) (Jadad Scale) 'It is the most widely used such assessment in the world.' A systematic-review looking at different scales used for quality assessment of RCTs (Olivo et al. 2008) concluded that 'The Jadad Scale presented the best validity and reliability evidence.' The Jadad Scale, however, has been criticised for being too simple, over-focused on blinding, and with low inter-rater reliability. An important limitation is that it does not include assessment of allocation concealment, which according to the Cochrane Collaboration ([www.cochrane.org](http://www.cochrane.org)) is crucial to avoid bias (Higgins and Green 2008, p192). Also, according to Juni et al. (1999) the Jadad Scale places more emphasis on the quality of reporting than on methodological quality.

## 7. Narrative Synthesis

This systematic review incorporates a narrative synthesis to present an overview of the data and findings from each study.

### 7.1 Critical Appraisal of Included Studies

#### 7.1.1 Emotion, Self-Regulation, Psychophysiological Coherence and Test Anxiety: Results From An Experiment Using Electrophysiological Measures (Bradley Et Al., 2010)

Bradley et al describe the construct of “psychophysiological coherence” – a state of sustained activation of positive emotions. This state involves a shift towards order, harmony of physiological and psychological processes, and synchronisation, which results in the generation of a heart rate wave form of a smooth sinewave at a frequency of 0.1 Hz. There is less activation of the sympathetic nervous system and greater parasympathetic activity, a better heart- brain synchronisation and great resonance between various physiological systems (McCraty & Tomasino, 2006) (Tiller et al. 1996). This increased physiological coherence directly affects physical functions, cognitive functions, and task performance because of improvements in focus, attention, accuracy, and speed of responses, greater emotional stability, decreased perception of stress and negative emotions.



Table 4. Cochrane Risk of Bias Assessment

Quality Item	Study	Bradley et al., 2010	Shahidi et al., 2017	Putwain & Pescod, 2018	Shen et al., 2018	Fergus & Limbers, 2019	Ugwuanji et al., 2020	Putwain and von der Embse, 2021	Zandi et al. 2021	Pachaiap et al., 2023	Xu & Wei, 2024
<b>Randomisation (check for allocation bias)</b>											
Was the method used to assign participants to the treatment groups truly random?		yes	Yes	yes	Yes	no	Yes	yes	yes	NA	yes
What is the allocation of treatment concealed?		no	Can't tell	yes	Can't tell	no	Yes	yes	Can't tell	NA	Can't tell
Was the number of participants randomised stated?		yes	Yes	yes	Yes	yes	Yes	yes	yes	NA	yes
<b>Comparability (check for confounding)</b>											
Were details of baseline comparability presented?		yes	Yes	yes	Yes	yes	Yes	yes	yes	yes	yes
Was baseline comparability achieved?		no	Yes	no	Can't tell	Can't tell	Can't tell	Can't tell	yes	Can't tell	yes
<b>Eligibility (check for selection bias)</b>											
Were eligibility criteria for study entry specified		no	Yes	yes	Yes	yes	Yes	yes	yes	yes	yes
Were there any co- interventions that may influence outcomes for each group?		No	No	no	no	no	no	no	no	no	no

Quality Item	Study	Bradley et al., 2010	Shahidi et al., 2017	Putwain & Pescod, 2018	Shen et al., 2018	Fergus & Limbers, 2019	Uenwuan yi et al., 2020	Putwain and von der Embse, 2021	Zandi et al. 2021	Pachaiap pan et al., 2023	Xu & Wei, 2024
<b>Blinding (check for detection bias)</b>											
Were outcome assessors blinded to treatment allocation?		no	Can't tell	yes	Yes	Can't tell	Yes	yes	Can't tell	NA	Can't tell
Were the individuals who administered the intervention blinded to treatment allocation?		no	Can't tell	Can't tell	Can't tell	yes	yes	Can't tell	Can't tell	NA	Can't tell
Were the participants blinded to treatment allocation?		no	Can't tell	Can't tell	Can't tell	yes	yes	Can't tell	Can't tell	NA	Can't tell
Was the success of the binding procedure assessed?		no	No	no	no	Can't tell	Can't tell	no	no	NA	no
<b>Withdrawals (check for attrition bias)</b>											
Were ≥ 80% of participants randomised including in the final analysis		yes	Yes	yes	yes	yes	Yes	yes	yes	NA	yes
Were reasons for participant withdrawals stated?		yes	Yes	yes	yes	yes	Yes	yes	yes	yes	yes
Were there any unexpected dropouts in either group?		no	Yes	no	no	no	no	no	no	yes	no

Quality Item ↑	Study ↑	Bradley et al., 2010	Shahidi et al., 2017	Putwain & Pescod, 2018	Shen et al., 2018	Fergus & Limbers, 2019	Ugwuanji et al., 2020	Putwain and von der Embse, 2021	Zandi et al. 2021	Pachaiappan et al., 2023	Xu & Wei, 2024
Was an intention-to-treat analysis included?		yes	Yes	yes	yes	yes	yes	yes	yes	no	yes
<b>Outcomes (check for outcome reporting bias)</b>											
Is there evidence that more outcomes were measured than were reported?		no	no	no	no	no	no	no	no	no	no

Table 5. Jaddad Scale scoring for included studies

Study	study described as randomized (this includes the use of words such as randomly, random, and randomization) (+1)	the method to generate the sequence of randomization was described		Study described as double blind (+1)	the method of double blinding was described		Withdrawals and dropouts described	Total Score
		Appropriate (+1)	Inappropriate (-1)		Appropriate (+1)	Inappropriate (-1)	Yes (+1) No	
Bradley et al., 2010	+1	+1						2
Shahidi et al., 2017	+1	0					+1	2
Putwain & Pessard, 2018	+1	+1					+1	3
Shen et al., 2018	+1	+1					+1	3
Fergus & Limbers, 2019	0	0					+1	1
Ugwuanyi et al., 2020	+1	+1					+1	3
Putwain and von der Embse, 2021	+1	0					+1	2
Zandi et al. 2021	+1	0					+1	2
Pachaiappan et al., 2023	0	0					+1	1
Xu & Wei, 2024	+1	+1					+1	3

136 students of 10<sup>th</sup> grade from two high schools in California were selected for this experimental study, in which the electrophysiological study design was a controlled lab experiment, simulating the stressful conditions around an exam. Continuous HRV recordings were gathered while the students undertook the digital/Colorwood conflict test used for its ability to induce psychological stress.

