

Biofeedback training on university student's anxiety management: A systematic review

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Abstract

University students are susceptible to anxiety disorders. Nowadays it's a growing problem, and cost-effective solutions are research's imperative. Biofeedback training might be a valid solution to reduce anxiety and improve student's health and performance.

The aim of this paper is to do a reflective and systematic review of scientific literature about biofeedback application in anxiety management among university students. A Pubmed/Medline database research with the keywords "biofeedback" AND "anxiety" AND "students" were analysed in the period between 2015 and 1980 (all papers obtained). The PRISMA criteria for reporting in systematic reviews and meta-analyses were applied. The inclusion criteria were: the use of instruments to measure anxiety, the use of biofeedback applications, university student samples, the presentation of quantitative or qualitative results. It was excluded articles outside the scope of subject; that do not met the inclusion criteria; and papers without access.

After applying this methodology, 17 scientific articles were included in the study. The instruments used, the dimensions, and the obtained results were analysed.

This review allowed us to conclude that biofeedback can help university students to manage their anxiety and stress levels, but more research is needed to reinforce empirical evidence about biofeedback as a technique to improve students' anxiety and stress.

Introduction

University students are susceptible to many stressors: new environment, difficult coursework, exams, time demands, financial pressure, changes in sleeping and eating habits, increased responsibilities, increased workload, meeting new people, career decisions, fear of failure and parental pressure [1,2].

Anxiety disorders are a growing problem in our society and are prevalent in university students, with more incidences at the first year [3]. Anxiety is an adaptive response to a perceived threat but beyond normal levels can lead to an out-of-proportion response, which can disrupt psychological functioning and manifest itself as physiological symptoms [1,4,5]. Therefore, anxiety and stress can affect academic performance, health, and well-being [6-8]. Given the pervasiveness of anxiety in student population, it is important to develop and implement interventions that can be easily used, inexpensive and have minimal side effects [3].

Since the 1960's, biofeedback is being used to treat certain medical conditions and to improve human's health performance. Biofeedback can be described as a self-regulation process (mind-body) of the body's physiological functions, to improve performance and health [9].

Biofeedback equipment, include specialized devices and sensors, that transmit information about physiological process like heart rate, skin temperature, brainwave activity, blood pressure, respiration, or muscle activity. From the moment that the person become aware of his or her physiological function, he/she can learn to modify thoughts, feelings, or behaviours in order to make positive changes of that physiological activity to improve health and performance [10,11]. Therefore, biofeedback training has proved to be helpful in reducing anxiety/stress symptoms as well as other health conditions like asthma,

attention deficit hyperactivity disorder, chronic pain, depression, epilepsy, headache, hypertension, insomnia, irritable bowel syndrome, posttraumatic stress disorder, stroke, and urinary incontinence [12].

There are many types of biofeedback: electroencephalograph (EEG), electrocardiogram (ECG), electromyography (EMG), electro dermal activity (EDA) and heart rate variability (HRV). These different types of biofeedback are used for different conditions. Interventions using biofeedback training can incorporate relaxation techniques to modify the autonomic nervous system by decreasing physiological arousal, leading to the decrease of stress/anxiety [10-12].

The aim of this study is to provide an overview of scientific evidence produced in "Biofeedback training on university student's anxiety management".

Methods

This paper is a reflective and systematic literature review study. Between 2015 and 1980, it was identified scientific papers published in international journals, using a digital format database research: MedLine and PubMed, and in a second phase it was used Scopus. The descriptors used in the research were: ["BIOFEEDBACK AND

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ANXIETY AND STUDENTS"], it was obtained 47 publications, in PubMed/MedLine database. All publications obtained in PubMed/MedLine database were analysed, 30 publications were excluded: 10 publications were outside the scope of the study, out of context themes; 9 had anxiety students but no use of biofeedback techniques; 5 with no access; 3 reported students with anxiety and other pathologies; and 3 do not referred any university/college students.

This structured research resulted in 17 publications about the subject that were intended to assess and within inclusion criteria (see figure 1).

The inclusion and exclusion criteria of the studies are described in Table 1.

The PRISMA criteria for preferred reporting items of systematic reviews was applied. The information collected was compiled and analysed regarding the year of publication, authors, sample, and country, methodology, results and aims.

The cataloguing and identification of repeated references were made through the computer program EndNote bibliographic referencing.

