EFFECTS OF MUSIC EMBEDDED WITH SUPERIMPOSED BINAURAL BEATS ON ANXIETY IN UNIVERSITY HEALTH SCIENCE STUDENTS

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DOCTOR OF PHILOSOPHY
IN COMMUNITY MEDICINE

GRADUATE SCHOOL
CHIANG MAI UNIVERSITY
DECEMBER 2018

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IN COMMUNITY MEDICINE

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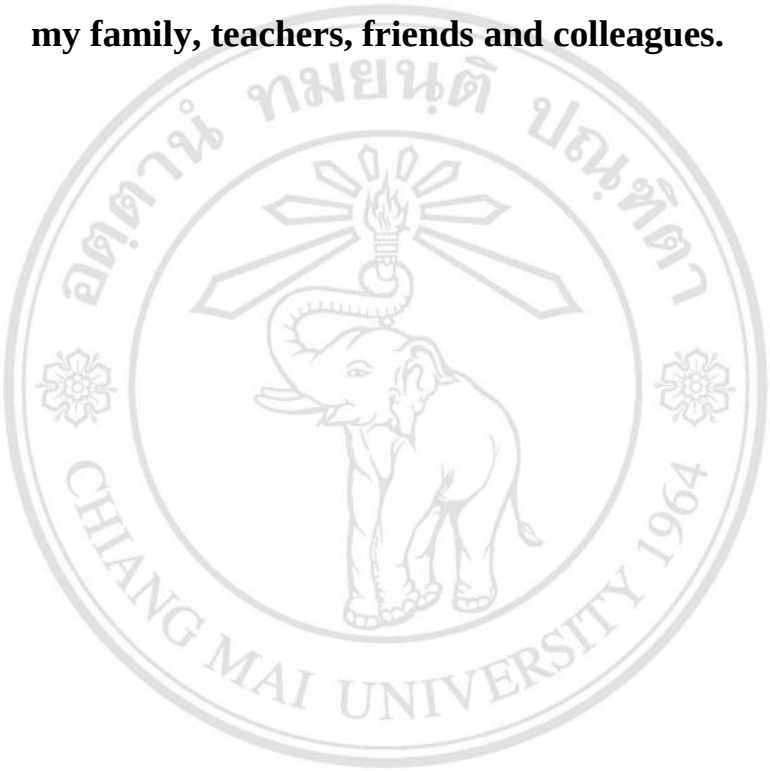
This dissertation is dedicated to

my family, teachers, friends and colleagues.



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หัวข้อดุษฎีนิพนธ์	ผลของดนตรีที่สอดแทรกซูเปอร์อิมโพสไบนูรัลบีทต่อความวิตกกังวลในนักศึกษามหาวิทยาลัย สาขาวิทยาศาสตร์สุขภาพ	
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บทคัดย่อ

การวิจัยนี้เพื่อศึกษาความชุกของความวิตกกังวล และผลของซูเปอร์อิม โพสไบนูรัลบีทในการลดความวิตกกังวลในนักศึกษามหาวิทยาลัย และเปรียบเทียบผลในการลดความวิตกกังวลของซูเปอร์อิมโพสไบนูรัลบีท ดนตรีบำบัด และการผ่อนคลายปกติ เป็นการศึกษาแบบ randomized controlled trial (RCT) แบบ double-blind กลุ่มตัวอย่าง 134 คน ได้รับการสุ่มเลือกจากนักศึกษามหาวิทยาลัยที่มีความวิตกกังวล 539 คน ใช้การสุ่มตัวอย่างแบบบล็อก (block randomization) ในการสุ่มกลุ่มตัวอย่างเข้ากลุ่มซูเปอร์อิมโพสไบนูรัลบีท (n = 45) กลุ่มดนตรีบำบัด (n = 45) และกลุ่มผ่อนคลายปกติ (control, n = 44) ทั้งสามกลุ่มได้รับการผ่อนคลายปกติในช่วงเวลา 20 นาทีทุกวันขณะได้รับการบำบัดตลอดในช่วง 5 วันติดต่อกัน ผลการศึกษาพบว่า ความชุกของความวิตกกังวลของนักศึกษามีค่า 43.29% ความแตกต่างของระดับความวิตกกังวลโดยใช้แบบวัดความวิตกกังวลแบบ State-Trait Anxiety Inventory ก่อนและหลังการรักษา สำหรับกลุ่มซูเปอร์อิมโพสไบนูรัลบีท กลุ่มดนตรีบำบัด และกลุ่มควบคุม พบมีความวิตกกังวลลดลงที่ระดับ -20.00 -16.00 และ -15.00 ตามลำดับ กลุ่มซูเปอร์อิมโพสไบนูรัลบีทและกลุ่มควบคุม มีความแตกต่างกันอย่างมีนัยสำคัญทางสถิติ (p = 0.04) และกลุ่มดนตรีบำบัด (p = 0.02) นอกจากนี้พบกลุ่มไบนูลรัลบีทมีระดับความวิตกกังวลลดลงทุกคน (ร้อยละ 100) แตกต่างจากกลุ่มควบคุมอย่างมีนัยสำคัญ (84.09%) (p <0.01) ดังนั้นการให้ซูเปอร์อิมโพสไบนูรัลบีท อาจลดความวิตกกังวลในนักศึกษามหาวิทยาลัยมากกว่าการฟังเพลงและวิธีการผ่อนคลายโดยทั่วไป ผลการวิจัยมีประโยชน์สำหรับผู้บริหารและผู้กำหนดนโยบายของมหาวิทยาลัยในการพัฒนาแนวทางช่วยเหลือและลดความวิตกกังวลให้กับนักศึกษามหาวิทยาลัยต่อไป

Dissertation Title	Effects of Music Embedded with Superimposed Binaural Beats on Anxiety in University Health Science Students	
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ABSTRACT

This study aimed to determine the prevalence of anxiety, and investigate the effects of superimposed binaural beats in reducing anxiety among university students and to compare the effects of superimposed binaural beats to those of receptive music therapy and relaxation treatment. The 134 participants with double-blind randomized controlled trial were randomly selected from 539 students with anxiety. According to block randomization, the participants were assigned to superimposed binaural beats (n = 45), receptive music listening (n = 45), and blank audio (control, n = 44) groups. All three groups received treatment in 20-minute daily sessions over a period of 5 consecutive days. The prevalence was 43.29 %. The median differences in anxiety level were measured by the State-Trait Anxiety Inventory form-Y before and after treatment for the superimposed binaural beats, music listening, and control groups were -20.00, -16.00, and -15.00, respectively. The differences between the superimposed binaural beats group and the control ($p = 0.04$) and music listening ($p = 0.02$) groups were statistically significant. Level of anxiety was effectively reduced in 100% of participants in the superimposed binaural beats group, and higher than the control group (84.09%: $p < 0.01$). Superimposed binaural beats - based interventions may reduce anxiety in university students more than music therapy and general relaxation. This findings are potentially beneficial for policymakers to develope interventions for reducing anxiety in university students.

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ข้อความแห่งการริเริ่ม

1) การใช้ Superimposed Binaural Beat ในการลดภาวะวิตกกังวลในนักศึกษามหาวิทยาลัยจะเป็นอีกแนวทางหนึ่งที่เหมาะสมกับบริบทของประชากรในกลุ่มวัยรุ่นหรือวัยผู้ใหญ่ตอนต้น
2) Superimposed Binaural Beat เป็นทางเลือกในการลดภาวะวิตกกังวลทางเลือกใหม่ ที่จะช่วยลดอัตราการใช้ยาในการรักษาภาวะวิตกกังวล ลดความสูญเสียทางเศรษฐกิจ ลดค่าใช้จ่ายในการใช้ยา รวมถึงลดผลข้างเคียงของการใช้ยากลุ่ม anxiolytic drug ซึ่งมีผลกระทบทั้งด้านร่างกายและจิตใจอีกด้วย

STATEMENT OF ORIGINALITY

1) The use of Superimposed Binaural Beat to reduce anxiety in university students is another option that is appropriate for the context of adolescent or early adulthood population.
2) The Superimposed Binaural Beat is an alternative treatment option to reduce the rate of drug use in the treatment of anxiety. Economic downturn and reduce the cost of medication. It also reduces the side effects of anxiolytic drug, which has both physical and psychological effects.

CHAPTER 1

INTRODUCTION

1.1 Background

From the epidemiological literature, anxiety is among the most common psychopathologies in general population[1]. In persons with psychological problems, the prevalence of anxiety has risen as well[2]. University students usually have a high level of stress as they experience several stressors in studying, examinations, as well as pressure from their peer, teachers or parents[3]. The stressors also encompass study overload, continuous pressure to success, competition with peers, financial problems and future expectation[4]. Highly anxious students can experience academic failure, mental and physical health issues[5]. Moreover, a prior study reported that university students dropped out of university mainly due to psychological problems [6]. Academic pressure further exacerbates the anxiety problem[7-9]. One - third of the students in the United States revealed that their academic performance was badly affected by anxiety and stress[10]. In Egypt, students in the Faculty of Medicine reported that anxiety greatly influenced their well-being related to their study and examinations[9]. Such adverse impacts contribute to physical and psychological problems with a rising number of university students coming in for services at the university health center[11, 12]. Study pressure, such as graduation expectation, academic attainment, and financial difficulties, led to anxiety among students[13]. Additionally, approximately 11.40 % of university students sought psychological help from the university counseling center and the number tended to increase steadily[14]. Approximately 40.00% of university students mentioned that they needed assistance with their psychological health issues, which were predominantly caused by anxiety. Interestingly, anxiety has also been a concern in medical profession[6]. This indicates that mental health problems, particularly anxiety, are significant factors of the attrition rates and well- being among university students.