The intervention aimed to teach both teachers and students a set of positive emotion-focused techniques to manage stress and test anxiety. These techniques involve intentionally shifting attention to the physical area of the heart while self-activating a positive emotion, such as love, compassion, or appreciation. This rapid initiation leads to an increased coherence in the heart's pattern of rhythmic activity, resulting in a change in the pattern of afferent cardiac signals sent to the brain, which reinforces the self-generated positive emotional shift and makes it easier to sustain. The study had three primary components aimed at both teachers and students in the intervention group: the Resilient Educator program for teachers, the TestEdge program for students, and heart rhythm coherence biofeedback training for teachers and students (Bradley et al.2007).

Measurement tools included, student opinion surveys, students' scores from pre-and post-intervention tests, electrophysiological measures by continuous HRV recordings via pulse measurement throughout the experiment.

The intervention successfully taught emotion self-regulation skills, leading to increased heart rhythm coherence and improved autonomic nervous system function among students in the experimental group. This skill acquisition was evidenced by a reduction in test anxiety and an improvement in emotional disposition. However, there was no significant increase in test performance for the full sample. Matched baseline test scores from 9th to 10th grade showed a notable and marginally significant difference in test score gains. Yet, the small sample size and the disproportionate representation of students from advanced classes in the control group might have affected these results. Furthermore, discriminant function analysis indicated a change in discriminating factors between the two groups, with changes in test anxiety and heart rhythm coherence becoming the prominent discriminators post-intervention. While the results suggest a causal link between emotion self-regulation skills and observed improvements, corroborating evidence is necessary. The findings emphasize the effectiveness of the TestEdge program in enhancing students' emotion self-regulation skills and reducing test anxiety.

The study had several limitations: significant differences in ethnic composition and academic levels between the intervention and control groups compromised matched-pairs comparisons, and the intervention group started with lower baseline HRV, potentially minimizing observed post-intervention differences. Additionally, the lack of data on English proficiency affected control over test performance factors, and using the Stroop Test to simulate test stress may not fully replicate high-stakes exam experiences. Finally, limited resources prevented utilizing a wait-listed control group to assess replication effects, missing additional data collection opportunities.

#### 7.1.2 Effectiveness of Mindfulness-based Stress Reduction on Emotion Regulation and Test Anxiety in Female High School Students (Shahidi et al., 2017)

In this randomised clinical trial, 50 students selected from high schools in Golpayegan, Iran, were randomly allocated to experimental (Mindfulness Based Stress Reduction) and control groups, the two groups were matched for each gender, age, and other moderating variables. The MBSR training intervention was given in 90 minute sessions weekly, for eight weeks in accordance with the concepts and techniques enumerated in the MBSR manual by Kabat-Zinn (Crane., 2002).

The Anxiety Scale (TAS) and The Cognitive Emotion Regulation Questionnaire (CERQ), were used as measurement tools after the intervention completion.

The collected data was analysed statistically and showed that MBSR had continuous significant effect on reducing test anxiety and on emotion regulation but not on self-blame.

The limitations of the study include a small sample size, a female only sample, no placebo group, no objective instruments for data collection, and no comparison of MBSR with any other gold standard therapy, such as CBT.

#### 7.1.3 Is Reducing Uncertain Control the Key to Successful Test Anxiety Intervention for Secondary School Students? Findings From a Randomized Control Trial (Putwain & Pescod, 2018)

This research focussed on the role of uncertain control in test anxiety. Control, along with locus and stability, constitutes one of the three dimensions by which individuals attribute causality to their actions (Weiner, 2010). In the context of evaluative situations, control refers to the extent to which an individual believes they are capable of affecting a successful outcome (Pekrun, 2006; Pekrun & Perry, 2014). Individuals with uncertain control cannot understand how their actions or choice of strategy is linked to outcomes, lack confidence in their abilities, and anticipate likely failure (Martin, 2002, 2007).

56 secondary school students from ethnically and socioeconomically heterogeneous backgrounds were randomly allocated into one of two intervention groups- early intervention or waitlist control group. Test anxiety measurement was done using the Revised Test Anxiety Scale (Hagtvet & Benson, 1997) and uncertain control was measured using the Motivation And Engagement Scale (Martin, 2007).

The RTAS was used to identify participants for the study- only those with scores above the 66% were invited to participate. The intervention was a multimodal computerised presentation which was created incorporating recent developments in the design and delivery of interventions for test anxiety. It was delivered in groups by trained facilitator over six sessions of 40 minutes each lasting for a six week period. A differing combinations of cognitive and behavioural approaches specifically suited to test anxiety interventions allowed a larger range of management approach.

The analysis of the results showed that moderate to large statistically significant reduction in worry and tension components of the testing were seen after the intervention giving an evidence to the effectiveness of the

intervention. However, test irrelevant thoughts and bodily symptoms related to the anxiety did not show any reduction post intervention. The study found that uncertain control mediated the effect of the intervention on worry and tension, which is a significant theoretical advancement as previous test anxiety interventions have yet to identify such mediators. The intervention's strategies, including identifying personal triggers for anxiety, controlling negative thoughts concerning failure and autonomic reactions, and learning test-preparation strategies, reduced uncertain control. Consequently, students believed they were more capable of achieving their anticipated examination outcomes, thereby reducing high levels of worry and tension.

While the study has limitations, including a relatively restricted sample and the exclusive use of self-report measures, it was sufficiently powered to demonstrate internal (experimental) validity. However, external (generalizability) validity could be compromised by the relatively small sample size

#### 7.1.4 Benefits of Expressive Writing in Reducing Test Anxiety: A Randomized Controlled Trial in Chinese Samples (Shen et al., 2018)

The study contributes valuable insights into the potential effectiveness of expressive writing in reducing test anxiety among Chinese senior-high-school students. A RCT by design, the study randomly allocated 75 senior school students with high test anxiety were divided into an experiment group that engaged in 20 minutes of expressive writing of positive emotions for 30 consecutive days and a control group that wrote down their daily events. Outcome measure tool used for assessing test anxiety was The Test Anxiety Scale(TAS) given before and after the intervention period. While the TAS scores did not differ between the two groups before the intervention, the post intervention scores showed statistically significant improvement in the experiment group.

