From Books to Beats: Exam Stress, Thyroid Hormone, And Heart Health in Students

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***Abstract*—Examinations, though central to academic life, impose psychological and physiological burdens that extend far beyond the test hall, influencing endocrine and cardiovascular regulation in ways often overlooked. This quasi-experimental study investigated the impact of exam-induced stress on thyroid function and heart health in 120 undergraduate students (60 males, 60 females; aged 18–25), with a particular focus on gender differences, recovery trajectories, and the therapeutic role of music. Using the Perceived Stress Scale (PSS-10), biochemical assays for T3, T4, and TSH, and cardiovascular measures including heart rate, blood pressure, and ECG, assessments were conducted across three phases: baseline, during exams, and two weeks post-exams. Results showed that stress scores rose significantly during exams ($p < 0.01$), with females reporting consistently higher stress yet demonstrating faster thyroid recovery, while males exhibited stronger cardiovascular reactivity, particularly in heart rate and blood pressure. TSH levels rose in both groups, underlining the thyroid's sensitivity to psychological strain. Importantly, students who engaged in daily music therapy and guided breathing exercises displayed lower stress scores, quicker normalization of heart rate and blood pressure, and more stable thyroid profiles compared to controls, suggesting that simple, non-pharmacological interventions can buffer stress-induced physiological disruption. The findings highlight that exam stress is not merely a psychological experience but a multidimensional challenge linking the brain, thyroid, and heart in a complex network of adaptation and strain. By revealing gender-specific patterns and demonstrating the restorative potential of music and relaxation practices, this study reframes academic stress as both a health risk and an opportunity for resilience-building. Ultimately, the work calls for integrating such low-cost interventions into educational environments to protect not only students' academic performance but also their long-term hormonal and cardiovascular well-being.**

***Index Terms*—Cardiovascular, Therapeutic, Demonstrate, Adaptation, Strain**

I. INTRODUCTION

Examinations are milestones in the academic journey, designed to measure intellectual competence, but they often evolve into powerful stressors that affect far more than a student's state of mind. Globally, studies estimate that 70–80% of students experience moderate to severe exam-related anxiety, and nearly one-third report physical manifestations such as insomnia, palpitations, headaches, and gastrointestinal distress during exam periods. These responses underscore that examinations are not solely cognitive events but also biological trials that activate the body's stress machinery.

The hypothalamic–pituitary–adrenal (HPA) axis is central to this stress response. In the face of exam anxiety, cortisol secretion rises, mobilizing energy reserves and triggering the sympathetic "fight-or-flight" system. While adaptive in the short term, sustained activation disrupts the hypothalamic–pituitary–thyroid (HPT) axis, altering thyroid function. The thyroid gland, through Triiodothyronine (T3) and Thyroxine (T4), regulates metabolism, thermogenesis, and cognitive function. Even transient hormonal shifts can impair attention, reduce working memory, and increase fatigue, precisely the faculties students rely upon during exams. Evidence suggests that up to 25% of young adults exhibit subtle, stress-related thyroid hormone fluctuations, which, though reversible, highlight the sensitivity of the gland to academic stressors (Karger, 2019).

The thyroid also maintains an intimate connection with the cardiovascular system. Thyroid hormones influence heart rate, myocardial contractility, and vascular tone. Hyperthyroid states accelerate cardiac output and predispose to arrhythmias, while hypothyroid states blunt cardiac efficiency. During exams, even modest thyroid imbalances may amplify cardiovascular responses. Empirical data show that students experience an average increase of 10–15 beats per minute in heart rate and 8–12 mmHg in systolic blood pressure during exam periods compared to baseline. Male students often display stronger cardiovascular reactivity, while females report higher stress yet demonstrate faster normalization of thyroid function. This duality mirrors broader epidemiological patterns: women are five to eight times more likely to develop thyroid dysfunction, whereas men are more vulnerable to stress-related cardiovascular disease (Biondi & Warsofsky, 2014).

Lifestyle factors compound these biological responses. Examination periods are frequently characterized by irregular sleep schedules (reported in nearly 60% of students), increased caffeine or stimulant intake, skipped meals, decreased physical activity, and social withdrawal. These disruptions magnify both perceived stress and physiological instability, creating a feedback loop that heightens vulnerability to thyroid and cardiac dysregulation. Strikingly, the pattern of altered thyroid function, heightened autonomic activity, and delayed recovery observed in stressed students shows parallels with post-traumatic stress disorder (PTSD), raising concerns about the cumulative effect of repeated exam stress episodes on long-term health.

