

## Synergistic Effects of White Noise and Energy-Focused Breathing on Psychophysiological Well-Being among Young Cadets in High-Demand Boarding Environments

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The present study aimed to evaluate the individual and combined effects of white noise exposure and energy-focused breathing practices on the psychophysiological well-being of young cadets aged 13-16 years undergoing rigorous residential training. It was hypothesized that the multimodal (sound-breath) intervention would yield greater improvements in emotional stability and perceived relaxation compared to either intervention alone or a control condition. A controlled quasi-experimental pre-post design was employed with 120 cadets randomly assigned to four groups ( $n = 30$  each): (A) Energy-Focused Breathing, (B) White Noise Exposure, (C) Combined Intervention, and (D) Control. Standardised self-report measures assessing perceived stress, emotional well-being, and relaxation were administered before and after a 4-week intervention period. Statistical analysis was performed using SPSS version 20, employing Chi-square tests to assess the significance of pre-post changes and intergroup associations. Significant improvements were observed across intervention groups, with the combined sound-breath group showing the most pronounced post-intervention gains in well-being and relaxation scores ( $p < 0.01$ ). Both individual interventions also demonstrated significant positive shifts in stress reduction ( $p < 0.05$ ). The Chi-square results indicated a robust association between intervention type and improved well-being outcomes, supporting the synergistic efficacy of combined auditory and breathing modulation. Structured integration of white noise and energy-focused breathing within high-stress educational settings offers a promising, non-invasive approach to enhancing emotional resilience and psychophysiological balance in adolescents. Such multimodal interventions could inform scalable frameworks for mental health promotion in rigorous institutional contexts.

**Keywords:** white noise, energy-focused breathing, adolescent well-being, stress modulation, psychophysiological regulation

Adolescence is a crucial phase of developmental transition characterised not only by ongoing rapid biological changes (Skinner & Zimmer-Gembeck, 2007) but also by psychological changes, such as improvements in emotional and social capabilities, adaptive functioning, and self-regulation abilities (Erikson, 1968; Kroger, 2000). Although each adolescent progress through a general developmental pattern, sometime uneven pace of development may result in stress that ranges from mild to severe psychological strain (Pratt, 2003). Chronic or

intense stress can negatively affect physical health. It interferes with the proper functioning of key physiological systems, including the nervous, endocrine, and immune systems (Sordi, 2004). Additionally, students at boarding schools face a spectrum of unique academic and psychological challenges arising from prolonged separation from their families, loneliness, and strict institutional discipline (Tang et al., 2020). These stressors, if left untreated, may lead to long-term emotional dysregulation and mental health issues (Tang

et al., 2020). Further, in India, many parents are hesitant to approach to avail mental health services due to social stigma; therefore, many institutions offer professional counselling and guidance services in institutions for student support (Deb et al., 2015; Patel et al., 2018; WHO, 2021). Although, student-counsellor ratio in India school setting are very low ; therefore, a low-cost and culturally grounded interventions would be more valuable for students in the Indian setting.

Breathing exercises derived from ancient Indian yogic practices have been found to improve mental health by reducing symptoms of anxiety, depression, other symptoms of stress, emotional regulation and cognitive functioning (Brown & Gerbarg, 2005). In traditional Indian philosophy, breath (prana) is considered the life force that sustains all living beings. Breathing techniques such as diaphragmatic breathing, alternate nostril breathing, and ujjayi (victorious breath) not only stimulate the parasympathetic nervous system but also lower cortisol levels, heart rate, and blood pressure (McCraty & Atkinson, 2012; Saraswati, 1996; Feuerstein, 2012). These techniques improve psychological adaptability, resilience, and internal stability over time which further leads to enhancement of quality of life (QoL) in the practitioners (National Center for Complementary and Integrative Health [NCCIH], 2021).

Similarly, sound-based relaxation practices such as mantra chanting and white noise have been proven to be effective for stress reduction and better sleep (Riedy et al., 2021). White noise is a type of sound signal that has equal intensity across all audible frequencies (20–20,000 Hz), which makes it effective for masking background distractions and promoting mental clarity, focus, and sleep quality (Riedy et al., 2021). In yogic and vedantic practices, sound is considered the prime manifestation of Akash

(ether), which is the most subtle of the five earthly elements, namely, earth, water, fire, air, and ether (Feuerstein, 2012; Sivananda, 2004). Further, the vocal vibrations of mantra breathing and ujjayi are used to deepen self-awareness, concentration and relaxation (Saraswati, 1996; Telles & Naveen, 2008).