Analysis of results and discussion

The present review revealed few studies about this issue:

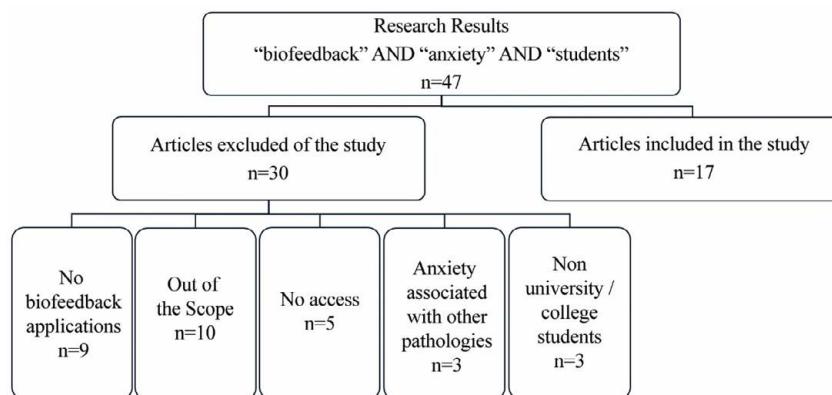


Figure 1. Flowchart – applying the inclusion and exclusion criteria in research.

Table 1. Criteria for inclusion and exclusion of the research “Biofeedback training on university student's anxiety management”.

Inclusion Criteria	Exclusion Criteria
Use of instruments to measure anxiety	No use of instruments to measure anxiety or used on non-university students
Use of biofeedback in university students	No use of biofeedback or used on non-university students
Presentation/analysing quantitative/qualitative data	Anxiety students with others pathologies No presentation/analysing quantitative/qualitative data Incomplete studies/without accessibility

Table 2. Summary of studies by decade.

Years	Studies	Country	Total Sample	Anxiety/Stress Psychological Measures
2010-2015	7	USA (3) Thailand (3) South Korea (1)	314	State Trait Anxiety Inventory (6) Perceived Stress Scale (4) Test Anxiety Inventory (1) Mood and Anxiety Symptom Questionnaire (1)
2000-2010	-	-	-	-
1990-2000	1	USA (1)	40	State Trait Anxiety Inventory (1)
1980-1990	9	USA (9)	414	State Trait Anxiety Inventory (6) Stress Level Assessment (1) Anxiety Differential (1) Achievement Anxiety Test (1) IPAT Anxiety Scale (1)

Table 3. Summary of analysed studies.