Given these challenges, it is critical to identify interventions that are safe, affordable, and easy to integrate into student routines. Music therapy has emerged as a promising candidate. Studies show that calming music reduces cortisol, improves mood regulation, and restores autonomic balance. A recent randomized controlled trial demonstrated that medical students participating in group music therapy showed a 20–25% reduction in anxiety scores and improved heart rate variability compared to the control group. Similarly, guided breathing exercises stimulate parasympathetic activity, counteracting the sympathetic dominance induced by stress and supporting both endocrine and cardiovascular recovery.

The present study explores the intertwined effects of exam stress on thyroid function and cardiovascular health in undergraduate students. It aims to identify gender-specific patterns of vulnerability, examine post-exam recovery trajectories, and evaluate whether a “from books to beats” approach using music therapy and deep breathing can serve as a protective intervention. By connecting psychological stress with hormonal and cardiac adaptation, this research reframes academic examinations as not only assessments of learning but also windows into resilience, physiology, and the hidden costs of modern education.

II. OBJECTIVES OF THE STUDY

Examinations are not just tests of memory and intellect; they are physiological stress tests where the body and mind are pushed into synchrony or strain. This research is driven by the idea that the unseen impact of academic stress may extend far beyond the exam hall, leaving fingerprints on the endocrine system and the heart. Against this backdrop, the study sets out with the following objectives:

1. To uncover the hidden hormonal footprints of stress by analyzing fluctuations in thyroid hormones (T3, T4, and TSH) before, during, and after academic examinations.
2. To chart the cardiovascular echoes of stress by examining changes in heart rate, blood pressure, and ECG patterns across exam phases.
3. To explore the gendered face of stress, comparing how male and female students differ in their thyroid responses, cardiovascular reactivity, and recovery speed.
4. To illuminate the recovery window, investigating how quickly the thyroid–heart axis returns to baseline once exams end, and whether incomplete recovery hints at long-term vulnerabilities.
5. To test the healing rhythm of music, evaluating whether music therapy and breathing exercises, simple, non-invasive, and affordable interventions, can buffer the storm of exam stress, supporting both mental clarity and physiological resilience.
6. To draw conceptual parallels with PTSD, considering whether repeated cycles of academic stress might model the same hormonal and

autonomic disruptions seen in trauma-related conditions.

III. LITERATURE REVIEW

The story of examinations is not written only in ink on answer sheets; it is inscribed deeply into the body's rhythms of hormones and heartbeats. For decades, researchers have described academic stress as one of the most potent psychological pressures in young adulthood, but only recently have we begun to trace its biological echoes across the thyroid gland and the cardiovascular system.

Stress as a Silent Conductor

Exams trigger the hypothalamic–pituitary–adrenal (HPA) axis, the body's primal "alarm system." The surge of cortisol that follows is not merely an emotional imprint; it reshapes how the thyroid and heart behave under strain. Samini et al. (2019) demonstrated that stress alters the hypothalamic–pituitary–thyroid (HPT) axis, leading to fluctuations in Triiodothyronine (T3), Thyroxine (T4), and Thyroid-Stimulating Hormone (TSH). What seems like a fleeting worry in the exam hall may, at the hormonal level, translate into slowed metabolism, disturbed concentration, or racing palpitations.

The Thyroid–Heart Duet

The thyroid and the heart share an intimate dialogue. Biondi and Warsofsky (2014) described thyroid hormones as "metabolic accelerators" of the cardiovascular system. Even subtle changes can shift heart rate and blood pressure. Student-focused studies have shown rises of 10–15 bpm in heart rate and 8–12 mmHg in blood pressure during examinations (Smith et al., 2022). While these changes appear temporary, repeated academic cycles may create a physiological pattern where stress primes the heart for overreaction. The thyroid acts here not as a passive observer, but as a co-conductor, either amplifying or soothing the cardiac symphony under pressure.

Gendered Pathways of Stress

The literature repeatedly highlights that stress is not experienced equally across genders. Women, who are biologically more prone to thyroid dysfunction, five to eight times more than men, also report higher exam-related anxiety. Yet paradoxically, they appear to bounce back faster in thyroid recovery. Men, conversely, may show stronger cardiovascular spikes, with sharper elevations in heart rate and blood pressure, and slower normalization afterwards. These differences suggest that exam stress is not a one-size-fits-all phenomenon but a biologically sculpted experience shaped by sex, hormones, and resilience mechanisms.

Echoes of Trauma: Parallels with PTSD

Interestingly, the endocrine and cardiovascular disruptions during exam stress mirror those documented in post-traumatic stress disorder (PTSD). Wang et al. (2018) reported altered thyroid and autonomic patterns in PTSD patients that resemble, in milder form, the transient imbalances seen in students under exam pressure. This comparison underscores a sobering reality: though exams are temporary, their repeated cycles may condition the body into patterns of stress reactivity with long-term implications.

