

HEALTH AND WELLNESS: BIOFEEDBACK INTERVENTIONS IN MITIGATING STRESS IN NURSING STUDENTS

by

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### **Abstract**

Biofeedback is a mind-body therapy that seeks to increase physiological awareness and gain control over certain physiological functions, such as heart rate and blood pressure. The impact of biofeedback on certain psychological conditions continues to be explored. Many studies in the past few years have focused on improving one's mental health and emotional well-being. Nursing students are under a significant amount of stress and are unstudied. Exploring the use of biofeedback as a therapy could prove to be beneficial for this population. This quantitative descriptive pilot study examined the use of heart rate variability (HRV) biofeedback and paced breathing on mitigating stress and anxiety in undergraduate baccalaureate nursing students. Study participants completed a stress/anxiety questionnaire, and their oxygen saturation, heart rate, and blood pressure were monitored intermittently for five minutes to provide a baseline reading. Participants then received face-to-face initial biofeedback training and were monitored for an additional five minutes while their breathing was paced. Participants were sent home with a paced breathing application and instructed to use the app twice a day for two weeks, at which point they came back to the lab for post-intervention data collections, with a repeat paced breathing session and a stress/anxiety questionnaire. This study received IRB approval. Our sample size was 10 undergraduate baccalaureate nursing students. Results were analyzed and showed a minimal reduction in stress, as well as heart rate and blood pressure. Biofeedback can be one effective tool for the management of stress and anxiety in undergraduate nursing students.

## **Health and Wellness: Biofeedback and Stress in Undergraduate Nursing Students**

### **Background**

In the past few decades, emotional well-being has become more of a focus in the health care industry and in everyday life. Individuals are focusing more and more on their mental health, and research on the effectiveness of certain stress-relieving mechanisms or relaxation techniques has gained more traction as the emphasis on emotional well-being has grown. Reducing stress and anxiety to improve one's mental health has been the focus of many modern research studies. One specific stress-relieving mechanism involves the field of biofeedback, specifically the study of heart rate variability.

Heart rate variability (HRV) is the measure of the changes in time intervals between individual heart beats (Shaffer & Ginsberg, 2017). A heart in good cardiovascular shape should have variation in those time intervals, also known as inter-beat intervals, because a "healthy" heart responds to autonomic regulation of physiologic processes. Such fluctuations can be mathematically analyzed to determine the level of self-regulatory capacity for that individual (Shaffer & Ginsberg, 2017). The concept of biofeedback addresses how to gain awareness of certain physiological responses and how to consciously manipulate those responses. Being able to control certain involuntary body mechanisms through voluntary techniques is one area of focus in the push for better mental health. Studies in this field utilize biofeedback to study the effectiveness of certain techniques on managing the physiological responses to certain environmental factors, such as stress, in certain populations. A particular population of interest for such studies involves undergraduate nursing students.

Nursing is one of the few health professions that can be pursued through obtaining an undergraduate degree. All of the necessary clinical training and didactic coursework is consolidated into either all four years or in the final two years of a baccalaureate program. As such, there is an immense amount of stress and anxiety placed on undergraduate nursing students to succeed and learn all they can in those few years before joining the workforce. Failure to progress costs the student precious time.

Many biofeedback studies focus on undergraduate nursing students because of their high stress levels, rigorous progression requirements, and heavy academic workload.

### **Literature Review**

An integrative review was conducted to gain knowledge and information surrounding biofeedback techniques and their efficacy in improving physiologic control over stress and anxiety. Through this collection of data, themes emerged, and further investigation into their relationships was explored. Although research was focused on nursing students and biofeedback interventions, information on related relaxation therapies such as mindfulness meditation and autogenic training became relevant when looking into stress and anxiety management. As a subset, testing anxiety and its relationship to academic performance were shown to improve when incorporating biofeedback technology to increase physiologic control, evidenced by a 2017 randomized control experimental study at the University of Basque Country (Arizeta et al., 2017). The importance of biofeedback intervention in managing generalized anxiety disorder and traumatic stress related symptoms allow for bridges to be made in expanding holistic and nonpharmacological management.

