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 study is to provide an overview of scientific evidence produced in “Biofeedback training on university student’s anxiety management”. The instruments used, the dimensions, and the obtained results were analysed.

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), electrodermal 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..."
ANXIETY AND STUDENTS\textsuperscript{[1]}, 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: “Biofeedback training on university student’s anxiety management”. For a brief summary, the analysed studies were grouped by decade and compiled in a summary table (Table 2).

A total of 768 adult students participated on the studies. The studies were conducted in the USA (76%), Thailand (18%) and South Korea (6%). Many instruments (validated scales) were used to measure anxiety and stress, such as: State Trait Anxiety Inventory (STAI, 57%); Perceived Stress Scale (PPS, 17%); Test Anxiety Inventory (TAI, 4%); Mood and Anxiety Symptom Questionnaire (MASQ, 4%); Stress Level Assessment (SLA, 4%); Anxiety Differential (AD, 4%); Achievement Anxiety Test (AAT, 4%); IPAT Anxiety Scale (4%).

A wide number of studies (9) took place between 1980 and 1989 (53%), after that and over the next 20 years (1990 to 2009) only one study (6%) was found, and recently the number of studies seemed to increase with 7 studies (41%) over the last 5 years (2010 to 2015).

For a better understanding of the systematic literature review, the analysed studies were compiled in a summary table (Table 3). On this table there are several items: Study (authors/year/country), aim, sample, country, procedures, instrument and findings.

Biofeedback efficacy was studied as a single technique, in addition with other techniques or compared to other forms of intervention, to

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

Table 2. Summary of studies by decade.

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

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”.
Table 3. Summary of analysed studies.