In Thailand, anxiety has a negative impact on the medical student's academic performance and emotions[7]. The corresponding rates among medical students in Thailand are 57.0 - 61.47%[15, 16], respectively. The common anxiety treatment includes medication that also has short and long-term side effects, both physically and economically[17]. Anxiety relieving medication is popularly used to help reduce anxiety. There are also other treatments such as muscular relaxation, listening to the music, and psychotherapy that requires specialists, so it may be inconvenient to access. Given the widespread negative effects of anxiety, initiative techniques or interventions that are feasible for a number of people, available, inexpensive and have minimal side effects should be developed and implemented.

1.2 Rationale

Previous evidence demonstrated that music have considerable benefits including a decrease in anxiety and activities of sympathetic nervous system and cardiovascular system (i.e. blood pressure, heart rate and respiratory rate) as well as improvement of sleep pattern and attention[7]. A study showed that music could actually reduce anxiety[18]. There has been the evolution in bringing the music with binaural beat. The 40 Hertz (Hz) auditory steady-state response (ASSR) has firstly been described as the response to the sinusoidal wave form of the ASSR with a periodicity corresponding to the stimulation rate and amplitude at 40 Hz in electroencephalographic recording from the human brain[19]. The amplitude-modulated tones show the periodical amplitude fluctuations at the modulation frequency. The corresponding ASSR follows the amplitude-modulated tone envelop of the stimulation[20-22]. Binaural beat (BB) is the beat perception of dichotic presentation of two pure tones with different frequencies, which arise from interaction of bilateral input at higher levels of the ascending auditory pathway[23, 24]. Mechanism of action is two-way; one is the effect on the limbic system, which regulates mood, and the other way is brainwave entrainment. The binaural beat (BB) is believed to be generated within the brain. It is believed that the first nucleus receiving auditory information from both ears and activated phase-sensitive neurons binaurally is the superior olivary complex and the inferior colliculus. The difference in the two pure tones is balanced by the fluctuation in frequency. A study found that 35 Hz was the maximum difference in the two tones perceived as beat for humans. Listening to 7-10 Hz BB may be beneficial to

reduce mild anxiety and leads to greater self- report relaxation[25]. For clinical intervention, BB has the potential to decrease acute pre- operative anxiety in the patient undergoing general surgery[26] and reduce moderately anxious emergency department patients by 10.00% - 15.00%[27]. BB embedded in ML may have benefit over music intervention alone in decreasing operative cataract surgery[28] and may be useful in reducing preoperative anxiety in dentistry[29]. However, a previous study reported that BB had positive effects on anxiety among anxious population but it was not statistical significant[30].

The superimposed binaural beat (SBB) is the new technique of binaural beat. Additional binaural beats are synthesized on the basis of frequency shifting of the sound waves from each traditional Thai musical instrument except the drum sounds (due to their extremely low frequency), apart from the original binaural beats which are created by the standard method of pure-tone sine wave frequency differentiation. It is expected that the quality and efficiency of SBB will be better than the traditional BB. Currently, traditional BB are used to reduce anxiety in patients in clinical trials but there is none for SBB.

Thus, anxiety is an important health problem in university students, causing significant negative consequences such as physical and mental impairments, decrease in academic learning ability. Therefore, the use of binaural beat is another way to tackle this situation without medication or using complicated methods. Although it is simple, convenient and appropriate for the student's life, and can reduce costs, little is known about coping with anxiety in students and about the treatment without medication. Therefore, a simple and cost-effective alternative choice is needed to treat anxiety without the use of drugs to increase the quality of life and quality of learning among university students.

This study aimed to investigate the effect of SBB in reducing anxiety among university students and to compare its effect with music listening (ML) and relaxation treatment. The findings will contribute to cheap and safe treatment options for high demands in the university setting.

1.3 Purposes of the study

1.3.1 To determine the prevalence of anxiety in university students.

1.3.2 To investigate the effects of music embedded with superimposed binaural beat on anxiety in university health science students.

1.3.3 To compare the effects of music embedded with binaural beat and music listening on anxiety in university health science students.

1.4 Literature review

1.4.1 Anxiety

Anxiety is the most prevailing psychological issue among people of all age groups, and young adults are no exception. Excessive anxiety impacts their everyday life, relationships, work, health and quality of life.

1.4.1.1 Definition of Anxiety

Anxiety, described as excessive worry or fear, manifests itself as a disturbance in mood, thinking, behavior, and physiological activity[31]. Barlow defined anxiety as a state of chronic "helplessness because of a perceived inability to predict, control, or obtain desired results or outcomes"[30] Fogiel[32] referred to anxiety as "a crucial concept in the study of abnormal psychology because it is considered to be both a symptom and a cause of varying neurotic disorders." Horwitz, Horwitz, and Cope[33] defined anxiety as "the subjective feeling of tension, apprehension, nervousness, and worry associated with an arousal of the autonomic nervous system". Bootzin and Richard described anxiety as "a feeling of dread, apprehension, or fear that is often accompanied by increased heart rate, perspiration, muscle tension, and rapid breathing." Hilgard, Atkinson, and Atkinson[34] viewed anxiety, commonly described by psychologists, as "a state of apprehension, a vague fear that is only indirectly associated with an object".

Anxiety has been given various definitions but there are similarities in that anxiety can be referred to as feeling apprehended that involves and impacts both physical well-being and the nervous system.

1.4.1.2 Broad Perspectives on Anxiety

Anxiety can be categorized as trait, situation-specific, and state anxiety as follows:

1) Trait Anxiety

Trait anxiety can be described as a person's personality contributing to anxiety in a variety of situations[35] and being stable over time[36]. A person who has high levels of trait anxiety lacks emotional stability and is generally nervous while a person who has little trait anxiety is generally calm, relaxed and emotionally stable.

2) Situation-Specific Anxiety

The situation-specific anxiety refers to individual's personality that leads to anxiety in a specific situation or a single context over time such as stage fright, and test anxiety. Although the situation-specific anxiety is stable as time passes, it is not always consistent in different situations. According to Speilberger,[35] the situation-specific anxiety refers to the possibility of feeling anxious in a specific type of situation.

3) State Anxiety

State anxiety is different from trait and situation-specific anxieties. State anxiety is the present moment or particular moment experience of anxiety that can vary as time goes by and differ with regard to intensity. MacIntyre[36] suggested that the state anxiety could be used to predict the negative consequences of anxiety, including physical symptoms and unpleasant emotions.

1.4.1.3 Bio-Behavioral Mechanism of Anxiety

Anxiety is a multifaceted phenomenon involving interplay between physical, psychological and behavior. It can be explained with the hypothalamus-pituitary-adrenal (HPA) axis, which is a regulatory feedback system between the brain, as well as physiologic and behavioral responses to stressors. Once a person faces a stressful event, the cerebral cortex perceives information about the event and appraises if this event is stressful. After that, the cortex transmits messages to the hypothalamus, a brain part where cognitive message becomes integrated with emotional content generated by the limbic system. In case the event is appraised as a threat, the amygdale, a particular area in the hypothalamus, releases the corticotropin-releasing hormone (CRH) that goes through the portal blood vessels reaching the anterior pituitary gland in which it induces the secretion of adrenocorticotropic hormone (ACTH). This hormone targets zonafasiculata and

reticularis cells in the adrenal cortex via the blood stream. The cortisol hormone is then biosynthesized and secreted as a result[37, 38].

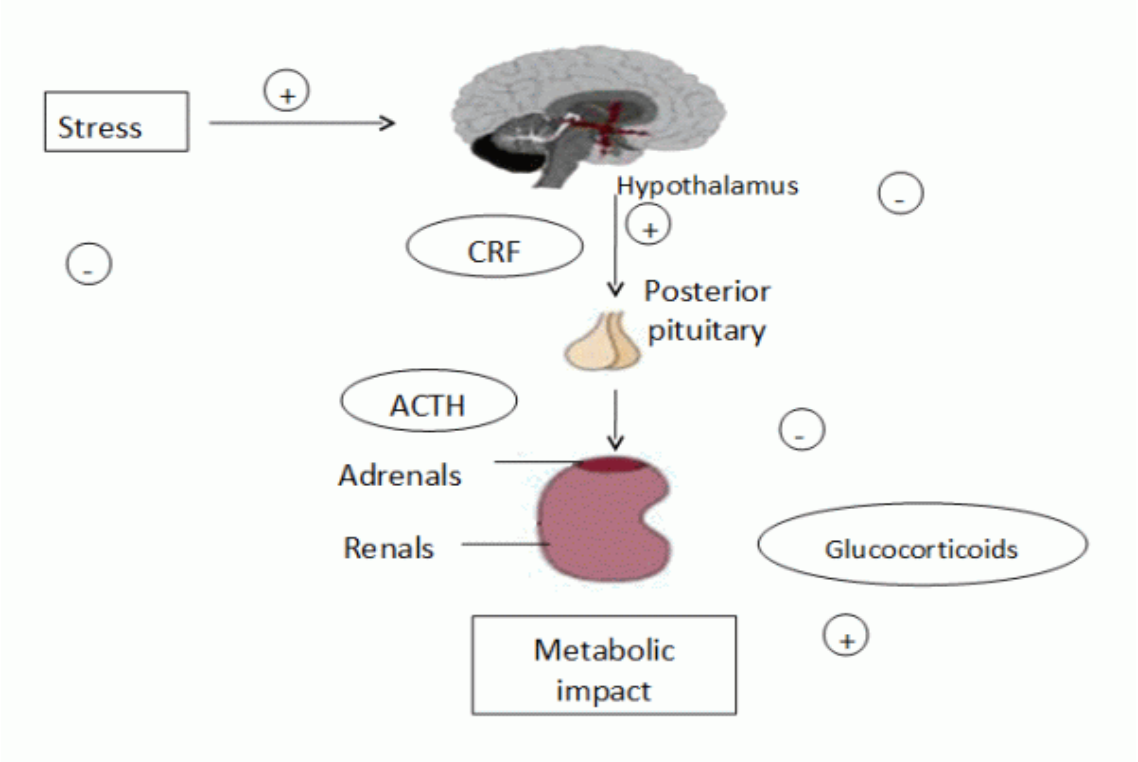

Figure 1.1 Anxiety mechanism

Source: http://www.encephalos.gr/48-3-07e.htm[38]

Cortisol receptors are in almost all body tissues. This hormone accelerates numerous metabolism process: gluconeogenesis and carbohydrates glycolysis in the liver, protolysis in the muscle tissues, and lypolysis in the fat tissues. In addition, it impacts the immune system that causes immunosupression, and the circulatory system that causes fluid and electrolyte retention, hypertension, and hypervolemia. This can be used to explain physical symptoms usually associated with anxiety such as hyperglycemia, infection, hypertension, tachycardia, flushing, and headache[39-41]. In terms of chronic anxiety, cortisol continues to release and then enhances lypolysis products and the risk for atherosclerosis ultimately. Continuous increases in atherosclerosis, heart rate, blood pressure might contributes to coronary heart disease[37]. Coronary heart disease is an important clinical condition reported by several studies to be related to chronic anxiety[42-44].