Study	Aim	Sample	Procedures	Instruments	Findings
Meier & Welch, 2015, USA. [22]	-Compare the effect of brief paced-breathing with biofeedback and exercise interventions on heart rate variability, state anxiety and affect.	N=32 college students.	Three 10-min interventions on separate days: paced-breathing with biofeedback (Biofeedback), a self-paced walk (Exercise); and an attention control condition of quiet studying (Quiet)	PSS. STAI. Activation Deactivation Adjective Checklist. Biofeedback (BVP).	-Biofeedback reduced anxiety more than the exercise condition. -Exercise temporarily increased energy, whereas biofeedback temporarily increased calmness.
P. Ratanasiripong <i>et al.</i> , 2015, Thailand. [8]	-Compare the efficacy between brief intervention programs (biofeedback and mindfulness) on levels of state anxiety and perceived stress in students.	N=89 nursing college students.	-The biofeedback and mindfulness groups received two training sessions. -The control group took no action. -Participants in both intervention groups were instructed to use their taught intervention three times per day for 4 weeks.	PSS. STAI. Biofeedback (HRV).	-Biofeedback significantly reduced anxiety and maintained stress levels in students. -Mindfulness meditation similarly decreased anxiety levels, while also significantly lowering stress levels. -The biofeedback group exhibited significant reduction in anxiety levels among the three groups at post intervention.
P. Ratanasiripong, <i>et al.</i> , 2015, Thailand [15]	-Study biofeedback efficacy in reducing anxiety and managing stress among students.	N=60 graduate nursing college students.	-Biofeedback group students was given a portable biofeedback device to use for 4 weeks. -Control group took no action.	PSS. STAI. Center for Epidemiological Study-Depression Scale. Biofeedback (HRV).	-Biofeedback intervention was effective in significantly reducing the levels of stress, anxiety, and depression, while the control group had increases in symptoms of anxiety and depression over the same timeframe.
Lee <i>et al.</i> , 2015, Korea. [1]	-To determine the effect of HRV biofeedback treatment and relaxation training in reducing trait anxiety compared to control group without any treatment.	N=15 students.	-Four HRV biofeedback sessions were provided for 45 minutes every two weeks. -Different relaxation techniques were provided for 45 minutes every two weeks.	STAI. Biofeedback (HRV).	-Significant difference in trait anxiety between the biofeedback treatment and the no treatment group. -No significant difference between the relaxation group and the no treatment control group. -No significant difference between the HRV biofeedback treatment and the relaxation training. -There is potential benefit in utilizing HRV biofeedback treatment for stress management programs and/or anxiety reduction treatment.
Prato & Yucha, 2013, USA. [5]	-To determine if students learn to decrease pulse rate, decrease breathing rate, and increase peripheral skin temperature using a biofeedback assisted relaxation training. -To find if relaxation training decrease test anxiety.	N=14 nursing students.	-Participants were introduced to diaphragmatic breathing, progressive muscle relaxation, and autogenic training each week. -Participants should practice the relaxation techniques and monitor and record their peripheral skin temperature, pulse rate, and respiratory rate for 15 minutes a day, every day between sessions.	Spielberger's Test Anxiety Inventory. Biofeedback (Thermal, HR, and respiratory rate).	-Statistically significant changes occurred in: respiratory rates and skin temperatures during the diaphragmatic breathing session; respiratory rates and peripheral skin temperatures during progressive muscle relaxation session; respiratory and pulse rates, and peripheral skin temperatures during the autogenic sessions. -No statistically significant difference was noted between the first and second TAI. -Subjective test anxiety scores of the students did not decrease by the end of training.
P. Ratanasiripong <i>et al.</i> , 2012, USA. [16]	-To investigate the impact of biofeedback intervention program on nursing students' levels of stress and anxiety during their first clinical training.	N=60 nursing students,	-Biofeedback group used portable biofeedback device for 5 weeks, training 3 times per day, -The participants in the control group did not receive any training or device to use.	PSS. STAI. Biofeedback (HRV).	-Biofeedback group was able to maintain the stress level while the control group had a significant increase in the stress level. -Biofeedback group had a significant reduction in anxiety, while the control group had a moderate increase in anxiety.
Henriques <i>et al.</i> , 2011 USA. [3]	-To examine the effectiveness of the HeartMath biofeedback software program as a stand-alone intervention for reducing anxiety and improving well-being in college students.	N=9 (pilot project). N=35 (second study).	-Pilot project students trained a biofeedback program 20 min a day, 5 days a week. -Second study participants used a desktop biofeedback system five times per week for 15 min per session.	Mood and Anxiety Symptom Questionnaire. STAI. Biofeedback (HR).	First study: -promising results and suggested that participating in the HeartMath computer-based biofeedback intervention resulted in a significant reduction in self-reported levels of anxiety and negative mood. Second study: -biofeedback program does reduce levels of anxiety. -no evidence that the program increased positive mood or general domains of well-being.-