Recovery: An Overlooked Chapter

While the onset of stress has been extensively mapped, the "after-story" of exams, the recovery phase, remains poorly understood. Few studies ask: How long does it take for thyroid hormones to return to baseline? Do students' cardiovascular markers fully recover, or do subtle imbalances persist? This missing piece is crucial, for resilience is measured not by the absence of stress, but by the body's capacity to restore harmony once the storm passes.

From Stress to Sound: Music as Medicine

Amid the quest for interventions, music has emerged as a gentle yet powerful. A study showed that music listening reduced cortisol levels and improved mood regulation under stress. More recently, Zhu et al. (2024) found that music therapy reduced test anxiety by nearly 25% and improved heart rate variability in medical students. Similarly, Istadi (2018) documented lower stress scores in students exposed to classical music during exam preparation. Together, these findings suggest that music does not merely distract; it actively engages the parasympathetic system, guiding the heart and hormones back into balance.

Bridging the Gaps

Despite promising insights, the literature reveals gaps that invite exploration. Most studies examine either psychology or physiology, but few integrate thyroid function and cardiovascular responses into a unified framework. Gender differences, while acknowledged, are inconsistently addressed. And the recovery phase where true resilience is measured, remains largely in the shadows. Importantly, while music therapy has shown benefits, its role in directly influencing

thyroid–heart interactions in academic stress contexts is still uncharted territory. The literature paints exam stress as a complex interplay of mind, hormones, and heartbeats. The thyroid–heart axis, often overlooked, emerges as a central mediator in this hidden symphony of strain and recovery. Gender adds texture, PTSD parallels add caution, and music offers hope. Yet the story remains unfinished: to understand how students truly move *from books to beats*, research must illuminate not just the physiology of stress, but the rhythms of recovery and resilience.

IV. METHODOLOGY

Study Design

This research was conceptualized as a quasi-experimental, pre–post design, aiming to capture the hidden physiological symphony of students caught in the whirlwind of academic examinations. Unlike routine cross-sectional assessments, this design provided a dynamic lens to evaluate how stress unfolds over time and how recovery strategies can recalibrate the body. The study's distinctive strength lies in its integration of psychological, endocrine, and cardiovascular dimensions, alongside gender-specific considerations, acknowledging that the human body does not respond uniformly to stress.

The design was not merely statistical; it was crafted to mirror the academic journey of students from the relative calm of baseline preparation, through the peak storm of exam stress, and finally into the lull of recovery. This temporal progression allowed the study to map stress as a process rather than a point-in-time event, enriching the ecological validity of the findings.

PARTICIPANTS

The study recruited 120 undergraduate students (60 males and 60 females), aged 18–25 years, representing a vibrant yet vulnerable academic cohort. Participants were selected using stratified random sampling to ensure a balanced representation of genders and to reduce sampling bias.

Inclusion and Exclusion Criteria were meticulously defined to minimize confounding factors. Students with known thyroid disorders, cardiovascular disease, psychiatric illness, pregnancy (in females), or those on long-term medications were excluded. This ensured that the physiological shifts observed could be more confidently attributed to exam-induced stress rather than pre-existing medical conditions.

All participants provided written informed consent, affirming their voluntary participation. Ethical sensitivity was upheld by ensuring that interventions such as music therapy and breathing exercises carried no risk of harm and could even yield long-term wellness benefits beyond the study period.

Tools and Measures

To capture the multi-layered impact of stress, a comprehensive set of tools was employed:

1. Psychological Stress Assessment

Stress perception was quantified using the Perceived Stress Scale (PSS-10), a widely validated instrument. The tool helped in capturing not only the presence of stress but also the subjective intensity experienced by each participant.

2. Biochemical Measures

Blood samples were analysed for serum T3, T4, and TSH levels using chemiluminescent immunoassay (CLIA). This choice of assay ensured both sensitivity and specificity, allowing the study to detect subtle hormonal fluctuations induced by exam stress.

3. Cardiovascular Parameters

- Heart Rate (HR) was measured to reflect autonomic nervous system activity.
- Blood Pressure (BP) provided insights into sympathetic arousal and vascular reactivity.
- Electrocardiography (ECG) served as a window into cardiac rhythm, offering early markers of stress-induced arrhythmic tendencies.

4. Female-Specific Variable

Recognizing the complex interplay between reproductive hormones and stress physiology, the menstrual phase was carefully recorded in female participants. This step added rigor by controlling for the natural variability in hormonal status, thus ensuring that changes in thyroid and cardiovascular parameters were primarily attributable to exam stress.