### **Biofeedback and Relaxation Related to Stress Reduction Among College Students**

College students exist in heavily unpredictable environments that require adaptability to rapid changes. Undergraduate nursing students, however, are tasked with coping with additional stressors, including clinical trainings, implementing technical skills, and rigorous coursework putting them at an increased vulnerability to developing stress when compared to the general college student population (Ratanasiripong et al., 2012). A group of eleven articles was identified related to biofeedback and relaxation techniques for stress and anxiety reduction among both nursing and non-nursing college students. Three randomized control studies were conducted to determine the effects of biofeedback technologies on perceived stress and anxiety in Thai nursing students (Ratanasiripong et al., 2012). When comparing each study, there was a ubiquitous significant decrease seen in anxiety levels using the

State Anxiety Scale from pre- and post-intervention in each of the 3 research studies. In two additional studies (Ratanasiripong et al., 2015a) (Ratanasiripong et al., 2015b) second-year baccalaureate nursing students beginning their first clinical training were instructed on use of a portable biofeedback device called the emWave PSR to control HRV through slow-paced breathing and positive emotions. The first study (Ratanasiripong et al., 2015b), showed a small non-significant increase in the Perceived Stress Scale among the biofeedback group with a significant increase in the control group. The study that sought to investigate the efficacy of biofeedback versus mindfulness meditation and resulted in statistically significant decreases in both anxiety and stress in the mindfulness meditation experimental group with significant decrease in anxiety with maintained perceived stress in the biofeedback group (Ratanasiripong, 2015b). Ratanasiripong's (2015a) research related to graduate students in public health nursing utilization of biofeedback incorporated an additional scale to monitor depression, the Center for Epidemiological Study-Depression scale. The postinterventional statistics among these students showed a significant decrease in depression in the biofeedback group while the control had a significant increase (Ratanasiripong et al., 2015a). Incorporating mechanisms to increase psychological well-being in nursing students was focused on by Ratanasiripong.

In a review of 26 intervention studies between 2009 and 2015 related to stress and anxiety reduction in nursing students such as guided imagery, pet-therapy, and peer-relationships, a biofeedback study was mentioned to allow further exploration of the topic (Turner & McCarthy, 2017). This led to research by Prato and Yucha (2013), which is discussed in the test anxiety portion. Two pilot study programs showed the impact of relaxation techniques with nursing students to evaluate the Perceived Stress (Choma, 2019) (Harmelink, 2016). A quasi-experimental study indicated that through heart-rate variability biofeedback, accelerated baccalaureate nursing (BSN) students significantly decreased their perceived stress, and increased coping abilities and resilience (Harmelink, 2016). In Choma's (2019) mixed method study in associate degree nursing students, three methodologies were

implemented: diaphragmatic breathing, guided imagery, and senior student mentors. It was found that the mentorship program among this population of students was reported to be the most helpful, although all interventions were shown to decrease perceived stress (Choma, 2019). A systematic stress reduction program utilizing cognitive modification was shown to significantly impact reported state anxiety in junior BSN students (Heaman, 1995). Managing stress and anxiety can lead to increased productivity and more positive outcomes as one enters their career as a nurse following graduation. Autogenic training as a subset of biofeedback intervention for nursing students was investigated in both Kanji's (2006) and Lim's (Lim & Kim, 2014) articles. In an experimental group, training significantly reduced physiologic indicators of stress such as blood pressure and pulse rates (Kanji et al., 2006). This relaxation technique aims to relieve tension, anger, and stress through muscular relaxation and slowing physical responses. The stress response was significantly reduced in an experimental group after having autogenic training (Lim & Kim, 2014).

Evidence showed that the use of biofeedback to improve psychophysiological health among non-nursing students is effective. Furthermore, there is a great need for providing undergraduate nursing student with accessible coping strategies for stress and anxiety. In years past, the number of mental health disorders in university students continues to rise (Chaló et al., 2017). Developing interventions that are brief and easily accepted, such as biofeedback smartphone technologies, could lead to more positive mental health outcomes. The Happify mobile health app used HRVBF and was shown to significantly lower salivary amylase in a study on undergraduate students at the University of California (Hunter et al., 2019). This study provided preliminary evidence that HRVBF lowers the stress response recovery.