Heaman, 1995, USA. [4]	-To investigate the effects of a 5-week stress management program for nursing students.	N=40 female nursing students.	-Five 90-minute sessions once a weekly over 5 weeks. -sessions consisted on didactic information; monitoring logs share; Quieting Response Audio Cassettes for relaxation training; and augmentation of biofeedback training.	STAI; Quieting Response Audio Cassettes; Biofeedback (EMG, Thermal, GSR)	-Posttreatment state anxiety scores of subjects in the stress management program were significantly lower than scores of the control group -Results support the benefits of integrating a stress management program into curricula for nursing students. -Developed proposals based on concepts of stress, anxiety and coping in their research course.
Drennen <i>et al.</i> , 1987 USA. [14]	Investigated Type A and B patterns with regard to women as interacting with biofeedback and a differential, challenging incentive set.	N=22 female college students.	-5 groups were designated either Type A/B: control (C); biofeedback / relaxation (BR); or competitive biofeedback / relaxation (BRC). -C group had EMG measured without biofeedback. -BR group made a 20 minutes EMG biofeedback. -BRC group were given the same instructions BR with a competitive instructional set to provide a mild challenging incentive.	STAI. Biofeedback (EMG).	-Pre and post anxiety scores indicated a reduction in self-reported state anxiety for all groups combined, but no differential reductions with respect to group or condition.
Valdés, 1985 USA. [17]	-To evaluate the results of the open-focus attention-training technique.	N=23 college students (1º study) N=28 (2º study)	-Open-focus technique without biofeedback training was used for two semesters. -Biofeedback training was incorporated in the third semester, twice over 8 weeks.	Stress Level Assessment. Biofeedback (Thermal, EMG, GSR, and EEG)	-Stress-related symptoms associated with anxiety and management of emotional problems showed significant posttraining improvement, as did physiological measures in all of the biofeedback modalities in which the experimental subjects were specifically trained.
Diaz & Carlson, 1984, USA. [13]	-Compare 3 EMG training procedures in relaxation.	N=32 college students.	-Four groups, received distinguished treatments during nine training sessions. -FNT: EMG frontal feedback. -MSO: three EMG training sessions each on the frontal area, forearm flexor and sternomastoid. -MSR: same as group MSO, in addition to the progressive relaxation cassette for home use. -CNT: received a continuous, noncontingent low tone.	Spielberger State Anxiety Scale; Biofeedback (EMG)	-The three biofeedback methods were apparently equally successful in maintaining reduced frontal and sternomastoid EMG activity, while the MSR method was the most successful in maintaining reduced skin conductance levels. -No method was superior in terms of alleviating overall subjective anxiety in the shock-anticipation session.
Fehring, 1983, USA. [18]	-To compare the effects of Benson's relaxation technique (BRT) with Benson's technique augmented with biofeedback (BAR) on the psychological stress symptoms of well students.	N=78 college students.	-(BAR) practiced Benson's technique with biofeedback at least once a day for eight weeks. -(BRT) practiced Benson's technique focusing on the word "one". -Control took no action.	STAI. Profile of Mood States. Biofeedback (GSR).	-BAR group had significantly lower state anxiety and POMS than the BRT and control groups. -BAR did augment Benson's technique in lowering psychological stress symptoms.
Schandler & Dana, 1983, USA. [24]	-Explore and compare the effects of cognitive imagery relaxation and biofeedback relaxation protocols. -Examine changes in identified tension behaviors, and assess changes across several related and unrelated personality dimensions.	N=45 female students volunteers.	-During three weekly sessions each person received either guided cognitive imagery relaxation, frontalis muscle feedback relaxation, or a self-rest control procedure.	Taylor-Johnson Temperament Analysis. Anxiety Differential. Biofeedback (EMG).	-Imagery procedure was associated with moderate reductions in physiological tension and significant reductions in state anxiety and three tension-related personality dimension. -Biofeedback persons showed the largest reductions in physiological tension, they displayed only small and variable changes in state anxiety and personality dimension. -Self-rest persons displayed lesser reductions in general tension with little physiological change.
McKinney & Gatchel, 1982, USA. [23]	-Evaluate the effectiveness of biofeedback, Speech Skills Training, and a combination of both in treating public-speaking anxiety.	N=42 volunteers.	-After a relaxation session, each group: (biofeedback training, speech skills training, and a combination of both) received a different intervention over the next 4 sessions.	STAI. Biofeedback (HR).	-All treatments were effective in lowering overt motor and self-report components of anxiety. -Only the biofeedback and combined group subjects demonstrated significantly less heart rate increase while speaking before an audience during the post treatment assessment.

Thyer <i>et al.</i> , 1981, USA. [19]	-Examines the relative efficacy of an in vivo distraction-coping training procedure, explicitly designed to provide test anxious students with attentional focusing skills, when added to a standard cognitive-behavioral test anxiety reduction program.	N=38 college students.	-Control group received core treatment program of: cognitive behavior therapy, progressive muscular relaxation training, and thermal biofeedback. -The experimental group received core treatment and additional in vivo distraction-coping training.	Test attitude inventory. STAI. Rational Behavior Inventory. Biofeedback (Thermal)	-Overall the efficacy of the core program was demonstrated with reductions in test, trait and state anxiety, and increases in personal belief systems. -In vivo distraction-coping was not found to result in more efficacious treatment as measured by self-report and performance variables.
Reed & Saslow, 1980, USA. [21]	-Compare applicability of EMG biofeedback to alleviating subjectively experienced test-taking anxiety along with the effects of relaxation training on locus of control.	N=27 psychology students.	-Both experimental groups attended eight half-hour training sessions on an individual basis: Two per week for 4 weeks. -One group received relaxation instructions and EMG biofeedback. -Other group received instructions alone. -Control group received no treatment.	Achievement Anxiety Test. STAI. Rotter Locus of control scale. Biofeedback (EMG).	-EMG feedback added little to the effectiveness of relaxation instructions and practice in decreasing subjective feelings of anxiety or lowering forehead muscle tension. -Relaxation instruction without EMG biofeedback had the desirable side effect of shifting students toward a more internal locus of control.
Hurley, 1980, USA. [25]	Compare hypnotic treatment, biofeedback treatment, trophotropic treatment, and control groups.	N=60 college students.	-Each group was trained separately, for 60 minutes, once a week, for 8 weeks, in a different technique (hypnotic, biofeedback, and trophotropic). -The control group did not meet during this time.	IPAT Anxiety Scale. Ego Strength Scale. Harvard Group Scale of Hypnotic Susceptibility. Biofeedback (EMG).	-Hypnosis was a more effective self-regulatory technique for lowering anxiety levels when compared to biofeedback or trophotropic response procedures. -To increasing ego strength, both the hypnotic training group and the biofeedback training group proved to be significant.

improve anxiety or stress.