The combined benefit of using breathing exercises with sound-based techniques has proven to be highly effective in reducing anxiety (Toussaint et al., 2021). This combined approach is believed to work complementarily by targeting both physiological arousal and cognitive-emotional processing (Jerath et al., 2015; Bradt & Dileo, 2014). Breathing exercises help to regulate autonomic nervous system activity, particularly by enhancing parasympathetic tone and reducing sympathetic overactivation, which are commonly observed state in anxiety (Brown & Gerbarg, 2005). Concurrently, sound-based interventions such as white noise provide kind of soothing auditory input that leads to relaxation (Toussaint et al., 2021). Therefore, breathing and sound are considered to be vehicles of the life force in Indian philosophy (Brahmi et al., 2025; Singh & Gupta, 2024).

The existing literature supports the individual benefits of both breathing exercises and white noise however, there is a dearth of researches evaluating combined effect of breathing exercises and white noise on well-being of children and adolescents students. Additionally, there is lack of study comparing efficacy of white noises based and breathing exercises based relaxation procedures in the management of Indian adolescent students. As these relaxation procedures are low-cost, scalable, and culturally acceptable for stress reduction especially in Indian adolescent population. Therefore, the present study aims to assess the impact of an integrated breathing exercise and white noise exposure on the overall well-being of children and

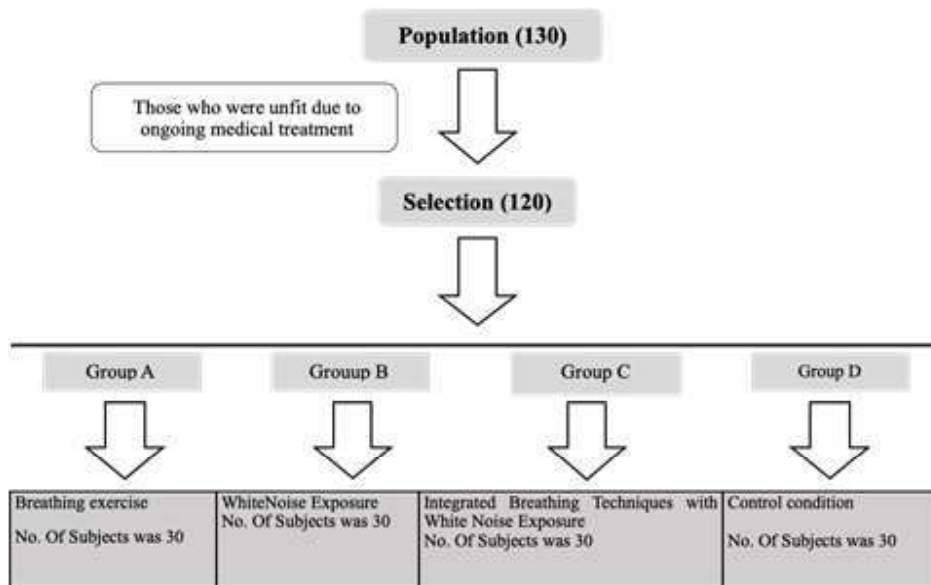
adolescents students and compare its effectiveness with only breathing and only sound based relation procedures.

### Method

#### Participants and procedure

The study was approved by the Review Board of Rastriya Raksha University. The present study was based on 'pre-and-post-test control group design' (Campbell and Stanley, 1963) comprised three experimental arms and a control arm. All the participants of the present study were selected from XXXXXX XXXXXX School, in XXXXXX. An initial pool of 130 participants were screened for this study, among 120 participants were matched with preset inclusion and exclusion criteria. The inclusion criteria of the study were as follows: co-operative, age range between 13-16 years, studying class 9th and above, and gave consent for the study. Students with any evidence of significant

physical illness or disability, organic and neurological disorder, and family history of mental illness were excluded. Included participants were randomly divided 30 each into four groups viz. combined breathing exercise and white noise, breathing exercise-only intervention, white noise-only intervention, and control groups. Randomisation was performed using a simple lottery method. Four distinct group labels (A, B, C, and D) were written on identical slips of paper, folded, and placed in a container. Each participant sequentially drew a slip from the container to determine their group assignment. This process ensured allocation concealment and resulted in four groups, each with 30 participants (n=30). The study was conducted from September 2024 to December 2024. Informed consent was also requested by the XXXXXX XXXXXX School, to conduct the study, as all the participants were adolescents.