### **Biofeedback and Relaxation Related to Test Anxiety and Academic Performance**

Academic stress and concomitant testing anxiety can greatly impact performance and success among nursing students. There is immense pressure to achieve adequate scores, pass courses, and

progress in the program. Five articles emerged containing information related to physiologic control using biofeedback in high-anxiety testing situations. The Prato & Yucha study (2013) and Manansingh studies (2019) incorporated relaxation programs into nursing programs to evaluate their impact on testing anxiety. It was found that biofeedback assisted relaxation training significantly reduced physiologic stress responses such as peripheral skin temperature, and pulse and respiratory rate (Prato & Yucha, 2013). Third semester nursing students were seen to have the highest rates of testing anxiety. Manansingh's (2019) study with relaxation techniques, such as breathing retraining, guided imagery, and music therapy, demonstrated a significant decrease among nursing students' test anxiety following the six weeks. Increased academic performance and psychophysiological well-being are oftentimes coexistent. Although Aritzeta's and his colleagues' study (2017) focused on non-nursing students, the experimental study showed the impact of biofeedback relaxation in significantly lowering anxiety and further increasing academic performance in undergraduate students. Autonomic nervous system function, as well as the role it plays in cognitive function and emotion, is important for future research. Analysis of two integrative reviews regarding strategies to reduce test anxiety in nursing students gave insight for future. Brodersen's (2017) article referenced Ratanasiripong's research (2012) (2015a) (2015b) along with Prato & Yucha's (2013) biofeedback program which impacted physiologic stress response indicators. The review identified nineteen interventions for testing anxiety in nursing students and expressed the need for future research in nursing education test anxiety. A systematic review by Quinn and Peters (2017) identified two categories of interventions: environmental adjustments and student behavioral modifications among nursing students. Investment in future research related to biofeedback interventions as means to decrease test anxiety and further improve academic performance was a theme throughout the articles.

## **Biofeedback and Relaxation Related to Existent Anxiety Disorder and Related Symptoms**

Managing generalized anxiety disorder (GAD) and related symptoms is a health issue that has become increasingly prevalent. Anxiety is associated with mental and physical pathologies and has even been described as the silent killer. Analysis of biofeedback intervention in neurophysiology contributed to 5 articles emerging. Research in biofeedback techniques in treating GAD was highlighted in Zafeiri's (2019) and Agnihotri's (2008) research studies. Both programs resulted in a decrease in anxiety and a more consistent pattern of generalized relaxation that was maintained during follow-up data collection (Agnihotri et al., 2008) (Zafeiri et al., 2019). There was a shift in classifications of anxiety seen from severe anxiety to mild anxiety. Investigation into biofeedback related to reducing anxiety-related symptoms such as low sleep quality, impaired psychological resilience, and depression was researched. Kizakevich (2019) additionally investigated treatment of traumatic and operational stress related to PTSD in a mixed population of military personnel through which biofeedback was used. This study called for a need of further research in the effectiveness of biofeedback apps used for biofeedback training. There was an overall beneficial outcome in van der Zwan's (2015) trial, showing reduced stress, anxiety, depression, and psychological well-being in a sample of adults with preintervention stress complaints. Lastly, a study in an outpatient psychiatry department sought to investigate the effectiveness of diaphragmatic breathing relaxation training to reduce anxiety disorder (Chen et al., 2017). It was found that through their breathing techniques, there was a significant reduction in anxiety self-report scores, heart rate, and respiratory rate over the eight weeks (Chen et al., 2017). Throughout the research, the efficacy of biofeedback as a nonpharmacological treatment for anxiety disorder and its related symptoms was demonstrated.

### **Research Questions and Aims**

This study aims to determine the extent to which nursing students feel stressed and overwhelmed, how nursing students cope with and manage that stress, and the extent to which

biofeedback and specific breathing techniques are successful in modifying stress levels in undergraduate nursing students.