The participants identified various triggers for positive emotions, such as relaxation, learning with others, concentrating on study, receiving praise, and avoiding punishment. However, despite focusing on positive emotions, many participants still showed signs of anxiety, including physiological and emotional responses like increased heart rate, dizziness, and feelings of panic.

The study identified three main components: anxiety manifestation, positive emotion, and insight. Anxiety manifestation included worry about learning and tests, while positive emotion encompassed positive cognition of learning and tests, as well as emotional responses. Insight referred to the deep feelings and thoughts participants expressed during later periods, such as realizing the happiness in their lives despite stress and anxiety.

The evaluations of the intervention focused on its effectiveness, frequency, and convenience. While many participants found expressive writing helpful in reducing anxiety, some still experienced troubles with anxiety. Writing frequency was generally acceptable, though some felt it was too frequent. However, most students found expressive writing convenient as it only required pen and paper and could be done anywhere.

The study found a correlation between the use of positive emotion and insight codes in later manuscripts and lower levels of test anxiety. Significant differences were observed in positive emotion, anxiety manifestation, and insight codes between the first and last 10 days of the study.

Statistically, the study suggests that expressive writing of positive emotions may help reduce test anxiety, especially when participants focus on insights and deeper feelings over time. However, this may be influenced by culture and results must be interpreted with appropriate reference and caution. Moreover, as students typically engaged in their expressive writing sessions in the evening, reflecting on their positive emotions may have contributed to ending their day on a positive note. This could have facilitated feelings of relaxation and potentially enhanced their sleep quality. Improved sleep patterns would likely lead to starting the school day with a more positive outlook and experiences. Consequently, this positive cycle could gradually mitigate test anxiety and potentially enhance learning efficiency over time.

While this method is flexible, cost-effective, and convenient, as it does not require specific locations or the presence of a counsellor, it could be more beneficial to implement in schools for students with severe test anxiety. This study is limited by its small sample size, lack of generalizability of results beyond the specific sample studied and the lack of measurement regarding changes in academic performance.

#### 7.1.5 Reducing Test Anxiety in School Settings: A Controlled Pilot Study Examining A Group Format Delivery of the Attention Training Technique among Adolescent Students (Fergus & Limbers, 2019)

In this study, 74 8<sup>th</sup> grade students were assigned to intervention or control group based on the period their health class met. The study implemented a group intervention using the Attention Training Technique (ATT) and a music-listening control condition to address test anxiety among students. Over five sessions conducted on consecutive weekdays, students listened to recordings in a designated lounge, with the research assistant present. Despite lacking explicit instructions on anxiety-reduction strategies, participants were instructed to listen to the

intervention attentively. The decision for five sessions was based on previous research indicating effectiveness after three sessions and logistical considerations aligning with the school week.

The Children Test Anxiety Scale (CTAS) and the Metacognitions Questionnaire for Children (MCQ-C) were used as assessment measurement tools. The study found that students' baseline test anxiety levels were comparable to those of similar samples. Most students exhibited moderate test anxiety severity, with no significant difference between the ATT and control groups. Regression analyses revealed significant effects of positive and negative metacognitive beliefs on post-intervention test anxiety. Specifically, the interaction between intervention group and metacognitive beliefs significantly predicted post-intervention test anxiety, with ATT demonstrating lower anxiety levels compared to the control group among students with high positive or negative metacognitive beliefs. Within-group analyses indicated moderate to large reductions in test anxiety following ATT among students with high metacognitive beliefs, whereas stability was observed in the control group. These findings suggest that ATT may effectively reduce test anxiety, particularly among students with high levels of metacognitive beliefs. Similar results were found for Cognitive test anxiety in the intervention group. Results from this study suggest that the Attention Training Technique (ATT) shows promise as an intervention for reducing test anxiety in adolescent students, particularly among those with stronger metacognitive beliefs about worry.

The study has several limitations that warrant consideration. First, the participants were drawn from health classes, and only those who returned assent and parent permission forms were included, potentially introducing selection bias. Additionally, students were not randomized individually to interventions, and class periods received interventions as a whole, which could have impacted results. Moreover, attendance at intervention sessions was not recorded, so the extent of students' engagement with the interventions remains unknown. The lack of consensus on preferred measures of metacognitive beliefs among children and adolescents also poses a limitation. Furthermore, while the effects of ATT were stable at a 3-week follow-up, longer-term follow-up periods were not examined. Finally, the study did not explore potential outcomes beyond test anxiety reduction, such as academic achievement or approaches to studying, which could provide a more comprehensive understanding of the intervention's impact.

#### 7.1.6 Effect of Cognitive-behavioural Therapy with Music Therapy in Reducing Physics Test Anxiety among Students as Measured by Generalized Test Anxiety Scale (Ugwuanyi et al., 2020)

A pre-test/post-test randomised controlled trial experimental design, this study randomly allocated 83 secondary school physics students, with mild to moderate test anxiety, to an intervention and a control group.

Utilizing music as a collective activity in therapy introduces clients to concepts of CBT through non-verbal facilitation, potentially prolonging therapeutic engagement beyond traditional talk therapy. Trimmer et al (2016) assert that music, being universal, holds intrinsic value across cultures and connects individuals on a fundamental level. In this intervention, music served as a delivery medium rather than a standalone therapy, aiding in comprehension of therapeutic concepts, facilitating discussions on sensitive topics, and fostering a positive therapeutic environment for students and facilitators alike. The program was designed as a 90 minute session of CBT based music, delivered once a week for 12 weeks, in groups and supervised by trained CBT and music therapists. The program aimed to decrease physics test anxiety in students through CBT group therapy integrated with music, enhancing comprehension and engagement. Music was infused into various aspects of therapy, including critical listening, songwriting, and playing instruments. Sessions followed a traditional CBT structure, addressing themes like thinking, behaviour, and emotions, and employed CBT tools such as behavioural experiments and thought records. Facilitators aimed to create a sense of coherence akin to "band practice." Sessions 1-3 focused on establishing rapport and understanding anxiety, while 4-7 addressed changing automatic thoughts. Sessions 8-11 emphasized music integration and discussion of CBT-related songs, alongside CBT techniques like cognitive restructuring and attention training.