5. Recovery Practices

The study uniquely integrated non-pharmacological interventions rooted in wellness science:

- Music therapy: Students listened to 30 minutes of instrumental or Indian raga music daily, chosen for its soothing rhythms and capacity to entrain heart rate and brain waves.
- Guided deep-breathing exercises: Students practiced 10 minutes/day of paced diaphragmatic breathing, designed to stimulate the parasympathetic system, lower stress hormones, and stabilize cardiovascular rhythms.

V. PROCEDURE

The study unfolded across three well-defined phases, each reflecting a chapter of the student's examination journey:

1. Baseline Phase (Two weeks before exams)

In this stage, students were assessed during relative academic calm. All key parameters, including stress levels (PSS-10), thyroid hormone profile, heart rate, blood pressure, ECG recordings, and menstrual phase (for females), were measured. This provided a reference frame to compare subsequent changes during stress and recovery.

2. Exam Phase (During exams)

This was the stress crescendo, when academic demands peaked. During this phase, all participants were reassessed for stress and physiological measures. Importantly, students were randomly divided into two groups:

- Control Group: Continued their normal routines without any structured recovery practices.
- Experimental Group: Received the dual interventions of music therapy and guided deep breathing daily.

This stratification allowed the study to evaluate whether these interventions could buffer the physiological toll of stress and enhance resilience.

3. Recovery Phase (Two weeks after exams)

As the storm of exams subsided, participants entered the recovery period. All measures were repeated to evaluate whether physiological parameters rebounded to baseline or whether stress effects lingered. Special attention was paid to gender differences in recovery, as emerging literature suggests that men and women may exhibit distinct stress trajectories—with women sometimes showing slower endocrine recovery due to the interplay of sex hormones.

The methodology was crafted not just to measure numbers but to capture the **story** behind the numbers. By comparing pre-exam, exam, and post-exam values, the study could track:

- The acute rise in stress biomarkers and cardiovascular reactivity.
- The gender-specific variations in stress and recovery.
- The modulatory role of music and deep breathing in restoring homeostasis.

The methodological framework of this study blends scientific precision with human-centered sensitivity. By embracing a holistic approach—measuring hormones, heart rhythms, psychological perceptions, and gender-specific differences—the study not only illuminates the hidden physiological toll of exams but also tests practical interventions that can be integrated into student life.

In doing so, it transforms the exam experience from being viewed solely as a cognitive challenge into a multi-system stress test for the human body, while also offering hope in the form of simple, accessible recovery practices.

VI. DATA ANALYSES

Data were analyzed using SPSS version 25 to ensure statistical rigor and accuracy. Descriptive statistics (mean, SD) were calculated to summarize baseline characteristics of the participants. To examine changes across phases, paired t-tests compared pre-exam (baseline) and exam values, as well as exam and recovery values. Two-way ANOVA was applied to explore the interaction between gender (male, female) and intervention status (control, experimental). Finally, Pearson's correlation was employed to examine associations between perceived stress scores (PSS-10), thyroid hormone levels, and cardiovascular markers.

This layered analytical strategy enabled us to capture not only the direct changes induced by exam stress but also the gendered nuances and the effectiveness of recovery interventions.

VII. RESULTS

The study tracked 120 undergraduate students (60 males, 60 females) through baseline, exam, and recovery phases. The findings reveal that examinations trigger significant shifts in psychological, endocrine, and cardiovascular states, with clear gender differences and positive intervention effects.

1. Stress Scores (PSS-10)

- Stress scores increased significantly during the exam phase compared to baseline ($p < 0.01$).
- Female students consistently reported higher stress levels than male students in all three phases.

- After exams, stress scores declined for both groups but remained slightly higher in females, indicating incomplete psychological recovery.

Interpretation: These results confirm that exams are potent psychological stressors, with female students perceiving greater stress intensity. This may reflect cultural, social, and biological influences, as well as heightened emotional sensitivity.

2. Thyroid Hormone (TSH)

- TSH levels rose during exams in both males and females, reflecting activation of the hypothalamic–pituitary–thyroid (HPT) axis.
- During recovery, females showed a clear drop in TSH back toward baseline, while male students exhibited little change, with values remaining elevated.

Interpretation: Despite reporting higher stress, females displayed faster endocrine recalibration, suggesting an adaptive thyroid response that may buffer long-term hormonal imbalance. Males, however, appeared to maintain sustained thyroid activation.

3. Heart Rate (HR)

- Both genders experienced elevated heart rates during exams.
- Males showed a higher peak increase than females.
- In recovery, HR decreased in both groups, but males' rates normalized more quickly, while females showed a slower return to baseline.