The first aim of this research project is to determine stress and anxiety levels in undergraduate nursing students. As previously discussed, the nursing education track is extremely rigorous and one of the few health care professions that can be joined with solely an undergraduate degree. Nursing students feel an overwhelming number of negative emotions in response to the high-stress academic environments in which they find themselves. This study aims to measure stress levels of nursing students to provide a baseline measurement to which the success of biofeedback interventions can be measured.

The second aim of this research project seeks to determine common interventions and coping mechanisms already in use by undergraduate nursing students. Individuals handle stress differently, and certain interventions, such as breathing techniques or guided imagery, are more commonly used in a wider array of people due to wider access and greater ease of use. People who feel increased levels of stress due to certain academic or career aspirations may develop stress-reducing techniques independently or may seek out professionals to provide them with coping mechanisms. Determining which relaxation techniques are already used by the nursing students being studied will provide more data for this project, as well as show how well the research subjects are independently managing stress for themselves.

The third and final aim of this research project is to determine how successfully biofeedback mitigates stress and anxiety in nursing students. New research on biofeedback and its ability to impact emotional well-being positively is being conducted, but this research project seeks to focus specifically on stress and anxiety in undergraduate nursing students. This project aims to prove that biofeedback is yet another successful technique that can be used to reduce negative physiological responses to stress and anxiety.

## Methodology

### Study Design

This was a quantitative descriptive study focused on biofeedback interventions in the management of stress and anxiety in a sample of undergraduate nursing students. Institutional review board approval was obtained prior to data collection. Collection of data was obtained through noninvasive measures.

For this study, pre- and post-intervention questionnaires were given to participants. Students came in for a baseline measurement of physiologic functions such as heart rate and blood pressure, along with two preintervention questionnaires. The questionnaires assessed perceived stress and anxiety levels as well as any pertinent cardiovascular history. Participants had a pulse oximeter and a blood pressure cuff placed and were instructed to sit quietly for five minutes, during which blood pressure and heart rate readings were intermittently taken. Participants then followed a paced-breathing exercise on a monitor for five minutes, during which repeat blood pressure and heart rate measures were taken. After the paced breathing exercise was completed, participants were given instructions on a smartphone app called "Breathing App". Participants were instructed to use the app at home to guide paced breathing exercises for ten minutes twice a day and whenever they felt stressed. Participants returned after two weeks for repeat data collection. Baseline measures of heart rate and blood pressure were taken for five minutes, then participants were led through another five-minute paced breathing exercise. The participants retook the stress and anxiety questionnaires as well.

### Sample/setting

A total sample size of 10 participants was agreed upon. Criteria for inclusion in the study involved being over eighteen years old, being currently enrolled in an undergraduate nursing program, and being able to follow directions adequately. Exclusion criteria included being a non-English speaker and being unable to place a blood pressure cuff on an arm. Research participants were studied in the

biofeedback laboratory at East Carolina University. A convenience sample of participants were recruited from the third semester cohort, and a snowball recruitment effort was implemented.

### **Evaluation**

Effectiveness of the paced breathing exercises was evaluated by analysis of blood pressure and heart rate data as well as comparison of the pre- and post-intervention stress and anxiety questionnaire data. Changes in heart rate variability were also analyzed using the root mean square of successive differences (RMSSD) measure.

### **Results**

Of the targeted sample size, 10 participants were recruited. The sample consisted of East Carolina College of Nursing students who were female, single, ages 20-23, and 90% white persons. One participant did not return for the repeat biofeedback session. Data was collected on the remaining, n=9. Through data collection and assessment, slight decreases between pre- and post-intervention mean data were observed. Pre-intervention mean data consisted of BP 119/74mmHg, HR 79 bpm, RMSSD 65.77. Post-intervention mean data consisted of BP 118/69mmHg, HR 75 bpm, RMSSD 63.16. Minimal reduction in stress levels was observed in pre- and post-intervention questionnaire data.