Generalized Anxiety test inventory was used as a measurement tool (Suinn, 1969).

The results after the statistical analysis showed that CBT-music was very significant in reducing the physics test anxiety and the this reduction was retained for several months as shown by the follow up evaluation.

This study is limited by its sample size and limitation to one subject only, namely physics. Also, insufficient control over music and a difficulty to assess prior exposure to CBT could have caused errors in results. Besides, the challenge that the songwriters faced to formulate lyrics to effectively capture the fundamental concepts of self-help material poses a question of generalisability of the findings of the study.

### 7.1.7 Cognitive–Behavioural Intervention For Test Anxiety In Adolescent Students: Do Benefits Extend To School-Related Wellbeing And Clinical Anxiety(Putwain And Von Der Embse 2021)

With an aim to study the effect of a CBI named STEPS (Strategies To Tackle Exam Pressure And Stress), the intervention was delivered by trained facilitators to 146 anxious high school students in groups of 5-7, randomly allocated to either control or intervention group. The participant characteristics are enumerated in Table 5. STEPS, a six-session multi-modal Cognitive Behavioural Intervention (CBI) manual for adolescent test anxiety, was designed to address the cognitive, emotional, and behavioural aspects associated with high test anxiety (Zeidner & Matthews, 2005).

Each of the six sessions focused on different components: understanding and recognizing test anxiety signs and its effects, challenging negative thought patterns about failure, learning and practicing physiological symptom control, developing study and test-taking skills, understanding motivation and avoidance behaviours, and evaluating the effectiveness of strategies employed (Putwain et al., 2014). The content of STEPS was delivered via a software called Articulate, ensuring standardised delivery of 45 minutes per session. A combination of activities, including psychoeducational instructions, quiz based in reinforcement of learning, exercises for self-reflection, anxiety management technique practices, and video clips of students that had recently taken their GCSE exams were included in the software. This was followed by exercises for homework.

Results of this study showed that STEPS was effective in reducing generalised anxiety, panic and test anxiety and the school related well-being of intervention group was improved as compared to the control group. The study also recorded a decrease in the test anxiety in the control group, hinting at the possibility that a general approach to school well-being may be effective in reducing test anxiety. However, the reduction in test anxiety was much larger in the intervention group.

While the multimodal approach to CBI acknowledging the complexity of this anxiety is the strength of this study, it is limited by its small sample size and the gender bias in the sample – more female students than males, limiting the generalisability of the findings and raising the question that are the interventions equally effective for both genders or if certain strategies may be more effective for one gender over the other. A lot of specificity in the intervention elements makes it difficult to discern which component of intervention contributed most to its efficacy, further limiting this study. Another limitation may be the focus of the study solely on outcomes and not on the processes that may have influenced the intervention success such as implementor characteristics, intervention delivery quality and participant engagement. Study also highlighted that high levels of test anxiety may be construed as a risk factor for clinical anxiety and observed that when central symptoms such as worry about failure, are deactivated, the associated anxiety symptoms are also deactivated. However, the lack of improvement in school related well-being highlights that test anxiety may be just one of the components of a larger construct of student well-being at school.

### 7.1.8 The Effectiveness of Mindfulness Training on Coping with Stress, Exam, Anxiety, and Happiness to Promote Health (Zandi et al. 2021)

Zandi et al(2021) investigated the effectiveness of mindfulness training on test anxiety along with coping with stress in female high school students from Iran. 40 students were randomly selected and assigned to either an experimental group or a control group in this quasi experimental study design. The tools to measure and collect data pertaining to the stress included “questionnaire to coping with stressful situations” by Endler and Parker (Endler & Parker, 1994) and Sarason test Anxiety Questionnaire. These were used both pre and post intervention.

Over the course of eight sessions, participants engaged in various mindfulness exercises and techniques. They began with basic mindfulness practices involving raisin meditation and progressed to coping strategies, breathing techniques, staying present, self-compassion, and integrating learned skills into daily life. Each session included specific homework assignments aimed at reinforcing and deepening mindfulness practice.

The study found that mindfulness training had significant positive effects on coping skills among secondary school female students in Sanandaj. Specifically, it improved problem-oriented coping while reducing emotion-oriented coping and avoidant coping. Additionally, mindfulness training led to a decrease in test anxiety and an increase in students' happiness levels. These findings were consistent with previous research and suggest that mindfulness can enhance coping strategies, reduce anxiety, and promote overall well-being among students.

This study found its limitations in the very small sample size and all female study participants, limiting its generalizability. Other limitations include a lack of follow-up to assess the effectiveness of mindfulness on the



variables over time, and the use of self-report questionnaires to collect data, which may have added to the bias in the results.

#### 7.1.9 Effect of Self-Hypnosis on Test Anxiety among Secondary School Students in Malaysia (Pachaiappan et al., 2023)

Conducted amongst a secondary school student cohort of 52 students with moderate to high test anxiety, this study assessed the efficacy of self-hypnosis in reducing test anxiety. The script for the self-hypnosis was adapted from *Grade Power: The Complete Guide to Improving Grades Through Self-hypnosis* (Alderson, 2004), *Hartlands Medical and Dental Hypnosis* (Hartland et al., 2002), *Exploring the Experiences of Participants Involved in a Hypnosis Intervention for Test-Anxious School Students* (Patterson, 2014). Throughout the intervention, hypnosis was conducted for a certain number of sessions and self-hypnosis was taught for the other number of sessions. Students also received audio recordings of hypnosis conducted to listen to after every session along with the script. The FTAS was administered four times during the course of intervention. The statistical analysis of the results showed that the students anxiety was significantly reduced across all four time points of measurement suggesting that the intervention was successful in reducing overall test anxiety.

The absence of a control group in its one-group pre-experimental design compromises internal validity, potentially influenced by factors like history, maturation, and testing (Spurlock, 2018). Furthermore, the Hawthorne effect, wherein participants alter their behaviour due to awareness of being observed or studied, may have impacted the study's findings.