#### Tool

A custom-made checklist was used to assess the stress level, emotional regulation ability, cognitive functioning, and overall well-being of the participants. It contained 11

items and responses lie on a 5-point Likert scale ranging from 1(Strongly Disagree) to 5(Strongly Agree).

## **Interventions**

### **Breathing exercise**

The guided breathing exercises were conducted for six sessions with the participation of a group of participants. In order to visualize energy flowing from their feet, up through their body, and ending at their head, participants were told to sit comfortably, close their eyes, and breathe in through their nose. They held their breath and visualized a cyclone of energy in their head before releasing it through their nose and seeing the energy spread out through their fingertips. Ten minutes were spent repeatedly performing this breathing technique. No extra auditory stimuli were offered and all other auditory, visual, and tactile stimuli in the room were minimised. The participants were instructed to practice breathing techniques independently in a hostel setting after completion of first session.

### **White Noise Exposure**

Exposures of white noise based relaxation exercise were given to a second group of participants. A 10-minute audio track of white noise was created using Audacity (v3.6.1) software. To ensure a comfortable listening experience a 2-second fade-in at the beginning and a 2-second fade-out at the end was created in the sound track. The audio was played from a phone through a speaker positioned 1.5 meters in front of the participant, with the volume adjusted for optimal comfort. Participants were instructed to sit quietly for the entire 10-minute session and were given no breathing or visualisation instructions. This group was intended to evaluate the effects of white noise exposure, independent of any active intervention. Therefore, no other intervention or relaxation exercises were implemented with this group. To maintain a controlled environment, all other auditory, visual, and tactile stimuli in the room were minimised.

### **Integrated Breathing Techniques with White Noise Exposure**

Third group of participants were exposed with combined intervention of guided breathing exercises and white noise exposure. They were asked to be seated comfortably, instructed to close their eyes, and guided to inhale deeply through the nose while visualising energy moving upward from the feet to the head. Upon inhalation, participants held their breath and imagined a cyclone of energy within the head, before exhaling through the nose and visualising energy dispersing through the fingertips. This breathing cycle was practised continuously for 10 minutes. At the same time, participants were exposed to a digitally generated white noise stimulus. The white noise, created using Audacity (v3.6.1) to ensure a mathematically pure signal with a flat power spectral density, was played from a mobile phone through a speaker positioned approximately 1.5 meters in front of the participant. To maintain a controlled environment, all other auditory, visual, and tactile stimuli in the room were minimised.

### **Control condition**

A control group was included to determine the true effectiveness of the relaxation exercises (i.e. breathing, white noise, and combined) by providing a baseline for comparison. Participants in the control group did not receive any form of relaxation intervention and continued their normal routine activities during the study period. This allowed us to isolate the effects of the relaxation exercises from other external or confounding factors, thereby enhancing the internal validity of the study and ensuring that any observed changes in the experimental groups could be attributed to the intervention itself.

## Statistical analysis

Pairwise comparison of pre-test and post-test score of participants in relaxation group, white noise group, and combined group was compared with control group. As all the scores were on nominal scale, therefore chi-square ( $X^2$ ) test was used for the pair wise as well as overall group comparisons. All the statistical computation was performed using SPSS version 20.

## Results

A series of chi-square tests was conducted to see the differences between the control group and each intervention group (white noise, energy focus breathing exercise, and combined intervention). At pre-assessment, there was no group differences found in the all measured items of stress level, emotional regulation ability, cognitive functioning, and overall well-being of the participants.