### **Discussion**

This pilot study demonstrated the efficacy of biofeedback interventions in stress reduction, positively impacting nursing students' coping abilities. With the burnout seen today in healthcare, specifically with bedside nurses, investment in methods to increase mental and emotional well-being is of utmost importance now more than ever. We believe that by implementing stress reduction techniques as a student, these self-management strategies could lead to positive coping as an RN. Limitations of this study include recruitment efforts and influencing variables during data collection. Recruitment of nursing student participants was challenging as these students voiced a lack of time outside of school and classwork. This resulted in a small homogenous sample of all females, ages 20-23,

90% white persons. All participants reported being relatively active and healthy, which potentially contributed to the insignificant differences seen between pre- and post-intervention data. Recruitment began during September 2021, but it was not until November-December that the target sample size was obtained. With this, influencing variables emerged, such as having final exams during the week of post-intervention data collection. Recommendations for future research and improvement revolve around the following statements. By implementing biofeedback interventions during the first semester of nursing school, students will have the tools and knowledge to engage in stress reduction, and a more longitudinal study can be conducted. Future beneficial partnerships include utilizing the Health Science Campus Center for Counseling and Student Development, a current one-on-one free counseling service for students, to offer biofeedback therapy. Investment in students mental and emotional health can impact success in nursing programs and future endeavors as an RN.

#### **Dissemination of Findings**

Through this project, we disseminated our findings at two different conferences. First, we presented to a group of nursing scientists at Collaborative Nurse Research Day sponsored by Eastern AHEC. We informed people of our project goals and findings while getting feedback for future research suggestions such as partnerships with the counseling center at East Carolina University. We then presented to a larger, interdisciplinary audience at Research & Creative Achievement Week to foster further communication between disciplines. We recognize the importance of interdisciplinary collaboration in furthering nursing research.

## References

- Agnihotri, H., Paul, M., & Sandhu, J. S. (2008). The comparative efficacy of two biofeedback techniques in the treatment of generalized anxiety disorder. *Pakistan Journal of Social and Clinical Psychology, 6*(1), 35.
- Aritzeta, A., Soroa, G., Balluerka, N., Muela, A., Gorostiaga, A., & Aliri, J. (2017). Reducing anxiety and improving academic performance through a biofeedback relaxation training program. *Applied Psychophysiology and Biofeedback, 42*(3), 193-202.  
<https://doi.org/10.1007/s10484-017-9367-z>.
- Brodersen, L. D. (2017). Interventions for test anxiety in undergraduate nursing students: An integrative review. *Nursing Education Perspectives, 38*(3), 131-137.  
<https://doi.org/http://dx.doi.org/10.1097/01.NEP.0000000000000142>.
- Chaló, P., Pereira, A., Batista, P., & Sancho, L. (2017). Brief biofeedback intervention on anxious freshman university students. *Applied Psychophysiology and Biofeedback, 42*(3), 163-168. <https://doi.org/10.1007/s10484-017-9361-5>.
- Chen, Y., Huang, X., Chien, C., & Cheng, J. (2017). The effectiveness of diaphragmatic breathing relaxation training for reducing anxiety. *Perspectives in Psychiatric Care, 53*(4), 329-336. <https://doi.org/10.1111/ppc.12184>.
- Choma, S. M. (2019). An evidence-based application of a stress reduction pilot project on first semester-associate degree nursing students (D.N.P.). Available from ProQuest Dissertations & Theses Global. (2240082006). <https://www.proquest.com/dissertations-theses/evidence-based-application-stress-reduction-pilot/docview/2240082006/se-2?accountid=10639>.
- Harmelink, A. J. (2016). Pilot study of the effects of heart rate variability biofeedback on perceived stress, perceived coping ability, and resilience in accelerated baccalaureate nursing students (Ph.D.). Available from ProQuest Central, ProQuest Dissertations & Theses Global.

(1837118041). <https://www.proquest.com/dissertations-theses/pilot-study-effects-heart-rate-variability/docview/1837118041/se-2?accountid=10639>.

Heaman, D. (1995). The quieting response (QR): A modality for reduction of psychophysiologic stress in nursing students. *The Journal of Nursing Education*, 34(1), 5-10.

Hunter, J. F., Olah, M. S., Williams, A. L., Parks, A. C., & Pressman, S. D. (2019). Effect of brief biofeedback via a smartphone app on stress recovery: Randomized experimental study. *Journal of Medical Internet Research Serious Games*, 7(4), e15974. <https://doi.org/10.2196/15974>.