#### 7.1.10 The Effect of Working Memory Training on Test Anxiety Symptoms and Attentional Control in Adolescents (Xu & Wei, 2024)

In this recent research paper, the authors investigated the benefit of a novel approach of working memory training to address test anxiety levels, coupling it with enhancement of attention control. They studied the effect of working memory training – an aspect researched by many but with inconsistent findings – some studies showing benefits of adaptive dual and n-back working memory task (Owens et al., 2013) (Sari et al., 2016) while others demonstrating that the dual n-back task could improve attention control but has no effect on anxiety symptoms (Ducrocq et al., 2017) (Wei et al., 2022).

46 school students between the age group 11-17 years were randomly selected and randomly allocated to the training or the control group using a minimization principle. The Anxiety Scale (Mandler & Sarason, 1952) was used to measure symptoms of test anxiety and The Attention Control Scale (Derryberry & Reed, 2002), the modified version of flanker task (Eriksen & Eriksen, 1974) and the modified Go/No go task (Simson et al., 1977) were used for measuring attention control.

The working memory training was achieved by the adaptive dual n-back working memory training task. Participants engaged in a memory task involving a 3×3 grid, blue squares, and spoken letters. Each trial began with a fixation point, followed by a blue square and a spoken letter. Participants memorized the square's location and the letter. After a delay, they recalled previous pairs and judged matches. Accuracy determined task difficulty: ≥80% advanced, 50-79% maintained, <50% made easier. Participants progressed through levels based on accuracy. Each session lasted 40 minutes with 20 blocks of trials. In the non-adaptive dual 1-back working memory training task participants engaged in a 1-back working memory task, recalling the location of a blue square and a spoken letter. They compared current stimuli with those from one trial back, using the same response keys. Each session lasted 25 minutes, consisting of 20 blocks with 21 trials each.

After a statistical analysis, the results showed that the training group showed significant relief of the test anxiety symptoms as compared to the control group while the ACS scores remains unchanged.

The limitations of this study include its small sample size that may have made it difficult to identify post-test differences between groups, especially those to do with the outcome of the behavioural tasks. There is also no assessment on the lasting effect of the benefit post intervention.

Table 6. Participant Characteristics in Included Studies

Study	Number				Mean Age	Intervention	Control	Race				Identified with test anxiety
	Total	Male	Female	Not specified				White Caucasian	Asian	Black	Other	
Bradley et al., 2010	136	64	72	0	15.3	77	59	65	16	1	54	yes
Shahidi et al., 2017	50	0	50	0	16*	25	25	0	0	0	50	yes
Putwain & Pescod, 2018	56	19	37	0	14.7	25	31	21	10	12	5	yes
Shen et al., 2018	75	21	54	0	16.84	38	37	0	75	0	0	yes
Fergus & Limbers, 2019	73	25	48	0	13.8	39	34	43	12	13	5	yes
Ugwuanyi et al., 2020	83	46	37	0	18	46	40	0	0	83	0	yes
Putwain and von der Embse 2021	161	39	101	6	14.1	80	81	105	26	13	2	yes
Zandi et al. 2021	40	0	40	0	16*	20	20	0	0	0	40	yes
Pachaiappan et al., 2023	22	4	18	0	16	22	0	0	22	0	0	yes
Xu & Wei, 2024	40	10	30	0	14.5	21	19	0	40	0	0	no

Table 7. Study characteristics

Author/Year	Country	Study Design	Intervention	Duration of Intervention	Control/Comparator	Evaluation/Assessment tools	Outcomes
Bradley et al., 2010	California, USA	Randomised Pre/post intervention experiment study design	<b>Emotional Self Regulation (TestEdge) Program</b> Classroom based emotional self-regulation to achieve psychophysiological coherence. Delivered by teachers (with prior training), 2 lessons per week, Test Edge program teaches students tools to improve test performance, enhance learning retention, increase emotional awareness, and manage stress in school and personal life	1 school semester (5 months)	Wait list control	Student Opinion survey, scores from CST, HRV recording	Improvement across all HRV measures, indicating that intervention had allowed students to better manage their emotions and to self-activate the psychophysiological coherence state under stressful conditions and reduced test anxiety.
Shahidi et al., 2017	Golpayegan, Iran	Randomised Clinical Trial	<b>Mindfulness based stress reduction</b> session, once a week	8 weeks	Life as usual	TAS, Cognitive emotional regulation questionnaire	MBSR program had continuous significant effects on test anxiety ( $P < 0.000$ ) and emotion regulation ( $P < 0.000$ )

Author/Year	Country	Study Design	Intervention	Duration of Intervention	Control/Comparator	Evaluation/Assessment tools	Outcomes
Putwain & Pescod, 2018	England	RCT	<b>STEPS</b> (Strategies To Tackle Exam Pressure And Stress), a multimodal intervention using combinations of Cognitive and behavioural approaches incorporating identification of test anxious signs, of negative <u>self talk</u> and replacing with positive talk, relaxation technique, study and test taking skills, goal setting and reflection.	40 mins weekly session for 6 weeks	Wait list control	Revised TAS Motivation and Engagement Scale	moderate to large reductions in the worry and tension components of test anxiety, and uncertain control, after the intervention.
Shen et al., 2018	Xinxiang city, China	RCT	20 mins of <b>expressive writing of positive emotions</b>	Daily for 30 days	Writing daily activities <u>everyday</u> for 30 days	TAS	Intervention group showed significant reduction in TAS scores ( $P < 0.001$ )

Author/Year	Country	Study Design	Intervention	Duration of Intervention	Control/Comparator	Evaluation/Assessment tools	Outcomes
Fergus & Limbers, 2019	USA	Controlled pilot study	Attention training technique (ATT) with Music, a form of CBT	12 minutes of recorded auditory listening technique to encourage disengagement from worry. Duration of intervention – 5 days	Listening to music (Mozart or Beethoven) for the same duration as intervention group	Children test anxiety scale (CTAS) Metacognition s Questionnaire for Children (MCQ-C)	ATT provided greater test anxiety reduction than the control group, effects remaining at the 3 week follow up.
Ugwuanyi et al., 2020	Nigeria	Pre-test post-test randomized control trial experimental design	CBT with music, 90 minutes group session per week. Involved listening, songwriting, and playing simple instruments, integrated with CBT techniques.	12 weeks	No treatment	Generalized test anxiety inventory	Significantly lower test anxiety scores at the post-treatment and at the follow-up measure.