1.4.1.4 Anxiety in Young Adult College Students

Anxiety can be accelerated by substantial developmental and psychosocial factors and often happens during or shortly before the college age[45]. Based on the theory of psychosocial development, 18- 24- year- old or young adult college students are considered as an adolescence stage which involves identity and identity confusion crisis. The successful identity development and adaptation with the challenges in this stage can give rise to successful and intimate relationships with others in the next stage[46]. There are certain tasks associated with young adult college students' life and affecting their identity formation. These include establishing identity, managing emotions, developing essential life skills such as competence, autonomy and interdependence, mature interpersonal relationships, purpose, and integrity[47]. In addition, academic requirements, financial issues, and relationships with other people, are determined as stressors in this population group[48] that negatively impact physical and psychological well-being[49], and lead to depression[50] and anxiety[48].

Although young adults should demonstrate development in their identity and self-definition, most of them tend to postpone attainment in these tasks[51]. They thus are emerging adults, not adults yet[52]. In particular, persons in this age group in the United States perform adult roles and responsibilities following their late teenage stage. During their transition to adulthood, they probably encounter challenges to meet their expectations for education, family, and relationships with others. This means the identity formation task might not be a normal part of their development but might be a difficult experience for them instead[53].

Although there was a rise in the prevalence of anxiety in American young adult university students from 7% in 2000[54] to 13% in 2007[55], these people had the smallest tendency to look for treatment[56]. Longitudinal prospective research has revealed that if adolescents and young adults receive no treatment for anxiety, it is likely to cause considerable behavioral, physical, and psychological problems including hypertension[57], coronary heart disease[44], suicide, depression[58], substance use disorders such as alcohol dependence[59], nicotine addiction, marijuana and hashish use[60]. Moreover, pathological anxiety disorders[61] tend to follow when anxiety is not treated, resulting in US$ 47 billion annually, which accounts for 31% of the total costs of mental illness care[62].

As there is strong evidence about anxiety and its negative consequences among young adult college students, a number of interventions and techniques relieving anxiety have been developed and implemented over the past two decades[63]. However, the prevalence of anxiety steadily increases in this population[54, 55, 64]. This indicates a theory-practice gap in this study field[65]. The main causes of this gap are 1) insufficient empirical evidence to support implementation of theory-based interventions[66]; 2) unclear understanding of the mechanism of certain proposed and extensively adopted interventions[67]; 3) limitation of implementation in practice[68]; and 4) inconsistency in the operational definitions of anxiety across studies that results from anxiety measures such as using instruments for assessing the pathological conditions of anxiety (i.e. Beck Anxiety Inventory)[69] to measure anxiety in non-clinical population[70], and the use of instrument that imbricates depression assessment, such as the State-Trait Anxiety Inventory.

1.4.1.5 Identifying Anxiety

The main criteria to distinguish anxiety from general worries include perceived distress and function ability. Even though severe anxiety somehow often interrupts functioning, mild or moderate anxiety may not be obvious without professional elicitation for information about issues in life that are producing worries. Painfulness and/or disparity of the fear and its associated perception of reality, as well as the actual reality are indicators of pathological anxiety. The anxiety symptoms include physical complaints such as chest pain and shortness of breath. Anxiety may cause some people to eat too much in hopes of self-calm, resulting in weight gain. Some people may avoid eating and then lose weight and subsequently gain weight, or they may skip meals and lose weight. Some people may also experience sleep disturbance to avoid their fears, try to be awake pondering about imaginations or exaggeration of dangers, or seek to avoid nightmares. In addition, anxious people may enjoy fewer activities due to their fear, causing them to stay home to be safe from fears, turn to alcohol or other substances to feel less frightened, and isolate from society[70].

1.4.1.6 Measures of Anxiety

1) The State-Trait Anxiety Inventory (STAI)

The STAI[35] is a 40-item inventory consisting of two subscales with 20 items each that assess state (STAI-S) and trait (STAI-T)anxiety. Only the State subscale was adopted in this study since current emotional distress was the main interest. The State subscale was reported to be internally consistent and valid for its use among both younger and older adults.

1.1) Purpose: To assess the presence and severity of current symptoms of anxiety and a generalized propensity of anxiety using self-report.

1.2) Content: This instrument consists of two subscales. First, the State Anxiety Scale (S-Anxiety) assesses the current state of anxiety by inquiring how respondents are feeling "right now," via items which evaluate subjective feelings of apprehension, tension, nervousness, worry, and activation/ arousal of the autonomic nervous system. Second, the Trait Anxiety Scale (T-Anxiety) assesses comparatively stable aspects of "anxiety proneness," namely normal states of calmness, confidence, and security.

1.3) Number of items: The STAI comprises 40 items, with 20 items for the S-Anxiety subscale and 20 items for T-Anxiety subscale. For children, STAIC has been developed, comprising 40 items as well. The scales also exist in short versions that have been developed separately.

1.4) Response options/scale: Responses for the S-Anxietyscale evaluate how intense current feelings are "at this moment". Responses include 1) not at all, 2) somewhat, 3) moderately so, and 4) very much so. In the T-Anxiety scale, the respondents state how frequent their feelings are "in general" using: 1) almost never, 2) sometimes, 3) often, and 4) almost always.

2) Beck Anxiety Inventory (BAI)

The self-report BAI[37] consists of 21 items to measure how severe the anxiety symptoms are with 14 items evaluating somatic symptoms, and 7 items evaluating cognitive and affective symptoms of anxiety. Initial studies reported high internal consistency (alpha = .92), as well as adequate convergent and discriminant validity for this instrument[37]. Preliminary research showed that this instrument had high internal consistency (alpha = .87) and acceptable temporal stability (.78) in its use among older adults.

2.1) Purpose: The BAI is a brief assessment for anxiety that emphasizes somatic symptoms. It can effectively distinguish anxiety from depression[71].

2.2) Content: The BAI is a self-report that evaluates symptoms of nervousness, dizziness, inability to relax, and so on.

2.3) Number of items: The BAI comprises 21 items in total.

As regards response options/scale, respondents state the extent to which they have experienced the individual symptoms in the past week on a 4-point Likert scale ranging from 0 (not at all) to 3 (severely).

3) Hospital Anxiety and Depression Scale-Anxiety (HADS-A)

3.1) Purpose: The HADS[72] has been designed as a brief assessment of common symptoms of anxiety and fear. The HADS screens medically ill patients for anxiety and depressive symptoms with clinical significance.

3.2) Content: The HADS-A includes specific items that assess generalized anxiety including tension, worry, fear, panic, difficulties in relaxing, and restlessness.

3.3) Number of items: The HADS-A consists of seven items.

3.4) Recall period/ response items: Respondents state their current feeling using a 4-point Likert scale ranging from 0 to 3. There are different anchor points for the Likert items, which are determined by the item (e.g., "I can sit still and feel relaxed" is scored as 0 for definitely and 3 for not at all; and "I get sudden feelings of panic" is scored as 0 for not at all and 3 for very much indeed).

4) Depression Anxiety Stress Scales (DASS)

The DASS, also referred to as the Self-Analysis Questionnaire (SAQ), is a measure with three self-assessment scales developed to evaluate the negative affection states of depression, anxiety and stress. Not only has the DASS been constructed to assess traditionally defined affection states, but it also serves to enhance the process of defining, understanding, and evaluating the prevalent and clinically significant emotional states that are commonly referred to as depression, anxiety and stress[73].

Each of the three DASS scales contains 14 items, which are further divided into subscales with 2-5 items of related content. The depression scale measures dysphoria, hopelessness, devaluation of life, self-deprecation, lack of interest or involvement, anhedonia, and inertia. The Anxiety scale appraises autonomic arousal,

skeletal muscle effects, situational anxiety, and subjective experience of anxious affect. The Stress scale deals with chronic non-specific arousal and evaluates problems with relaxing, nervous arousal, and becoming easily upset/agitated, irritable/over-reactive and impatient. The respondents rate the degree to which they have encountered each state in the past week on a 4-point severity/frequency scales. The calculation of the scores for DASS is performed by summing the scores for the related items.

Besides the 42-item questionnaire, there is also a short version DASS21 with 7 items in each scale. Since the scales of the DASS have been reported with high internal consistency and meaningful discriminations in various settings, the scales is expected to be appropriate for research and clinical uses to assess the current state or changes in state over time (e.g., in the course of treatment) on the three dimensions, namely depression, anxiety and stress[73].

However, this research assessed anxiety using the STAI[35] because the STAI is a tool that can separate anxiety from both general anxiety and anxiety at that time. In this study, the tool was used to identify the ways to reduce the currently occurring anxiety. Therefore, the STAI Form Y was an appropriate measurement in this study as aforementioned.

1.4.2 Supportive Interventions

Supportive interventions include dealing with a cause of anxiety such as health problems, financial difficulties, and relationship problems. In addition, spiritual experiences such as meditation can relieve anxiety.