<table>
<thead>
<tr>
<th>Study</th>
<th>Aim</th>
<th>Sample</th>
<th>Procedures</th>
<th>Instruments</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meier &amp; Welch, 2015, USA. [22]</td>
<td>-Compare the effect of brief paced-breathing with biofeedback and exercise interventions on heart rate variability, state anxiety and affect.</td>
<td>N=12 college students.</td>
<td>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)</td>
<td>PSS, STAI Activation Deactivation Adjective Checklist. Biofeedback (BVP).</td>
<td>-Biofeedback reduced anxiety more than the exercise condition. -Exercise temporarily increased energy, whereas biofeedback temporarily increased calmness.</td>
</tr>
<tr>
<td>P. Ratanasiripong et al., 2015, Thailand. [8]</td>
<td>-Compare the efficacy between brief intervention programs (biofeedback and mindfulness) on levels of state anxiety and perceived stress in students.</td>
<td>N=89 nursing college students.</td>
<td>-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.</td>
<td>PSS, STAI Biofeedback (HRV).</td>
<td>-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.</td>
</tr>
<tr>
<td>P. Ratanasiripong et al., 2015, Thailand [15]</td>
<td>-Study biofeedback efficacy in reducing anxiety and managing stress among students.</td>
<td>N=60 graduate nursing college students.</td>
<td>-Biofeedback group students were given a portable biofeedback device to use for 4 weeks. -Control group took no action.</td>
<td>PSS, STAI Center for Epidemiological Study-Depression Scale. Biofeedback (HRV).</td>
<td>-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.</td>
</tr>
<tr>
<td>Lee et al., 2015, Korea. [1]</td>
<td>-To determine the effect of HRV biofeedback treatment and relaxation training in reducing trait anxiety compared to control group without any treatment.</td>
<td>N=15 students.</td>
<td>-Four HRV biofeedback sessions were provided for 45 minutes every two weeks. -Different relaxation techniques were provided for 45 minutes every two weeks.</td>
<td>STAI Biofeedback (HRV).</td>
<td>-Significant difference in trait anxiety between the biofeedback treatment and 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.</td>
</tr>
<tr>
<td>Prato &amp; Yucha, 2013, USA. [5]</td>
<td>-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.</td>
<td>N=14 nursing students.</td>
<td>-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.</td>
<td>Spielberger’s Test Anxiety Inventory. Biofeedback (Thermal, HR, and respiratory rate).</td>
<td>-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.</td>
</tr>
<tr>
<td>P. Ratanasiripong et al., 2012, USA. [16]</td>
<td>-To investigate the impact of biofeedback intervention program on nursing students’ levels of stress and anxiety during their first clinical training.</td>
<td>N=60 nursing students,</td>
<td>-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.</td>
<td>PSS, STAI Biofeedback (HRV).</td>
<td>-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.</td>
</tr>
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<td>Henrique et al., 2011 USA. [3]</td>
<td>-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.</td>
<td>N=9 (pilot project). N=35 (second study).</td>
<td>-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.</td>
<td>Mood and Anxiety Symptom Questionnaire. STAI Biofeedback (HR).</td>
<td>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.-</td>
</tr>
<tr>
<td>Author(s)</td>
<td>Year</td>
<td>Study Description</td>
<td>Participants</td>
<td>Main Findings</td>
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<tr>
<td>Chaló P (2017)</td>
<td></td>
<td>Investigate the effects of a 5-week stress management program for nursing students.</td>
<td>N=40 female</td>
<td>Five 90-minute sessions once a weekly over 5 weeks. Sessions consisted on didactic information; monitoring logs share; Quieting Response Audio Cassette for relaxation training; and augmentation of biofeedback training.</td>
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<tr>
<td>Drennen et al., 1987</td>
<td>USA.</td>
<td>Investigated Type A and B patterns with regard to women as interacting with biofeedback and a differential, challenging incentive set.</td>
<td>N=22 female</td>
<td>Five 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 20 minutes EMG biofeedback.</td>
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<tr>
<td>Valdés, 1985</td>
<td>USA.</td>
<td>To evaluate the results of the open-focus attention-training technique.</td>
<td>N=23 college</td>
<td>Open-focus technique without biofeedback training was used for two semesters. Biofeedback training was incorporated in the third semester, twice over 8 weeks.</td>
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<tr>
<td>Diaz &amp; Carlson, 1984</td>
<td>USA.</td>
<td>Compare 3 EMG training procedures in relaxation.</td>
<td>N=32 college</td>
<td>Four groups, received distinguished treatments during nine training sessions. Unt: 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.</td>
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<tr>
<td>Fehring, 1983</td>
<td>USA.</td>
<td>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.</td>
<td>N=78 college</td>
<td>(BAR) practiced Benson's technique with biofeedback at least once a day for eight weeks. (BRT) practiced Benson's technique focusing on the word &quot;one&quot;. Control took no action.</td>
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<tr>
<td>Schandler &amp; Dana, 1983</td>
<td>USA.</td>
<td>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.</td>
<td>N=45 female</td>
<td>During three weekly sessions each per-som received either guided cognitive imagery relaxation, frontalis muscle feedback relaxation, or a self-rest control procedure.</td>
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</tr>
<tr>
<td>McKinney &amp; Gatchel, 1982</td>
<td>USA.</td>
<td>Evaluate the effectiveness of biofeedback, Speech Skills Training, and a combination of both in treating public-speaking anxiety.</td>
<td>N=42 volunteers</td>
<td>After e relaxation session, each group: biofeedback training, speech skills training, and a combination of both) received a different intervention over the next 4 sessions.</td>
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</tbody>
</table>

STAI: Spielberger State Anxiety Scale
BAR: Quieting Response Audio Cassette
BRT: Benson's Relaxation Technique
EMG: Electromyography
MSR: Quieting Response Audio Cassette
C: Control Group
BAR: Benson's Relaxation Technique Group
MSO: Three EMG Training Sessions Group
CNT: Continuous Low Tone Group
BRC: Benson's Relaxation and Biofeedback Group
N=40 female nursing students
N=22 female college students
N=45 female students volunteers
N=42 volunteers
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 [8], 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 anxiety 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. Mc Kinney 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 interest in biofeedback. 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.

References

5. Prato CA, Yucha CB (2013) Biofeedback-assisted relaxation training to decrease test anxiety in nursing students. J Nurs Educ 34: 5-10. [Crossref]
14. Drennen WT, Ford HH, Rutledge LL (1987) Biofeedback, Competitive Set, and Type A/Type B Interactions with Female College Students. Psychol Rep 60: 983-989. [Crossref]