At post intervention participants of energy focus breathing exercise group show significant improvement in controlling of emotions ( $X^2_{(4)} = 32.11, p < .001$ ), emotional stability, ( $X^2_{(4)} = 38.18, p < .001$ ), feeling grounded ( $X^2_{(4)} = 37.94, p < .001$ ), Feel overwhelmed ( $X^2_{(4)} = 43.72, p < .001$ ), Feeling stressed ( $X^2_{(4)} = 39.52, p < .001$ ), Concentration ( $X^2_{(4)} = 41.42, p < .001$ ), Though clarity ( $X^2_{(4)} = 41.79, p < .001$ ) Distractibility ( $X^2_{(4)} = 39.59, p < .001$ ) Often tired/drained ( $X^2_{(4)} = 41.49, p < .001$ ) Sleep ( $X^2_{(4)} = 36.11, p < .001$ ) Perceived well-being ( $X^2_{(4)} = 40.78, p < .001$ ) were as follow.

Similarly, at post-assessment, participant who underwent through white noise based relaxation practices showed significant improvement in ability to control emotions ( $X^2_{(4)} = 316.54, p < .001$ ), emotional stability, ( $X^2_{(4)} = 20.52, p < .001$ ), feeling grounded ( $X^2_{(4)} = 16.4, p < .001$ ), Feel overwhelmed ( $X^2_{(4)} = 21.37, p < .001$ ), Feeling stressed ( $X^2_{(4)} = 24.68, p < .001$ ), Concentration ( $X^2_{(4)} = 21.21, p < .001$ ), Though clarity ( $X^2_{(4)} = 25.71, p < .001$ ) Distractibility ( $X^2_{(4)} = 21.43, p < .001$ ) Often tired/drained ( $X^2_{(4)} = 22.67, p < .001$ ) Sleep ( $X^2_{(4)} = 20.69, p < .001$ ) Perceived well-being ( $X^2_{(4)} = 21.56, p < .001$ ) These were the results obtained

The combined intervention group also differed significantly from the control group across all measured outcomes. For instance, the ability to control emotions was considerably higher in the combined intervention group controlling emotion ( $X^2_{(4)} = 46.41, p < .001$ ), emotional stability, ( $X^2_{(4)} = 50.9, p < .001$ ), feeling grounded ( $X^2_{(4)} = 49.19, p < .001$ ), Feel overwhelmed ( $X^2_{(4)} = 52.13, p < .001$ ), Feeling stressed ( $X^2_{(4)} = 50.13, p < .001$ ), Concentration ( $X^2_{(4)} = 49.56, p < .001$ ), Though clarity ( $X^2_{(4)} = 50.52, p < .001$ ) Distractibility ( $X^2_{(4)} = 52.61, p < .001$ ) Often tired/drained ( $X^2_{(4)} = 52.61, p < .001$ ) Sleep ( $X^2_{(4)} = 49.38, p < .001$ ) Perceived well-being ( $X^2_{(4)} = 49.82, p < .001$ ) these findings demonstrate the combined intervention have outperformed all the groups in all the measured outcomes.

Table 1. Therapeutic outcome of Breathing Exercises, White Noise Based Relaxation, and Combined Breathing and White Noise Based Relaxation exercises

Item	Comparisons of Control Group and White Noise			Comparison of Control Group and Energy Focus Breathing Exercise			Comparison of Control Group and Combined Intervention		
	X <sup>2</sup>	df	p-value	X <sup>2</sup>	df	p-value	X <sup>2</sup>	df	p-value
Controlling emotions	16.54	3	<.001	32.108	4	<.001	46.41	4	<.001
Emotionality	20.52	3	<.001	38.176	4	<.001	50.9	4	<.001
Feeling "grounded"	16.4	2	<.001	37.941	4	<.001	49.19	4	<.001
Feel overwhelmed	21.37	4	<.001	43.718	4	<.001	52.53	4	<.001
Feeling stressed	24.68	3	<.001	39.516	4	<.001	50.13	4	<.001
Concentration	21.21	4	<.001	41.414	4	<.001	49.56	4	<.001
Thought clarity	25.71	3	<.001	41.789	4	<.001	50.52	4	<.001
Distractibility	21.43	4	<.001	39.583	4	<.001	52.61	4	<.001
Often tired/drained	22.67	3	<.001	41.488	4	<.001	52.61	4	<.001
Sleep	20.69	3	<.001	36.077	4	<.001	49.38	4	<.001
Perceived well-being	21.56	3	<.001	40.781	4	<.001	49.82	4	<.001

(X<sup>2</sup>= chi square, df = degree of freedom)

### Discussion

The present study investigates the effectiveness of white noise, energy-focused breathing exercise, and combined approaches of white noise and energy-focused breathing exercises on overall stress level and well-being of adolescent participants. This study was conducted in a residential army school where cadets usually lived in high-pressure boarding environments. All three intervention groups viz. white noise, energy-focused breathing exercise, and combined approaches of white noise and energy-focused breathing exercises, showed statistically significant improvements across all the outcome domains compared with the control group.