1.4.3 Psychotherapies

Psychotherapy, or talk therapy, serves as a method to assist people who have a wide range of mental and emotional problems. Psychotherapy can help reduce or control problematic symptoms for improved function and well-being, and healing. Psychotherapy can be used to deal with problems in coping with everyday life; the impact of trauma, medical illness or loss (e.g., when a loved one passes away), and specific mental disorders (e.g., depression or anxiety). Psychotherapy is available in many types that have different effectiveness, depending on the problems. Psychotherapy can be adopted alongside medication or other therapies[74]. All of psychotherapies need specialized training. The important therapies range from cognitive behavioral therapy, to problem-solving, and interpersonal therapy, which incorporate verbal aspects, education and support to reduce

anxiety in a systematic manner, such as sleep hygiene, deep breathing, and progressive muscle relaxation. Psychotherapy is classified into five broad categories[74]:

1.4.3.1 Psychoanalysis and psychodynamic therapies. These therapies aim to change troublesome behaviors, feelings, and thoughts through the discovery of their unconscious meanings and motivations. Psychoanalytical therapies involve a close collaboration between the therapist and the patient. Patients gain an insight into themselves by interacting with the therapist[75]

1.4.3.2 Behavior therapy. This therapy emphasizes the learner's role in forming both normal and abnormal behaviors.

1.4.3.3 Cognitive therapy. This therapy focuses on persons' thoughts instead of their actions. It is believed that dysfunctional emotions or behaviors are the results of dysfunctional thinking. Thus, people can change the way they think and behave when they change their ideas.

1.4.3.4 Humanistic therapy. This approach believes that people can make reasonable choices and develop to their full capability. It is also crucial to recognize and respect other people.

1.4.3.5 Integrative or holistic therapy. Instead of confining themselves to only one approach, several thrapists combine elements from different approaches and customize their treatment based on each client's needs[76].

1.4.4 Psychiatric Medications[77]

Anti-anxiety medications help reduce the symptoms of anxiety, such as panic attacks, or extreme fear and worry. Benzodiazepines such as alprazolam (Xanax), clonazepam (Klonopin), and lorazepam (Ativan) are antianxiety drugs with most frequent prescription. They can be beneficial either alone or in combination with psychotherapy. Side effects of psychiatric medication can develop after long-term use of a medication. The brain is a responsive and adaptive system, and it adjusts to changes in its chemistry in complex and sometimes unexpected ways. It can change its structure or reduce its production of specific chemicals in response to the continued presence of certain medications. Long-term impacts on the brain other than those intended for treatment can occur.

1.4.5 Keeping Active

A prior study showed that participation in leisure activities could help in reducing depression and anxiety and could enhance well- being in participants[78]. Additionally, taking part in physical activity and sport has been reported to have beneficial effects on psychological health, especially in reducing anxiety, depression, psychological distress and emotional disturbance, as well as making the youths healthy and happy. However, strong evidence has reported that exercise is related to lower levels of anxiety only in clinical settings, and little research has been conducted to investigate how exercise affects anxiety in reality[79]. A systematic review of related randomized controlled trials (RCTs) reported that exercise was effective when used with other treatments such as cognitive behavioural therapy.

1.4.6 Cognitive Behavioral Therapy

Cognitive behavioral therapy (CBT) is the alternative treatment that is effective in reducing the symptoms of almost all psychological problems, especially anxiety and depression[80, 81]. It aims to enable the persons to understand the relationship between their negative thoughts and mood and behavior, and the ways to modify behavior toward better quality of life[82]. Despite its effectiveness in children and young people, CBT has not been proved whether it is more effective than other treatments or not[83].

1.4.7 Mindfulness

Mindfulness focuses on awareness of sensation, emotion and thoughts arising in the present moment and accepting them as they are. Mindfulness techniques such as meditation practice enable people to escape from the "automatic pilot mode" causing negative thoughts and responses. For anxious persons, mindfulness helps them feel body symptoms experienced and fully observe their reactions in a different way, instead of avoidance or withdrawal from such feelings[65,80].

1.4.8 Music Therapy

Music therapy combines music and guidance given by a trained music therapist. Even though a great deal of research has claimed that it is merely the influence of listening to music, most experts believe that the key to the therapy also lies within the process in which the therapist interacts with the client. "It is not merely the music, but the intervention by the therapist that is crucial"[84]. This applies to the goal to reduce anxiety. In only one of the aforementioned studies, music therapy was performed with a music therapist.

1.4.8.1 History of Music Therapy

For hundreds of years, music has served as a healing tool. The beginning of the 20th century marked the development of music therapy modern's development in which traveling people played music for veterans across the country during and following the World Wars I- II. Thanks to music, the veterans were relieved from their injuries to the body, emotion, and mind. When the health care teams started to be aware of the influence of music on the healing process, they called for decent training of the musicians so that they could provide proper music therapy. In 1944, Michigan State University finally began to include music therapy in its curriculum. Since then, music therapy has flourished and, in 1998, the American Music Therapy Association was established to raise awareness, train, educate and offer opportunity to people with an interest in music therapy(85).

In the United States, music therapy started at the end of the 18th century. Nevertheless, music has been used as a tool to heal people since the ancient times as suggested by evidence found in the Bible, and the ancient Egyptian, Chinese, Indian, Greek, and Roman Empires. In the modern times, music is still a powerful tool for healing despite the difference in its use from the ancient times(86).

The development of the music therapist profession in the United States started during the First and the Second World Wars when Veterans Administration Hospitals adopted music as a tool to treat injuries from the wars. Both in active and passive manners, veterans participated in music therapy that aimed to relieve the perceived pain. Music was seen by many physicians and nurses as having power to heal the veterans psychologically, physiologically, cognitively, and emotionally. From that time on, music therapy programs have been created in universities and colleges. The year 1950 witnessed a foundation of a professional organization in collaboration of music therapists working with veterans, and people with mental retardation, hearing/ visual impairment, and psychiatric symptoms. This was the beginning of the National Association for Music Therapy (NAMT). In 1998, NAMT was joined by another music therapy organization and became American Music Therapy Association (AMTA)(87).

The idea of music as a power for healing on health and behavior dated back in the times of Aristotle and Plato. The modern profession officially started after the First and the Second World Wars when amateur and professional musicians played for

veterans in hospitals nationwide, who were physically and emotionally injured from the wars. When seeing the patients respond to music, the physicians and the nurses called for the employment of musicians in the hospitals. However, the musicians had to be trained before they could be hired by hospitals, which led to the development of curriculum for music therapy[87].

1.4.8.2 The definition of music therapy[88]

American Music Therapy Association (AMTA) [88] has defined music therapy as the use of music by professional music therapists for clinical healing based on patient's symptoms. Association of Professional Music Therapist (AMPT) of the United Kingdom has referred to music therapy as a form of treatment that focuses on good relationship between the therapists and the patients with the aim to improve the patients' symptoms through the creative use of music in an arranged place where the music therapists will employ their musical experience and activities toward the goal of healing that is determined by the patients' symptoms.

In summary, music therapy refers to the use of musical approaches to healing toward better emotional, physical, and psychological development. The music used must be approved by the professionals, including music therapists, physicians, social workers, psychologists, patients, and patients' family.

1.4.8.3 Components of music

1) Rhythm refers to the movement of sounds in a particular period, or the duration of sounds such as drumming to produce different rhythms. Rhythm is the art of managing accent and duration of sounds, which can be measured in beat/ minute. It can activate the mechanisms of different systems in the body and contribute to emotional responses. Rhythm is greatly influential on humans. It is believed that rhythm is associated with the functions of the body such as heart beats, blood pressure, digestion, and brain function. Rhythm motivates humans to respond or move voluntarily. Fast rhythm arouse excitement while slow rhythm results in a sense of security, peace, focus, and relaxation[89].

2) Tempo refers to the pace of beats in a song, which can be measured in beat/ minute. In general, one beat has a tempo of 50-120 mn (Metronom Measurement) which is a device that measures the beat within a minute, which can vary depending on different beats. Generally, the standard beat is equivalent to human

heartbeat that is 60-70 beats. When compared with the heartbeat, if the tempo is faster, it will be marked as fast tempo and will be marked as slow if it is slower than the heartbeat. The tempo that is faster than the heartbeat can cause stress while the tempo that is slower than the heartbeat can result in a sense of insecurity or anxiety. The tempo that is equivalent to the heartbeat will lead to a peaceful feeling[90].

3) Pitch refers to high or low sounds within a minute, which is measured in Hertz. In general, the auditory ability of humans is in the frequency range of 20-20,000 Hertz (normal speaking sound has a frequency of 85-1,100 Hertz). Sounds with high frequency have high pitch while those with low frequency have low pitch. Pitch has both physical and psychological effects on humans. Very low pitch leads to a sense of fear and lack of confidence, while low pitch generates a feeling of relaxation and calmness[90]. Moderately high pitch contributes to a comfortable feeling while extremely high pitch leads to excitement, arousal, and exhaustion[91]. Like beat, pitch influences feelings due to its association with the nervous system.

4) Volume intensity refers to the measurable intensity of a sound in decibel (db). Humans can bear a sound of 0-120 decibels (normal talk is approximately 50-60 decibels). A sound of greater than 100 decibels is harmful to the ears. Soft sounds give a feeling of happiness, peace, and mental comfort, while high-volume sounds lead to emotional arousal, activating the endocrine system to cause muscle constriction and twitching. Prolonged exposure to high-volume sounds can be disturbing and cause fatigue[91].

5) Melody is generated through the arrangement and the combination of sounds with different pitches, durations, volumes and qualities while incorporating rhythms in an artistic manner and taking into account the harmony of the duration of each sound. Melody is the component of a sound that is easy to memorize and understand, allowing the listeners to be able to distinguish one song from another. Melody is associated with humans' feelings. Minor mode melody arouses sad feeling whereas major mode melody can cause a sense of cheerfulness. Thus, melody is used as a medium in psychological healing because it is associated with humans' feelings. It can facilitate the development of relationship and the reduction of anxiety, resulting in a sense of peace, relaxation, and creativity[91].

6) Harmony refers to the combination of various sounds with different quality using harmonized rhythm and melody. Without harmony, it will result in dissonance. In contrast, with harmony, there will be a sense of relief, comfort, warmth and freedom[91].