Author/Year	Country	Study Design	Intervention	Duration of Intervention	Control/Comparator	Evaluation/Assessment tools	Outcomes
<b>Putwain and von der Embse 2021</b>	England	RCT	<b>STEPS</b> - Six sessions of multimodal CBT delivered by professionals in groups of 5-7, 45 mins/session	6 consecutive weeks	Wait list control	RTA scale, SWBS, RCADS	Test anxiety showed a large reduction following intervention compared to control group
<b>Zandi et al. 2021</b>	Iran	Quasi experimental with control group, with pre-test and post -test.	<b>Mindfulness based stress reduction</b> :Eight sessions of mindfulness training covering communication, coping with obstacles, breathing techniques, staying present, granting oneself permission, understanding thoughts, self-care, and reflection. Mindfulness exercises included raisin meditation, breathing space, and sitting meditation, with corresponding homework assignments to practice mindfulness in daily activities	2 weeks	No training	Oxford happiness , <u>Sarson</u> Exam anxiety and <u>Andler</u> and <u>Parker</u> Stress management Questionnaires .	A significant difference between the mean scores of test anxiety pre and <u>post test</u> were seen

Author/Year	Country	Study Design	Intervention	Duration of Intervention	Control/Comparator	Evaluation/Assessment tools	Outcomes
<b>Pachaiappan et al., 2023</b>	Malaysia	Quantitative approach with pre experimental design	<b>Self-hypnosis</b> :Five hypnosis sessions with students, aiming to build rapport and dispel misconceptions about hypnosis. Each session included inductions such as the eye roll technique and Hartland's Progressive Muscle Relaxation, followed by ego strengthening and posthypnotic suggestions. Homework involved listening to hypnosis audios and practicing self-hypnosis.	5 weeks	Pre test/ post test study design	FTAS	test anxiety was significantly reduced across four time points, $F(3,60) = 19.747, p < .001$ , $\eta^2 = 0.5$ , as measured by the FTAS
<b>Xu &amp; Wei, 2024</b>	China	Randomised clinical trial	<b>Working memory training tasks</b> ( the adaptive dual n back WM training task and behavioural tasks ( flanker task and Go/No-go task)	5 days a week for 2 weeks		TAS ACS	Reduced test anxiety in intervention group but no improvement in Attention Concentration.

## 8. Results

This systematic review analysed a total of seven hundred and thirty six participants ( $N=736$ , male  $n= 228$ , female  $n= 487$ , not specified  $n=6$  ). Out of these three hundred and ninety three were part of an intervention group while three hundred and forty six were comparators/controls.

This systematic review analysed the interventions based on emotional self-regulation, mindfulness based stress reduction, multimodal therapies, positive emotions and expressive writing, attention training techniques, cognitive behavioural therapy with Music, working memory training and self-hypnosis.

Bradley et al. (2010) conducted their study in California, USA, employing a classroom-based emotional self-regulation program known as the Test Edge program. This program, delivered by trained teachers over a school semester, involved two lessons per week focusing on improving test performance, learning retention, emotional awareness, and stress management. The intervention group showed significant improvements across all heart rate variability (HRV) measures, indicating enhanced emotion management and the ability to achieve psychophysiological coherence under stress, thus reducing test anxiety compared to the wait list control group.

In Golpayegan, Iran, Shahidi et al. (2017) evaluated the effects of a mindfulness-based stress reduction (MBSR) program. Participants attended weekly sessions for eight weeks. The study found that the MBSR program led to continuous significant reductions in test anxiety and improvements in emotion regulation, as measured by the Test Anxiety Scale (TAS) and the Cognitive Emotional Regulation Questionnaire, with p-values less than 0.001 for both outcomes, compared to the control group who continued with their usual life.

Putwain and Pescod (2018) in England investigated a multimodal intervention incorporating cognitive and behavioural approaches over six weekly sessions. This intervention focused on identifying test anxiety signs, replacing negative self-talk with positive affirmations, relaxation techniques, study skills, and goal setting. The results demonstrated moderate to large reductions in the worry and tension components of test anxiety and uncertain control, as measured by the Revised Test Anxiety Scale (TAS) and the Motivation and Engagement Scale, compared to the wait list control group.

Shen et al. (2018) from Xinxiang City, China, explored the impact of expressive writing of positive emotions, with participants writing daily for 30 days. The intervention group exhibited a significant reduction in TAS scores ( $P < 0.001$ ) compared to the control group, who wrote about daily activities. This suggests that expressive writing about positive emotions can effectively reduce test anxiety.

Fergus and Limbers (2019) in the USA conducted a controlled pilot study using an attention training technique (ATT) as a form of cognitive-behavioural therapy (CBT). Participants engaged in a 12-minute recorded auditory listening technique aimed at encouraging disengagement from worry, for five days. Compared to the control group, who listened to music (Mozart or Beethoven), the ATT group showed greater reductions in test anxiety as measured by the Children Test Anxiety Scale (CTAS) and the Metacognitions Questionnaire for Children (MCQ-C), with effects persisting at a three-week follow-up.

Ugwuanyi et al. (2020) in Nigeria examined the effects of CBT integrated with music over 12 weeks. The intervention included listening, songwriting, and playing simple instruments alongside CBT techniques in weekly 90-minute group sessions. The results showed significantly lower test anxiety scores post-treatment and at follow-up, as measured by the Generalized Test Anxiety Inventory, compared to the no-treatment control group.

Putwain and von der Embse (2021) conducted an RCT in England using the STEPS program, which involved six sessions of multimodal CBT delivered by professionals in groups of 5-7 students over six consecutive weeks. The intervention led to a substantial reduction in test anxiety compared to the wait list control group, as measured by the Revised Test Anxiety Scale (RTA), the Satisfaction with Life Scale (SWBS), and the Revised Child Anxiety and Depression Scale (RCADS).

In Iran, Zandi et al. (2021) conducted a quasi-experimental study with a control group, providing eight sessions of mindfulness training over two weeks. The training covered communication, coping with obstacles, breathing techniques, staying present, and self-care, with mindfulness exercises such as raisin meditation, breathing space, and sitting meditation. The intervention group showed a significant reduction in test anxiety, as measured by the Sarson Exam Anxiety and Andler and Parker Stress Management Questionnaires, compared to the control group.