Five studies analysed only biofeedback intervention. Four studies presented a significant reduction of measured anxiety levels after biofeedback intervention [3,13-16], and one found no significant differences on anxiety self-reported measures after biofeedback training but there was a reduction on physiological responses to stress [5].

The use of biofeedback with other forms of intervention was found on 6 articles. All studies presented a reduction of the measured anxiety levels for programs of biofeedback combined with: Stroebel's Quieting Response [4]; an attention-training program [17]; Benson's technique [18], a common core treatment program of cognitive behaviour therapy, progressive muscular relaxation and biofeedback [19], with 1-year follow-up [20]; and progressive relaxation [21].

Biofeedback alone was also compared with other techniques on 6 studies. When compared with a self-paced exercise program, biofeedback decreased anxiety and increased calmness [22]. Another study compared biofeedback and mindfulness, both reduced anxiety but mindfulness significantly lowered stress levels while biofeedback maintained them [8]. Lee *et al.* [1] compared biofeedback and relaxation training and found that, despite no differences were found between these interventions, only biofeedback presented significant reduction when compared with the control group. McKinney and Gatchel [23] concluded that biofeedback as well as speech skills training were effective on reducing anxiety. Different results were found in a study where biofeedback displayed little change in Anxiety Differential scores when compared with imagery relaxation [24]. Hurley [25] also found hypnosis to be a more effective self-regulatory technique when compared to biofeedback.

It is important to highlight that 2010 seem to mark a return of research on this specific field. After the period between 1980 and 1989, when were published most of the analysed articles, the research seem to almost stop. Two justifications help explain it. First, the increasing anxiety in university students, and the personal, social and economic

consequences, makes this subject more relevant. Second, the traditional biofeedback involved complex multi-channel input and presented a cost that was prohibitive for many campuses, but in recent years new low cost, portable, more accurate and friendly-user devices have been developed and allowed biofeedback to expand [9].

Summary of methodological limitations

The selected methodology for the inclusion and exclusion criteria of the current study always limits the obtained results. It can leave out many valid data studies and relevant factors to the understanding of the theme can be excluded. The lack of publications in this area, also conditioned the selection, analysis and generalization of results.

We found limitations in the analysed articles: not representative sample of population or small sample size [1,3,4,15-17], short treatment duration; incomplete data follow-up or lack of follow-up on the long-term impact of biofeedback on anxiety [16]; preliminary study [14]; insufficient available statistical evidence [17]; unable to conduct analyses corresponding the changes in self-report with the coherence data recorded by computer-based biofeedback program [3].

Implications for practice

High anxiety is a growing problem in society and in university students. Consequently this disorder can affect academic performance, health and quality of life/well-being.

This literature review aimed to present the information obtained about "Biofeedback training on university student's anxiety management". Despite of the scarce publications found, this study intended to find what has be done and highlight what should be done.

Most studies have reported that biofeedback training has demonstrated to be an effective form of intervention to help graduate students to significantly reduce their levels of stress and anxiety, but more researches are needed because there are only few systematic studies on this field.

The current review suggests new studies about biofeedback training and longitudinal studies, to analyse the implications over time. Furthermore, it is important to extend these studies to other countries.

It is important to explore effective and accessible strategies to help students to decrease anxiety symptoms, to reduce physiological activation and improve psychological well-being. Therefore, developing interventions that cost-effective and that can be easily implemented may be valuable in educational environments, and biofeedback intervention can be a solution to help those students [15].

Conclusion

From the present study, we can conclude that biofeedback training can be effectively used as an effective tool to decrease anxiety and stress symptoms, and could play an important role on campus health cares.

This study sought to address the issue and intended to draw attention to the importance of recognizing this problem of society.

Thus, more research is needed, more interventions/programs, and more tools are needed to assess the impact of biofeedback applications in anxiety treatments in university students, improving health behaviours and the quality of life of these students. It is important to have academic programs to take action and help students acquire skills to improve their physical and emotional health.

Conflict of interest

The authors declare that they have no conflict of interest.

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