7) Tone color or sound quality refers to the quality of a sound that originates from different sources. The diversity in tone color depends on various factors such as the method through with the sound is produced (e. g., with stringed, woodwind, percussion, and keyboard instruments), materials of musical instruments (e.g., bamboo, coconut shells, metal), and shape or size of musical instruments. These natural differences result in different sounds and feelings. For instance, the sound produced from a woodwind instrument like flute provokes an imagination of flying in the sky like birds and a cheerful feeling. When hearing a violin sound, one usually thinks of the easy breeze because violin is a stringed instrument that can produce beautiful melody; its clear high-pitched sound can convey almost all types of feeling[91].

8) Forms are equivalent to the frame that encompasses rhythm, melody, harmony, tone color, and other components together, toward harmonized direction[92]..

9) Direction depends on the direction of the source and the medium. Musical sounds are subject to refraction like light, causing different volumes in different locations. In addition, echo also plays a role[91].

10) Expression of music is the key that impresses the singer and the listeners, allowing them to access the feeling of the songs[93]. It is the method to express emotion, feeling, and ideas while playing a musical instrument or singing such as comfort, sadness, frustration, and excitement[91].

1.4.8.4 Benefits of Music

Historically, music has been related to the learning process. Aristotles believed that people became a certain quality in their characters on the account of listening to music. Blooms believed that music was the center of education, for giving passions and preparing the soul for peaceful reasoning. Research over several decades has been carried out on possibilities of students benefitting from the presence of music. Gardiner highlighted some ways that music could be beneficial to students and institutions. Enhanced brain development, school attendance, and decreased drug abuse

are outlined as some of the benefits of music to students. Music training has been linked to mathematics and science achievement. According to Gardiner[94], involvement in music provides an extremely rich experience to individuals involving cognition, emotion and aesthetics. It develops individual capabilities and performance skills. During the process of learning music, individuals stretch themselves mentally in various ways and the mental capability of the learner develops to learn other things such as academics. A curriculum known as Learning through an Expanded Arts Program (LEAP) helps students learn academic subjects by the method of hands-on experience with art and music. When standardized evaluations of these projects were done, it was shown that of the students that took part in the program, 93.4% understood subject matters better. According to the report from their nine teachers, 93% of the students acquired self-discipline while 97% showed an optimistic attitude toward school[95].

1.4.8.5 Effects of music on brain, body, mind and mood

Music arouses emotional state and leads to satisfaction. Most people have had experience in physical responses to music that is a natural response which is free from control. In addition, music influences the function of the mind and other systems of the body such as respiration, heartbeat, and blood pressure. These responses are involuntory reflex[96]. To date, more research has been conducted to investigate the effect of music on transformations in people based on the premise that when music penetrates through the hearing organs, it is carried by nerves to the thalamus and cortisol. In a conscious state, music can change the mood and feeling in the cortisol which is the upper brain, thus influencing emotional imagination, intelligence, and memory. In an unconscious state, music can change mood and thoughts in the thalamus, which is a lower and important part of the brain that transfers emotions and thoughts to the cerebral hemisphere along the nervous pathway. The soundwaves can activate the automatic nervous system and muscles[90]. Therefore, music influences physiological changes of humans, both physically and psychologically, as described below.

After entering the cochlea in the ears, resembling a shell and full of auditory nerves that distinguish the frequency of the soundwaves, the sound will be sent to the brainstem. It is also transmitted to the auditory cortex[97] and to the limbic system which involves emotions and feelings[98]. The soundwave sent there can influence the function of parasympathetic nervous system and sympathetic nervous system.

Parasympathetic nervous system is essential to the development of good mood such as cheerfulness, satisfaction, and joy. When activated, this nervous system will restore the body into the equilibrium or normal state, and decrease blood pressure, heartbeat and metabolism, resulting in better sleep. In contrast, sympathetic nervous system is an important part that causes negative or bad mood such as anger, fear, or disgust[99]. In addition, soundwaves influence the function of the immune system, endocrine system, and neuropeptide, causing physical and psychological changes, alterations in thoughts and mood based on the musical stimuli.

Music therapy contributes to relaxation with harmonized combination of sounds, music, and rhythm. It affects the function of the central nervous system in the limbic system, which is a center to control emotions, feelings, and perception. Music affects the limbic system in that it induces mood alterations in which anxiety is reduced while muscles are relaxed. The limbic system works with the cortex by transmitting emotional responses, namely decreased anxiety and relaxation. Then, the limbic system sends nervous signals to the hypothalamus, stimulating the release of CRH and reducing the function of the sympathetic nervous system which then reduces the function of the central nervous system and increases the perception while decreasing the function of the nervous system and the muscles. This leads to physiological response by reducing the function of the heart system, the respiratory system, the need for oxygen, the tension of muscles, the level of epinephrine and blood pressure[100].

Regarding physiological effects, music therapy leads to changes in respiratory rate, heart rate, blood pressure, blood circulation, pupillary response, muscle tension, nervous system, and metabolic system. The changes in respiratory rate, heart rate, blood pressure, and muscle tension are attributed to the volume, the pitch, and rhythm of music. In soothing music, the rhythm is approximately 60 beats/minute, which can decrease the respiration rate, heart rate, and blood pressure[101], as well as reduce and slower blood circulation in brain, and decrease oxygen consumption and metabolism. In contrast, in lively music, the rhythm is more than 90 beats/ minute and can increase blood circulation[102].

In addition, it has been suggested that human brainwaves move in rhythm that is similar to that of music, and music rhythm deeply influences brain function[90]. Music transforms brainwaves into alpha and theta, which are brainwaves that

occur when the body is in a deeply relaxed, as in meditation. These brainwaves activate the limbic to release serotonin that further stimulates the forebrain to secrete endorphin[103, 104] that has similar properties to opium but 1,000 times stronger, causing relaxation and happiness[105]. Moreover, the sounds of music with similar frequency to individual basic frequency can combine with the body's frequency, leading to healing of emotion, body, organs, enzymes, cells, and atoms. This is explained by heart rate and pulse. When the heart beats, there is arterial vessel resonance that further affects atoms, then molecules, cells, and organs[106].

With regard to psychological changes, the impact of music therapy can be measured in conjunction with physiological changes. In general, music stimulates emotional state that results in pleasure. This may be explained by the belief that music can free the imagination and emotions hidden deeply in the mind, rhythm, styles, melody, harmony, and feeling serving as determinants of emotional responses. Biley claimed that music could shape the mind, the body, and the emotion, and music can penetrate into the listeners' level of awareness that cannot be accessed with words or touches; listening to music distracts a person from the current situation to a pleasurable feeling, so music can relieve stress, anxiety, and fear[107]. Evidence suggests that lively music is associated with a higher level of anxiety than soothing music, and soothing music is more effective in reducing anxiety than non-instrumental music[99].

1.4.8.6 Music and the brain

Music was stated as one of the seven intelligences. Musical Intelligence was hence defined as the abilities to produce and appreciate rhythm, pitch, and timbre of music and appreciation of musical forms of ex pressiveness. According to Gardner, since music makes use of quite a number of attributes, it allows for flexible thinking[108]. Hence, musical training is a way that effectively enhances the conceptual- holistic- creative thinking process, while also assisting in the molding and integrating of the capabilities of the mind. Musical capabilities appear to be represented first in the right hemisphere of the brain. However, as one's skills improve, capabilities that have been in the right hemisphere can be increasingly found in the left. Apparently, with musical training, a large proportion of skills travel across the corpus callosum and enter the left hemisphere which is linguistically dominant[108]. When subjects get engaged in spatial-temporal tasks, such as the Stanford-Binet paper folding task, the same areas of the brain discussed earlier

become activated[109]. The dorsolateral prefrontal cortex is important in coordination of complex tasks in working memory. Interestingly, these areas are not necessarily activated when listeners are made to listen to other musical pieces, such as Beethoven's Fur Elise[110].

A study by Schmidt and colleagues on the development of infants' regional electrocortical (EEG) and heart rate (ECG) responses to affective musical stimuli during the first twelve months after birth yielded results showing that effective music significantly stimulated activity in the brain during the first year of a human being's life. The effect of affective music stimuli during the first 12 months caused a clear developmental change on the brain activity of infants. The authors found that affective music significantly increased brain activity at three months of age and had a calming effect afterwards[111].

Research by Azizi[112] showed that music enrichment triggered stimulation of the formation of synapses and the development of dendrites in the brain. Hence, training children in music at an early age activates higher brain functions, including complex reasoning tasks. The pathways used for spatial reasoning are the same as music pathways in the brain. Therefore, when an individual listens to music, the spatial pathways are activated and ready to be used. New ones grow from neurons that are activated frequently. Proteins known as neurotrophins are responsible for stimulation of growth of dendrites. The concentration of neurotrophins in the brain is highest during 18 childhoods, when connecting cells in the brain are in the process of undergoing their greatest growth and development. However, continued learning increases the level of neurotrophic activity in the brain region charged with new learning and new memory formation. Because of its plasticity, the brain is able to reshape itself and reorganize the networks of dendrite-neuron connections as response to increase or decrease in use of the pathways. Evidence of brain plasticity is seen in people who repeatedly practice activities which are controlled by parts of their sensory, visual, coordination or motor systems for specialized learned activities. Research carried out by Elbert and colleagues[113] showed that stringed musical instruments players who used fingers of their left hands to perform complex movements along the strings manifested increased somatosensory regions (cortex representation) of the brain's parietal lobe which was associated with left-hand fingers. In a report on research in neuroplasticity and changes in grey matter resulting

from training, Draganski and colleagues[114] reported that people who learned the art of juggling had an increased amount of gray matter in their occipital lobes. However, when they discontinued practicing juggling, the new gray matter disappeared. The authors explained that this took place due a process referred to as pruning, which involved the decrease in the connecting dendrites and other connecting cells that were not used.