Kanji, N., White, A., & Ernst, E. (2006). Autogenic training to reduce anxiety in nursing students: Randomized controlled trial. *Journal of Advanced Nursing*, 53(6), 729-735. <https://doi.org/10.1111/j.1365-2648.2006.03779.x>.

Kizakevich, P. N., Eckhoff, R. P., Lewis, G. F., Davila, M. I., Hourani, L. L., Watkins, R., Weimer, B., Wills, T., Morgan, J. K., Morgan, T., Meleth, S., Lewis, A., Krzyzanowski, M. C., Ramirez, D., Boyce, M., Litavec, S. D., Lane, M. E., & Strange, L. B. (2019). Biofeedback-assisted resilience training for traumatic and operational stress: Preliminary analysis of a self-delivered digital health methodology. *Journal of Medical Internet Research mHealth and uHealth*, 7(9), e12590. <https://doi.org/10.2196/12590>.

Lim, S., & Kim, C. (2014). Effects of autogenic training on stress response and heart rate variability in nursing students. *Asian Nursing Research*, 8(4), 286-292. <https://doi.org/10.1016/j.anr.2014.06.003>.

Manansingh, S., Tatum, S. L., & Elsa-Sofia Morote. (2019). Effects of relaxation techniques on nursing students' academic stress and test anxiety. *The Journal of Nursing Education*, 58(9), 534-537. <https://doi.org/http://dx.doi.org/10.3928/01484834-20190819-07>.

Prato, C. A., & Yucha, C. B. (2013). Biofeedback-assisted relaxation training to decrease test

anxiety in nursing students. *Nursing Education Perspectives*, 34(2), 76-81.

<https://doi.org/10.5480/1536-5026-34.2.76>.

Quinn, B. L., & Peters, A. (2017). Strategies to reduce nursing student test anxiety: A literature review. *The Journal of Nursing Education*, 56(3), 145-151. <https://doi.org/10.3928/01484834-20170222-05>.

Ratanasiripong, P., Kaewboonchoo, O., Ratanasiripong, N., Hanklang, S., & Chumchai, P.

(2015). Biofeedback intervention for stress, anxiety, and depression among graduate students in public health nursing. *Nursing Research and Practice*, 2015, 160746-5.

<https://doi.org/10.1155/2015/160746>.

Ratanasiripong, P., Park, J. F., Ratanasiripong, N., & Kathalae, D. (2015). Stress and anxiety management in nursing students: Biofeedback and mindfulness meditation. *The Journal of Nursing Education*, 54(9), 520-524. <https://doi.org/10.3928/01484834-20150814-07>.

Ratanasiripong, P., Ratanasiripong, N., & Kathalae, D. (2012). Biofeedback intervention for stress and anxiety among nursing students: A randomized controlled trial. *International Scholarly Research Notices Nursing*, 2012, 827972-5. <https://doi.org/10.5402/2012/827972>.

Shaffer, F., & Ginsberg, J. P. (2017). An overview of heart rate variability metrics and norms. *Frontiers in Public Health*, 5, 258. <https://doi.org/10.3389/fpubh.2017.00258>.

Turner, K., & McCarthy, V. L. (2017). Stress and anxiety among nursing students: A review of intervention strategies in literature between 2009 and 2015. *Nurse Education in Practice*, 22, 21-29. <https://doi.org/http://dx.doi.org/10.1016/j.nepr.2016.11.002>.

van der Zwan, J. E., de Vente, W., Huizink, A. C., Bögels, S. M., & de Bruin, E. I. (2015).

Physical activity, mindfulness meditation, or heart rate variability biofeedback for stress reduction: A randomized controlled trial. *Applied Psychophysiology and Biofeedback*, 40(4), 257-268. <https://doi.org/10.1007/s10484-015-9293-x>.

Zafeiri, E., Kandylaki, A., Zyga, S., Zarogiannis, I., & Panoutsopoulos, G. I. (2019). The contribution of biofeedback brain boy method to the treatment of anxiety disorders. *Materia Socio-Medica*, 31(2), 105-109. <https://doi.org/10.5455/msm.2019.31.105-109>.