Interpretation: Males appear more prone to sharp sympathetic activation, while females exhibit prolonged autonomic imbalance, suggesting gender-specific vulnerabilities in cardiac regulation under stress.

4. Systolic Blood Pressure (SBP)

- SBP rose significantly during exams in both genders, with males showing a slightly greater increase.
- In the recovery phase, SBP improved in both groups, but females' values remained closer to exam levels, indicating slower vascular recovery.

Interpretation: These findings support the notion that while male cardiovascular systems show stronger acute reactivity, females may experience lingering sympathetic arousal that delays normalization of blood pressure.

5. Effects of Recovery Practices (Music and Breathing)

Students in the experimental group who practiced music therapy (30 minutes/day) and deep breathing (10 minutes/day) showed marked benefits compared to controls:

- Lower stress scores during exams and faster post-exam decline.
- Accelerated normalization of heart rate and blood pressure.
- Improved TSH recovery, particularly among females, who demonstrated a rapid return to baseline values.

By contrast, the control group (no intervention) displayed slower recovery across all parameters, with prolonged stress and delayed physiological stabilization. Interpretation: These results affirm that even simple, non-invasive interventions can enhance resilience, supporting both psychological and physiological balance. They highlight the synergistic power of music and breathwork, engaging the parasympathetic system to offset exam-related sympathetic arousal.

VIII. INTEGRATED FINDINGS

Taken together, the results reveal a multi-system stress response that is both gendered and modifiable:

- Stress Perception: Exams elevate stress in all students, but females consistently report higher levels.
- Endocrine Response: Both genders exhibit exam-related TSH increases, but females demonstrate faster recovery, whereas males sustain elevated levels.
- Cardiovascular Effects: Males show greater acute increases in HR and BP, but females recover more slowly, highlighting different physiological stress burdens.
- Intervention Impact: Music therapy and deep breathing act as effective buffers, promoting faster recovery across stress, endocrine, and cardiovascular domains.

Examinations, though designed as academic assessments, act as physiological stress tests. They amplify stress perception, disrupt thyroid function, and alter cardiovascular rhythms. Importantly, these effects are gender-specific: men experience sharper acute responses, while women endure slower recovery, particularly in cardiovascular measures.

Encouragingly, structured recovery practices, music therapy, and deep breathing proved highly effective in restoring balance. They not only lowered stress scores but also accelerated normalization of thyroid and cardiovascular parameters, making them promising tools for integration into academic and wellness programs.

This study underscores the importance of viewing examinations not merely as intellectual challenges but as holistic experiences affecting body and mind. By acknowledging gender differences and embracing simple, culturally resonant interventions, institutions can cultivate healthier learning environments where students are better equipped to meet academic demands without compromising their well-being.

IX. RESULT TABLE SUMMARY

Parameter	Baseline	Exam	Recovery	Observed Gender Difference
Stress Score (PSS)	M: 18, F: 20	M: 26, F: 30	M: 20, F: 23	Females consistently reported higher stress, with slower psychological recovery.
TSH (µl/ml)	M: 2.1, F: 2.0	M: 2.6, F: 2.7	M: 2.5, F: 2.1	Both increased during exams, but females showed a faster return to baseline.
Heart Rate (bpm)	M: 72, F: 74	M: 88, F: 84	M: 75, F: 78	Males showed a greater exam rise but a better recovery; females took longer to normalize.
Systolic BP (mmHg)	M: 118, F: 115	M: 132, F: 126	M: 120, F: 118	Males had stronger pressor responses and faster recovery times; females had slower restoration of baseline.

X. CONCLUSION

Examinations, while meant to assess knowledge, unfold as hidden stress tests that reverberate through the thyroid and heart, shaping distinct gendered pathways of strain and recovery. This study shows that males respond with sharper cardiovascular spikes, while females, despite perceiving greater stress, demonstrate quicker thyroid recalibration reminding us that academic pressure is never a uniform experience. Yet within this complex interplay of hormones and heartbeats, music and mindful breathing emerged as quiet healers, restoring balance more swiftly and softening the toll of stress. These findings affirm that wellness need not be expensive or elusive; it can lie in simple rhythms of melody and breath, woven seamlessly into daily routines. Examinations, then, should be reframed not only as trials of intellect but also as opportunities to nurture resilience, teaching students to balance achievement with well-being. By embracing such interventions, educational spaces can transform from mere arenas of performance into environments that safeguard harmony between body, mind, and spirit, where learning is not just about passing tests, but about sustaining health, clarity, and strength for the journeys beyond.

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