1.4.8.7 Positive effects of music listening

A repeated-measures design study of 30 undergraduate students by Cockerton and colleagues[115] involving students completing two cognitive tests, one in silence and one in the presence of background music revealed that suggested that music facilitated cognitive performance more than the control condition. In their study, the students who worked in the presence of background music completed more problems than those that worked in silence and got more answers correct. Cockerton and colleagues suggested that the improvement in performance while background music played could have been associated with the type of music[115]. Another study conducted by Boltz and colleagues showed that Music increased memory performance. In this research, different effects of background music on the recall filmed events were studied. Results showed that participants who were exposed to background music which could cause positive affect had higher performance memory levels than those who were exposed to background music that produced negative effect[116]. According to Jensen, priming is very important in initiating, enhancing and directing attention to a class activity. Music can be used to stimulate students' attention in class. Music influences the process of attentiveness, emotions and memory. In a study by Davidson and Powell[117], it was shown that playing of background music in the classroom had a similar positive effect on students' attention span, or 31 on-task performance in the classroom. Music woke and aroused the listener's emotions, which modulated and controlled many cognitive processes. An analysis of collected data on music listening practices in workplace settings in the UK indicated that for best work performance by workers and their well-being, respondents preferred music of their choice. Lesiuk carried out research on the relationship between individual music listening (using earphones or headphones) for computer programmers, and the corresponding effects on work quality, the time spent on task and affect. Forty-one male and fifteen female workers participated in the research for five weeks. The data of measurements for the impact of listening to music on state

positive effect, work quality and time-on-task among developers of computer information systems were collected. The research was carried out in the field instead of in a laboratory. According to the results, the workers working in non-musical ambiance registered the lowest state positive affect and quality-of-work. Under this condition, the time-on-task was also found to be the longest[118].

1.4.8.8 Music and anxiety

Many people claim that they are able to lower high anxiety feelings by listening to relaxing music. This section reviews research associating music with anxiety. Thompson and colleagues carried out a study to examine whether people would perform better following listening to Mozart's music. They investigated whether it might be a consequence of differences in arousal and moods. The results collected here showed that the best spatial task skills' performance was observed in the group who listened to Mozart's compositions. They concluded that Mozart's effect was an artifact of mood and arousal[119]. Research carried out by Krout[120] showed that anxiety could be significantly lowered by listening to music. Music was used widely to controlling anxiety in the medical field. A study by Bolwerk on myocardial infarction patients showed that patients who listened to music had their anxiety levels decrease greatly[121]. Hardie assigned one hundred and ninety students to two groups, one to sit for an intermediate algebra test in the presence of background music while the second group (control group) sat for the test in silence. The choice of music was Baroque, Classical and Romantic era music with tempos between 72 and 88 beats per minute. The anxiety level in students without background music increased significantly as opposed to the experimental group which remained unchanged. Chlan and colleagues found that the group that listened to music recorded lowest anxiety and discomfort than students in the control group[122].

1.4.9 Binaural beat

With the blending of two pure sound signals with comparable frequency that leads to phase interference in the waves, a composite signal is generated that has medium frequency. Also, the amplitude is modulated when the frequency is equivalent to the contrast between both of the initial frequencies. For instance, when 100 Hz and 110 Hz sounds are blended, this will create a signal with 105 Hz that goes up and down in amplitude with 10 Hz frequency. The modulation of signal amplitude is referred to as an auditory beat[123]. Similarly, a person will hear the medium frequency and modulated

amplitude when sound signals with resembling frequencies are perceived separately by the each ear via headphones, regardless of the fact that only one of those frequencies is heard by each ear and these signals are not physically seen. Termed “binaural auditory beat” and recognized since 1839, this situation is caused when the brain processes two different sound signals at the brainstem’s olivary nuclei level. A person will hear binaural beat when the ears perceive two sound signals with dissimilar frequencies[124].

The frequency of binaural beat frequency is equivalent to the contrast between the frequencies perceived by each ear[72]. Foster carried out a study to examine the effects of alpha-frequency binaural beat stimulation mixed with alpha neurofeedback on alpha- frequency brainwave production. The results showed that the blending of binaural-beat stimulation and alpha neurofeedback contributed to higher alpha generation than only by neurofeedback with statistical significance. However, the group that was presented with merely binaural- beat stimulation yielded significantly higher alpha production. In a review to investigate the effects of Hemi- Sync tapes on electrocortical activity[125], music therapy was performed with binaural beats to relax the brain. The music was generally soft and tranquilizing, and incorporated natural sounds (e. g., waterfalls, singing birds, the ocean). The result from the patients’ diary revealed that the use of binaural beat could significantly decrease anxiety[126]. Symptoms of anxiety can appear in three areas: behavior changes (such as agitation and shunning), physiological changes (e. g., perspiration cardiac palpitation and respiratory change), and cognitive changes (e. g., negative and unrealistic though. Most current treatment for anxiety uses psychopharmacology or anxiolytic medication, psychotherapy and/or relaxation therapy. Binaural beat sound, if effective, would provide an easy, cost effective method to help this population, and can be used at home in conjunction with existing therapies[126].

Regarding sound localization, the hearing system of human performs analysis of interaural differences in time perceived by the two ears in small- range frequency, referred to as critical bands. If the frequency is under 1000- 1500 Hz, interaural time differences are assessed based on interaural phase differences in the two ears’ signals. In addition, the heard sound is assessed based on the processing of the signals perceived by two ears. If different pure tones (sinusoidal signals that have dissimilar frequencies) are perceived by each ear, this will result in time-dependent phase as well as time difference between the two ears. The perception of sound is determined by the disparity in the frequency between the signals heard by each ear[125,126].

In case the frequency difference between the signals heard by each ear is under a few hertz, the hearing system can support the alterations in the interaural time differences. Consequently, there is a perception of an auditory event that is traveling in the head. The perception of direction will be consistent with the instantaneous interaural time difference[126].

In case the frequency difference between the signals perceived by each ear is more than 10 hertz, the hearing system will not be able to process the alterations in the interaural parameters, contributing to an auditory diffusion event in which the sounds become consistent with the overlapping of the signal perceived by the two ears. This is when there is a rapid change in the amplitude and the loudness. If the frequency difference between the signals perceived by each ear is more than 30 hertz, there will be a cocktail party effect in which the hearing system can process the signals based on two different origins in two dissimilar locations, leading to the perception of two different signals[125,126].

A person can hear binaural beats regardless of headphones. These beats are created when two distinct pure tones are produced via loudspeakers. The person will hear a similar sound with auditory events that travels between rooms, in low- frequency differences, and sound diffusion in marginally larger differences in frequency. When there is larger differences in frequency, there will be obvious origins of localized sound[10]. Nevertheless, headphones yield better result than speakers.

1.4.9.1 History of brainwave entrainment

So far, people have not recognized binaural beats. It is merely known that consistent rhythmic signals contribute to very effective therapy and spiritual well-being. Melinda Maxfield carried out a study on the drumbeats employed in the ceremonies of diverse cultures and reported that the beat at a constant rate of 4.5 beats in a second stimulated a hypnotic state among the listeners. This was caused when the brain shifted into a 4.5-beat-per-second brainwave frequency that was a low Theta brainwave state. Binaural beats have been of great importance in therapy and spirituality in most cultures for ages[127]. The Tibetan monks, Native American shamans, Hindu healers, and mastered Yogis use repetitive beats and chanting to stimulate consciousness, therapy and spiritual development.

In 1839, Heinrich Wilhelm Dove found binaural beats and the science started to recognize them. Despite constant scientific investigation, binaural beats were relatively for 134 years[128]. In 1973, Gerald Oster reviewed a number of binaural beat studies since Dove and conducted a study on "Auditory Beats in the Brain" where he provided extensive new knowledge and novel laboratory results for inquiry about binaural beats. To Oster, binaural beats served as a great instrument for cognitive and neurological research that could give insight into how animals could detect sounds in their three-dimensional context and animals' prominent ability to detect and concentrate on specific sounds amid noises. He also regarded binaural beats as an effective method of medical diagnosis for hearing impairment and common neurological problems. Not long after that, Robert Monroe, with support from Thomas Campbell and Dennis Mennerich, initiated an investigation on the effects of binaural beats on consciousness. Robert attempted to recreate a subjective impression of 4Hz oscillation related to out-of-body experiences and discovered that binaural beats were an effective method of accessing altered consciousness states. Monroe began the binaural beat self-development industry and established The Monroe Institute, which is a non-profit binaural beat research and education organization today[128].

Investigating hearing phenomenon of binaural beating allows for an understanding of the influence of rhythm on stimulation. A person hears binaural beats when each of two consistent sounds with almost similar frequencies is presented via stereo to each ear. Phase differences between these signals arouses a perceived vibrato or wavering with the frequency of the difference between both (stereo left and right) auditory inputs, referred to as the binaural beat. Binaural beating initiates in a pair of superior olivary nuclei of brain stem[128]. Beating-frequency input travels through the neuro system to the reticular formation. This input is usually regarded as concurrently "volume conducted" to the cortex and objectively assessed by EEG as a response to frequency. This cortical assessment is called the "frequency-following response[129]" because its period (frequency in cycles per second) is consistent with the frequency of the beat stimuli and the vibration occurring in the olivary nuclei and then the reticular formation[130]

1.4.9.2 Binaural beat and physiology changes

The sensation of binaural beats is believed to originate in the superior olivary nucleus, a part of the brain stem. They appear to be related to the brain's ability to

locate the sources of sounds in three dimensions and to track moving sounds, which also involves inferior colliculus (IC) neurons[131]. Regarding entrainment, the study of rhythmicity provides insights into the understanding of temporal information processing in the human brain. Auditory rhythms rapidly entrain motor responses into stable steady synchronization states below and above conscious perception thresholds. Activated regions include primary sensorimotor and cingulate areas, bilateral opercular premotor areas, bilateral SII, ventral prefrontal cortex, and, subcortically, anterior insula, putamen, and thalamus. Within the cerebellum, vermal regions and anterior hemispheres ipsilateral to the movement become significantly activated. Tracking temporal modulations additionally activate predominantly right prefrontal, anterior cingulate, and intraparietal regions as well as posterior cerebellar hemispheres[132]. A study of aphasic subjects who had a severe stroke versus normal subjects showed that the aphasic subject could not hear the binaural beats while the normal subjects could[133].