Pachaiappan et al. (2023) in Malaysia implemented a pre-experimental design with five hypnosis sessions aiming to build rapport and dispel misconceptions about hypnosis. Each session included techniques such as the eye roll technique and Hartland's Progressive Muscle Relaxation, followed by ego strengthening and posthypnotic suggestions. Homework involved listening to hypnosis audios and practicing self-hypnosis. The intervention significantly reduced test anxiety across four time points, as measured by the FTAS, with  $F(3,60) = 19.747$ ,  $p < .001$ ,  $\eta^2 = 0.5$ .

Finally, Xu and Wei (2024) in China conducted an RCT using working memory training tasks over two weeks. Participants engaged in adaptive dual n-back WM training tasks and behavioural tasks (flanker task and



Go/No-go task). The intervention group showed reduced test anxiety as measured by the TAS and Attention Concentration Scale (ACS), although there was no improvement in attention concentration.

In summary, these studies demonstrate that various interventions, including emotional self-regulation, mindfulness-based stress reduction, cognitive-behavioural approaches, expressive writing, attention training, and music-integrated CBT, are effective in reducing test anxiety. The outcomes suggest that these interventions can significantly improve emotional regulation, reduce worry and tension, and enhance coping strategies, contributing to lower levels of test anxiety in diverse populations.

## 9. Discussion

Anxiety about examinations – or test anxiety (TA) – concerns the “phenomenological, affective, and behavioural responses that accompany concern about the possible negative consequences of poor performance in an examination or other performance-evaluative situations” (Zeidner & Matthews, 2005).

According to the Self-referent and Executive Processing (S-REF) model (Zeidner & Matthews, 2005), the enhanced emotional reaction and worry during evaluative situations comes from two executive processes: an assessment of the evaluative situation and the plans for coping with that situation.

Students who experience test anxiety tend to perceive exams as personally significant events, especially when failure seems probable. Consequently, they often resort to unproductive coping mechanisms with a focus to minimize emotional impact, such as avoiding the situation altogether, rather than adopting strategies that could potentially prevent failure, like seeking assistance. Negative beliefs about how they handle stress, such as considering worry as a helpful tactic, contribute to maintaining this view of exams as threatening. Moreover, their self-perception is influenced by pessimistic thoughts about their academic capabilities and their proficiency in studying and taking tests. This pessimism leads them to avoid opportunities aimed at enhancing their academic skills and exam-taking abilities, thus solidifying their negative self-beliefs. This results in a further elevated anxiety state, disturbed focus and distress (Putwain, 2019) (Brandmo et al. 2019) (Putwain et al. 2016).

Educators face the enormous challenge to prepare students for testing in a way that their performance reflects their true academic ability, resulting in accurate test data necessary for curricular and administrative decision making (Erford and Moore-Thomas 2004).

The aims and objectives of this study were to ascertain the most beneficial intervention for exam stress in adolescents and the secondary objectives were to critically evaluate interventions, identify contributing factors to exam stress, assess its prevalence, and synthesize empirical evidence. Now, we delve into the findings to determine the most effective strategies, taking into account regional, cultural, and educational system variations.

Having systematically reviewed all the studies done on exam stress in high school students, there is one consensus – irrespective of the intervention utilized as a means to alleviate exam stress, there was statistically significant benefit seen for every one of the interventions. For better understanding of how interventions may effect exam anxiety, an understanding of the construct of exam anxiety needs to be examined.

Spielberger's model of test anxiety (Spielberger 1966, 1976) highlights three aspects of the construct of test anxiety. These are ‘the stressor’ – which is the stress associated with the situation of test/exam, ‘the threat’ – an evaluation of the degree of threat, which is the subjective perception of threat posed by the stressor to the individual, and ‘the anxiety response’ – the emotional state which is activated in response to the perceived threat and may include worry, negative thoughts and physiological effects. He further goes on to assert that the anxiety reaction varies as a function of the degree of the perceived threat (Spielberger and Vagg 1995a) since all physiological and emotional aspects of the anxiety response are based on the assessment of the stressor. It is assumed that working on changing the perception and thoughts about the stressor and its perceived threat, it is possible to reign in the emotions around anxiety, resulting in improvement of performance in the test (Spielberger and Vagg 1995b).

Considering the above explanation, interventions focusing on changing thought process should have a significant improvement in test anxiety. However, such is not the case, the justification of which may lie in further research. Neuroscientific evidence shows that emotions often occur without any involvement of the cognitive system, and besides, they have the capability of significantly affecting the process of cognition and its output (LeDoux 1996; LeDoux 1994 ; Niedenthal and Kitayama 1994). It has also been shown that emotions have an influence on all aspects of cognition and behaviour (Immordino-Yang and Damasio 2007).

The psychophysiological approach, on the other hand, emphasizes the role of emotions and physiological processes in shaping our experience (Damasio 2003). Recent research highlights the importance of heart signals in emotional regulation (Lane et al. 2009; McCraty and Tomasino 2006; McCraty et al. 2006; Thayer et al. 2009).

Heart rate variability (HRV) has been identified as a measure of emotional stability and cognitive function. Higher resting HRV is linked to superior cognitive performance. Heart rhythm patterns also influence emotional states and cognitive function. Coherent heart rhythm patterns, associated with positive emotions, such as of appreciation, compassion and love, enhance cognitive function and task performance. Conversely, incoherent heart rhythms, associated with stress and negative emotions, impair cognitive function. Understanding this link between the heart, emotions, and cognition can help in managing test anxiety effectively. This has help identify a state called "psychophysiological coherence," associated with sustained positive emotions, in which there is increased order and harmony in both physiological and psychological processes (Bradley et al.2010). Physiological changes include a smooth, sine wave-like heart rate variability (HRV), increased synchronization between the autonomic nervous system branches, and enhanced heart-brain synchronization. Psychophysiological coherence leads to improvements in cognitive function and task performance, emotional stability, and a reduction in stress perception (McCraty et al. 2006). Importantly, this state can be intentionally generated using positive emotion-based tools and techniques Childre and Martin 1999). Regular practice of coherence-building techniques, induces lasting improvements in health, emotional balance, and cognitive function, promoting a more harmonious state of being.