The findings of the present study are consistent with the findings of previous studies that have also reported that structured breathing, such as slow or mindful

breathing, reduces anxiety, depression, and stress while it enhances emotional regulation and cognitive function of the participants (Brown & Gerbarg, 2005). As, slow breathing enhances autonomic, cerebral, and psychological flexibility and modulates brain regions involved in emotion and cognition (Zaccaro et al., 2018; Herrero et al., 2018); therefore, participants of energy-focused breathing exercise showed marked improvement in their emotional and other psychological functioning after the completion of intervention. Similar findings have been reported in many clinical trials as energy focused breathing improves sleep quality, reduces negative emotions, and decreases anxiety and insomnia severity over the long term (Wang et al., 2022).

The present study revealed that white noise based relaxation technique also shown marked improvement in psychological functioning e.g. cognitive, emotional, etc.

compared to participants of control group. The present study revealed that white noise based relaxation procedure also shown marked improvement in psychological functioning e.g. cognitive, emotional, etc., functioning of the adolescent students compared to students of control group.

White noise-based exposure essentially lessens impulsiveness in the prefrontal cortex, a region essential to emotional regulation and executive function (Riedy et al., 2021) that promote sustained attention and cognitive function, which further lead to improvement in sleep quality, and enhancement of attention and cognitive performance (Ebben et al., 2021). Furthermore, it can synchronize breathing patterns, which improves relaxation even more (Buxton et al., 2021).

We found combined implementation of white noise and energy-focused breathing exercises provides best intervention methods to deal with students' stressors and enhancement of various psychological functioning of the participants. Because slow nasal breathing directly influences brain regions linked to emotional and cognitive control, while white noise reduces prefrontal cortical excitability, supporting calm and focus (Herrero et al., 2018; Riedy et al., 2021), this group has shown better improvements in the various domains of cognition and emotions. The present findings are in unison with the findings of previous studies; for instance, (Buxton et al., 2021) have reported that combining noise and nature-based sounds are optimal method to impart physiological adaptation and stress reduction. Additionally, the dual approach gives both self-regulation and sensory modulation, which may provide the maximum emotional and cognitive benefits (Zaccaro et al., 2018). Therefore, combined approaches have been shown to produce better improvements in sleep and anxiety than any one of the approaches (Wang et al., 2022).

However, not a single study that have reported adverse effects from these interventions when properly applied; therefore, the present findings support the idea that non-invasive, scalable strategies are effective for enhancing well-being and attention in youth, especially in high-stress settings of a boarding environment. Additionally, both interventions are low-cost, easy to implement, and culturally adaptable, which makes them suitable for large-scale use in resource-constrained environments (NCCIH, 2021; Patel et al., 2018).

Although the present study is a pioneer in evaluating the effectiveness of white noise-based relaxation techniques in managing student stressors and their well-being, the study has certain limitations. First, the study has a relatively small sample size, which may restrict the generalizability of the findings. Future research should aim to increase the sample size and include more diverse participant groups to enhance the generalizability of findings. Secondly, the study primarily relies on quantitative data; incorporating qualitative methods such as interviews or open-ended questionnaires could yield more detailed insights into participants' subjective experiences with the interventions, for instance, how they perceived improvements in grounding or stress management. Lastly, although the present study only examined short-term treatment effectiveness, this was also a major limitation of this study; therefore, it is recommended that the long-term effects of these therapeutic procedures should be extended at least for 6 months in order to better understand the enduring impact of the interventions over time.

### **Conclusion**

Interventions involving white noise, energy-focused breathing exercises, and their combination significantly reduce stress

levels and improve the overall well-being of adolescent cadets in a high-pressure residential army school environment. All three intervention groups demonstrated statistically significant improvements in psychological functioning, including cognitive and emotional domains compared to the control group. These results are in line with previous research, reinforcing the effectiveness of structured breathing and white noise relaxation techniques for enhancing emotional regulation, reducing anxiety, and boosting mental health among adolescents in demanding settings.

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