Research has shown that the human brain is able to separate the sounds that are heard from both ears due to the frequency, loudness, sound characteristics, and different time periods. Nevertheless, if the frequency of the sound that hits two ears is different than 30 Hz, the brain will interpret as a single sound with the origin within the brain. Most listeners cannot hear the low frequency sounds of binaural beats because binaural beats often have a lower frequency than the waves that human ears hear, but will recognize that there are binaural beats by changing the focal point of the sound back and forth within the brain. The sound that is synthesized to produce binaural beats should be in the range of 1000 - 1500 Hz. Studies and research measuring EEG have shown that the use of binaural beats can induce brain waves to a certain extent change[124]. Another level is called brainwave entrainment. For example, to change brain waves from a state of alert or brain wave frequency in the Beta phase or about 20 Hz to a relaxed state, or brainwave frequency in the Alpha range, or about 10 Hz, the therapy starts with music or sound with binaural beats of about 20 Hz at the beginning of the song and gradually changes the beat frequency to 10 Hz at the end of the song to induce overall brain waves more orderly. The maximum electrical activity is located in the upper part of the brain[124]. Binaural beats are useful in relieving symptoms and increasing the potential of the brain through brain wave adjustments as follows:

1.4.9.3 Effects on brain function

In addition to hearing, binaural beats can affect the brain's functions. This phenomenon is called "frequency-following response" in which when a person is stimulated by a brain wave-frequency, the ruling brainwave frequency tends to shift in accordance with the stimulus's frequency (a process termed entrainment)[134]. Moreover, evidence has shown that binaural beats are associated with spatial perception as well as stereo auditory recognition, and due to the frequency-following response, multiple locations of the brain are activated[4, 15, 16, 135, 136]. The stimulus is not necessarily related to hearing but it can be related to seeing[7] or both[123] (such as Dreamachine).

The aural perception of humans is confined to the frequency ranging from 20 Hz-20,000 Hz. Nevertheless, in human brain, the wave frequency is approximately under 40 Hz. Therefore, binaural beat frequencies are employed. A 40 Hz beat frequency is generated by the brain using binaural sound and assessed in experimentation[72]. As there is the consistency of the perceived beat frequency with the delta, theta, alpha, beta, or gamma range of the brainwave, the brainwaves entrain or shift toward the frequency of the beat[137]. For instance, when the right ear is presented with a wave with 315 Hz and the left ear with a 325 Hz wave, the brain shifts towards the frequency of 10 Hz, in the alpha range. Because alpha range is linked to a relaxed feeling, a person will feel relaxed but will be more active with beta range. In an investigation of binaural sound stimulation with beta range and delta/theta range, participants exposed to beta-range sounds were more alert and had better mood than others[31, 83].

Binaural beat stimulation is used relatively widely in an effort to stimulate a wide range of conscious states, and some studies were conducted to examine the influence of these stimuli on relaxation, concentration, attention, and conscious states[13]. Evidence has demonstrated that a repetitive training to differentiate similar frequency signals that a plastic reorganization of the brain happens for the trained frequencies[30] will allow a person's asymmetric hemispheric balancing[32].

Table 1.1 Brain wave frequency[30]

Frequency range	**Wave**	**Usually associated with:**
> 40 Hz	Gamma	Higher mental activity
13–39 Hz	Beta	Active, anxious thinking and active concentration, arousal, cognition, or paranoia
7–13 Hz	Alpha	Relaxation, pre-sleep and pre-wake drowsiness, REM sleep
8–12 Hz	Mu	Mu rhythm, Sensorimotor rhythm
4–7 Hz	Theta	Deep meditation/relaxation, NREM sleep
< 4 Hz	Delta	Deep dreamless sleep, loss of body awareness

Source: Le Scouarnec RP. et al. (2001)

The predominant frequency dictates a person's state. For instance, with alpha waves in the brain, a person will be in the alpha state in which there is relaxation but awakening. Nevertheless, there will be other frequencies as well, but with less amplitude. The brain entrains better in case the entraining frequency is similar to the person' s initial predominant frequency. Thus, it is recommended to begin with a frequency close to a person' s current predominant frequency (usually approximately 20 Hz or below in an awaken person) and then gradually turn it down or up towards the intended frequency[31].

To some persons, pure sine waves are undesirable. Therefore, a pink noise or other natural backgrounds (e. g. , sounds of stream) can be incorporated. Moreover, as far as the person can hear the beat, the effectiveness is unlikely to be improved by turning up the volume, so it is advised to use a soft volume. One theory suggests reducing the volume until the beat is almost inaudible. However, this is unlikely[31].

1.4.9.4 Newly-Developed Superimposed Binaural Beat

Binaural beat employs the principle of separation of the left and right frequencies in the same song. In previous studies, BB has been used to reduce anxiety in patients and some are not significant. However, superimposed binaural beat produces binaural beat by separating the left and right frequencies in all musical instruments and bring together a music later. It is believed that it will be more effective in inducing brain waves at a relaxed wave than the original BB[27,28].

In the present study, an acute anxiety was conducted using the State STAI model to investigate. The way to reduce anxiety using the new SBB was called superimposed binaural beat.

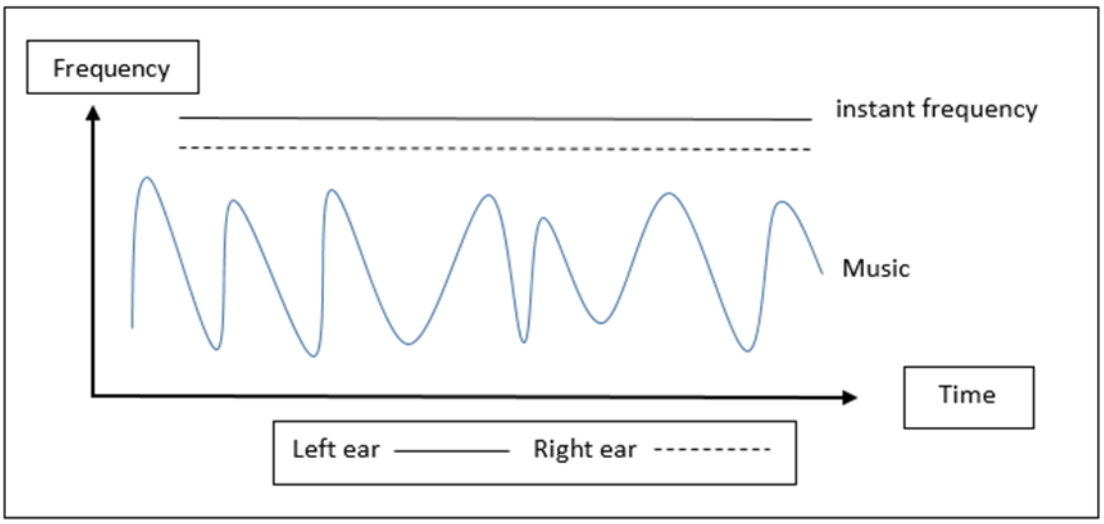

Figure 1.2 The traditional binaural beat

The traditional binaural beat with separate left and right ear frequency in the whole song.

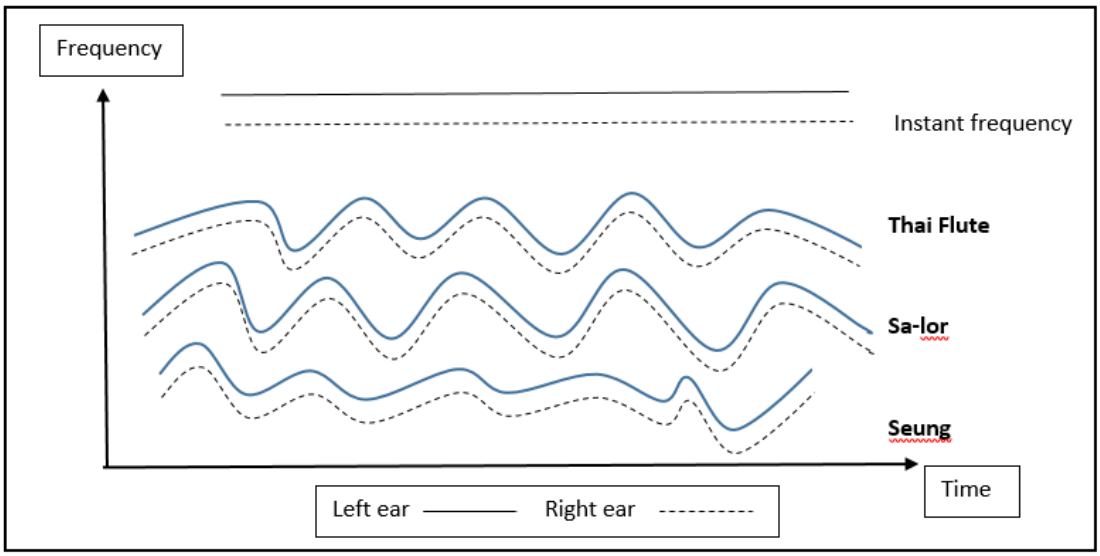

Figure 1.3 The superimposed binaural beat

The superimposed binaural beat with separate left and right ear frequency in each musical instrument