Research spanning from childhood (e.g., von der Embse et al., 2013) to early adulthood (e.g., Ergene 2003; Zeidner 1998) suggests that pinpointing the root cause of academic anxieties allows for tailored interventions to aid student success. For example, students experiencing test anxiety due to study skill deficits may benefit from academic coaching or learning strategies. Alternatively, those facing physiological symptoms might find mindfulness meditation interventions helpful.

Students with high levels of test anxiety often face challenges during test preparation (the time between the announcement of a test till the actual test) which can negatively impact their performance. These challenges include unproductive motivation, ineffective study habits and time management which includes poor study skills, and difficulties in concentrating or remembering information.

Moreover, when they feel stressed about tests, they may use coping strategies that further burden their cognitive resources, making it harder to focus on learning. Identifying and addressing these issues can help improve their test performance (Cassady 2022) (Koerner et al. 2017).

### *9.1 Test Anxiety and Performance Measures*

The common education related performance measured include achievement in typical classroom tests, Grade Point Average (GPA), Intelligence Quotient (IQ) and Standardized Exams ( like the SAT/ACT, A levels, GCSE, IB , CBSE, ICSE ). Studies have shown a negative correlation between test anxiety and test performance, the largest negative correlation being with the university entrance exams and standardised tests that are considered the "high-stakes" exams (von der Embse et al., 2018) (Segool et al., 2013).

There is also a negative correlation between test anxiety and IQ test results, especially on the verbal and cognitive component of the test, indicating that the "worry" may be interfering with verbal demands and working memory (Lee, 1999) (Chapell et al., 2005) (Markham & Darke, 1991).

### *9.2 Test Anxiety and Intrapersonal Variables*

A thirty year meta analytical review on the predictors and correlates of test anxiety found that self-esteem and self-efficacy had the strongest negative correlation with test anxiety (von der Embse et al., 2018), similar to previous research Hembree (1988). Recent studies also showed a clear negative and consistent connection between self-concept and test anxiety. This highlights the profile of anxious students who may have negative beliefs of themselves, and the capability of succeeding in academic or personal challenges (Raufelder & Ringeisen, 2016). However, the relationship between locus of control and test anxiety is weaker, suggesting that students' beliefs about their control over their environment can vary. Test anxiety has been shown to be positively associated with extrinsic motivation, meaning students driven by external pressures rather than personal interests were more likely to experience higher test anxiety. Additionally, students with high test anxiety tended to avoid performance and mastery goals and use avoidance coping strategies, especially in high-stakes testing situations (Putwain & Symes, 2010).

It has also been found that neuroticism is linked to higher anxiety levels (Watson & Clark, 1984), while conscientiousness is linked to personal traits like motivation and self-confidence, which tend to be associated with lower test anxiety. This suggests that certain personality traits and their related qualities can help predict who might have higher or lower test anxiety.

### 9.3 Test Anxiety and Demographic Correlates

It's commonly believed that certain groups of people experience higher levels of test anxiety, which can affect their test scores. These differences in how test anxiety shows up are often used to identify students who might need extra support. Past research, like Hembree's work, has been used to support this idea, but testing has changed a lot since then. It has been found in recent studies found that while females still tend to have higher test anxiety than males, the difference isn't as big as previously thought (von der Embse et al., 2018). Similarly, minority students also have slightly higher test anxiety, but not as much as previously reported. New studies also show that tests perceived as harder and tests with more consequences tend to cause more anxiety.

### 9.4 Living Environment and Test Anxiety

Other research has shown that both personal factors and the living situation can affect test anxiety. For instance, McDonald (2001) found several factors linked to test anxiety, such as kids feeling pressure from their parents to do well in school, fearing the consequences of not meeting expectations, getting praised for their grades rather than their effort, comparing themselves a lot to their classmates, and being in a competitive classroom. Aljalil and Asadi (2015) discovered that parents who are perfectionists tend to have kids with more test anxiety. Ablard and Parker (1997) discovered that while some parental support for academic success can be beneficial, setting unrealistic expectations may lead to pressure and performance anxiety in their children. They observed that children of parents who are excessively critical or overly focused on achievement goals are more likely to experience performance anxiety.

School climate refers to the overall atmosphere of a school, including how it's organized, how teachers teach, and how students interact with each other. It shapes the values, behaviours, and norms of individuals and groups in the school. Studies (Loukas & Murphy, 2007; Loukas & Robinson, 2004) have shown that the way classes are taught and the emotional environment of the school are closely linked to academic success and can help reduce the impact of certain risk factors. Besides affecting academic achievement, aspects of school climate are also linked to students' ability to regulate themselves, their emotional well-being, and how well they get along with others ((Naveh-Benjamin, 1991). Particularly, the relationships between students have been found to influence test anxiety (Tanzer, 1990). McDonald (2001) also found that how well you do in school connected to test anxiety, with students who do well academically having higher rates of test anxiety.

## 10. Conclusions

Understanding the causes and effects of test anxiety is crucial, especially in current times when educational decisions often rely on students' standardized test performance. Students suffering from test anxiety may not always be recognized in school settings because it is not classified as an official disorder. Unlike more disruptive behaviours, test anxiety can easily be overlooked by teachers and parents, making it vital to screen for and address it.

Common triggers for test anxiety include family dynamics, anxiety and attention disorders, obsessive-compulsive behaviours, learned helplessness, perfectionism, stereotype threats, poor study and test-taking skills, past poor test performance, peer pressure, low self-esteem, negative self-statements, lack of motivation, family expectations, and pressures related to high-stakes testing.

To address these issues, educators need to identify students with excessive anxiety, build effective study and test-taking skills, implement anxiety reduction strategies, provide attribution training, and use accessible, student-friendly tests. Additionally, involving students in the testing process, offering appropriate testing accommodations, and continuously evaluating strategies to overcome test anxiety are crucial steps. By understanding and addressing these factors, educators can create a more supportive environment that helps reduce test anxiety and improve student performance.

While further, more widespread research is needed to understand and analyse the best approach to managing exam anxiety, an approach that targets all identified contributors to exam anxiety, made available to all students, irrespective of their “diagnosis” of exam anxiety, would be ideal and will be targeted in the designing of the app targeted to management of exam anxiety amongst high school students.

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