1.4.10 Conceptual framework

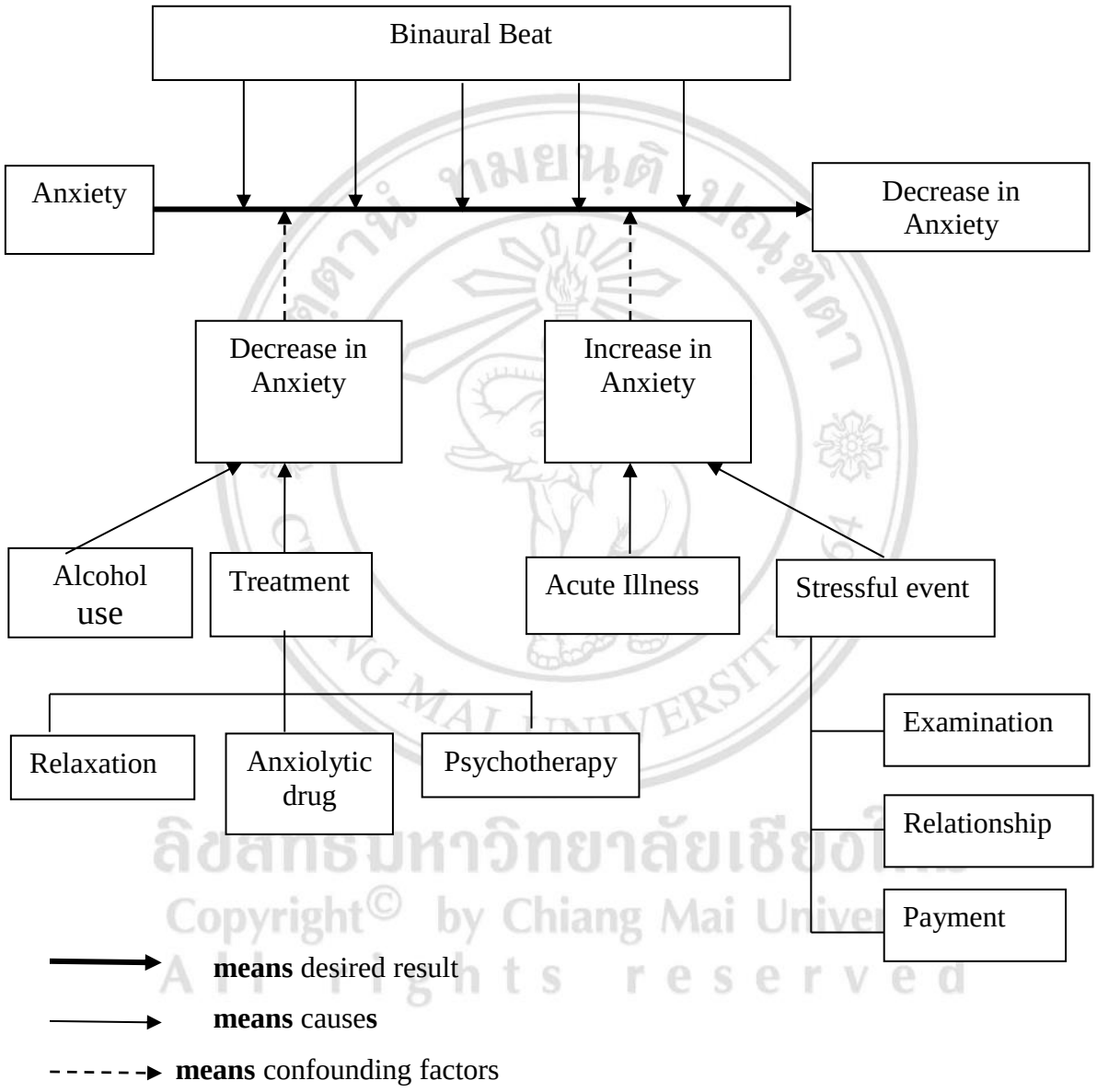

Figure 1.4 Conceptual framework

In a situation where people are anxious and the need for anxiety is reduced, the use of binaural beat is believed to produce the desired result. That is, it can reduce anxiety by brainwave induction to the frequency in the relaxed wave. In the planning of the study,

the sample was randomly selected. However, during the trial period there were other complications that increased or decreased anxiety level. Complications included the following: relaxation training psychotherapy treatment, and medication including alcohol to relieve anxiety. The level of anxiety was reduced but the occurrence of acute illness or stressful events, such as conflicts, quarrels, economic problems, could increase anxiety level. This could bring about a heightened level of anxiety. These variables had to be controlled by random sampling. The therapy sessions have to take the smallest amount of time. These variables need to be controlled by random sampling. The tools that take the smallest amount of time can prevent time- dependent confounding variables. Other variables were controlled using a questionnaire for screening out every day before getting treatment.

1.5 Scope of the study

This study was a randomize control trial. The objective was to determine the effectiveness of binaural beat on anxiety in university health science students who were studying in health science program at University of Phayao in the academic year 2016.

1.6 Expected benefits from the study

The results of the study will contribute to new knowledge to serve as a basis for providing care fore college students with anxiety and can be applied in the other samples such as the elderly with anxiety in the future.

1.7 Operational Definitions

1.7.1 Binaual beat refers to Thai Lanna music whose frequencies between left and right ears were adjusted to be 10 Hz different.

1. 7. 2 Superimposed binaural beat refers to Lanna music whose frequencies between left and right ears in each musical instrument were adjusted to be 10 Hz different.

1. 7. 3 Music listening refers to Thai Lanna music that had been edited to last 20 minutes/session.

1.7.4 General relaxation refers to relaxation with a relaxing chair.

1.7.5 Anxiety refers to the students who had anxiety symtom assessed by the STAI test.

1.7.6 The university students refers to the university health science students in University of Phayao in academic year 2016.

CHAPTER 2

METHODOLOGY

This study was conducted using a cross-sectional study design to determine the prevalence of anxiety in university health science students. A randomized control trial (RCT) was used to find out the ways to reduce anxiety among university health science students. The population consisted of 6,480 health sciences students. Of the 1,245 samples for investigating the prevalence of anxiety, simple random sampling was used to recruit 45 students with high levels of anxiety for the SBB, 45 for music listening, and 45 for general relaxation groups.

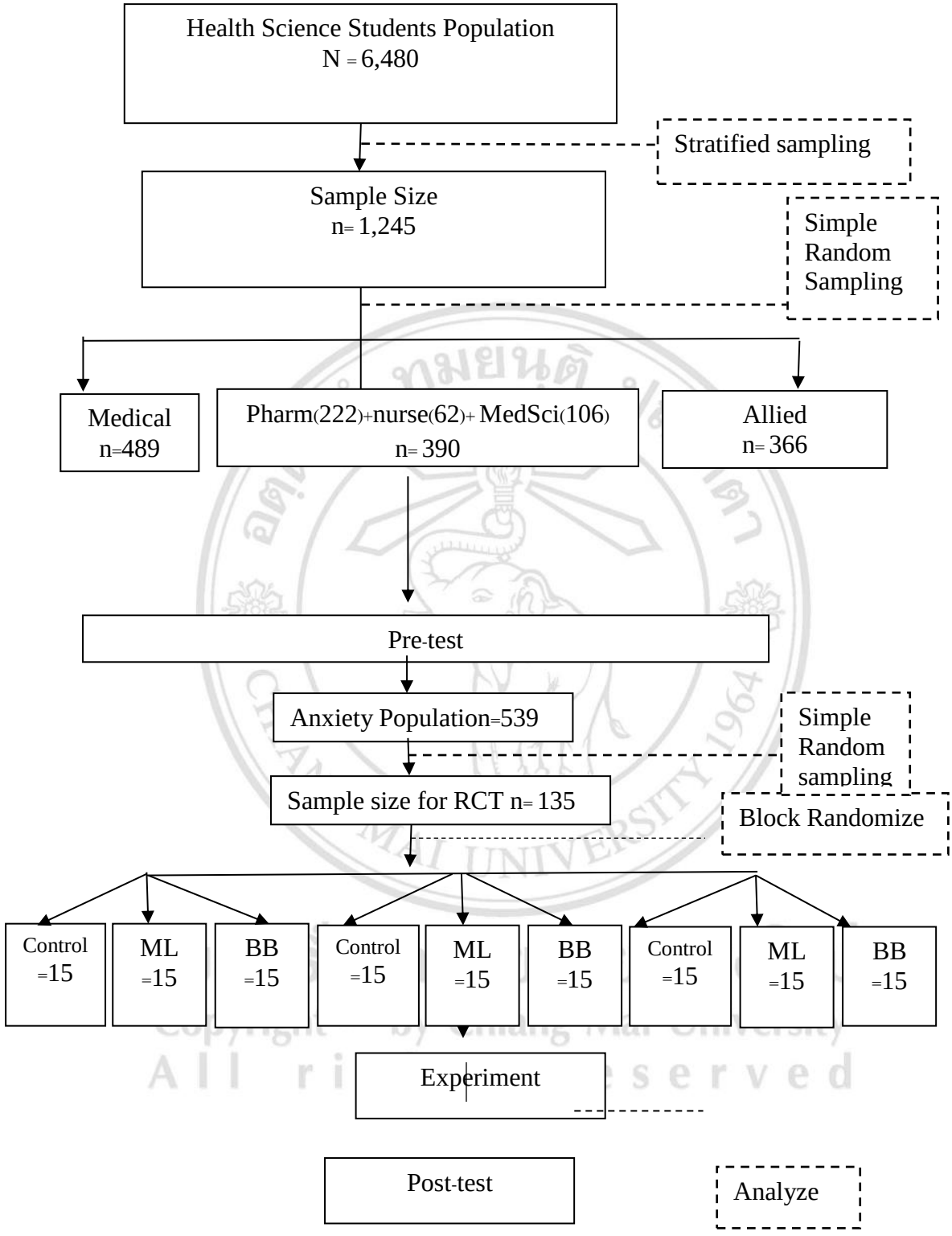

Figure 2.1 Subject recruitment procedures

Medical means students in the School of Medicine

Pharm means students in the School of Pharmacy

Nurse means students in the School of Nursing

MedScien means students in the School of Medical Science

AlliHS means students in the School of Allied Health Science

2.1 Part I: Cross-sectional study

2.1.1 Objective: To determine the prevalence of anxiety in university students

2.1.2 Study Design

The cross-sectional study was designed to determine the prevalence of anxiety stage in students who were studying in six schools of health sciences win University of Phayao. The STAI was used to assess the anxiety score.

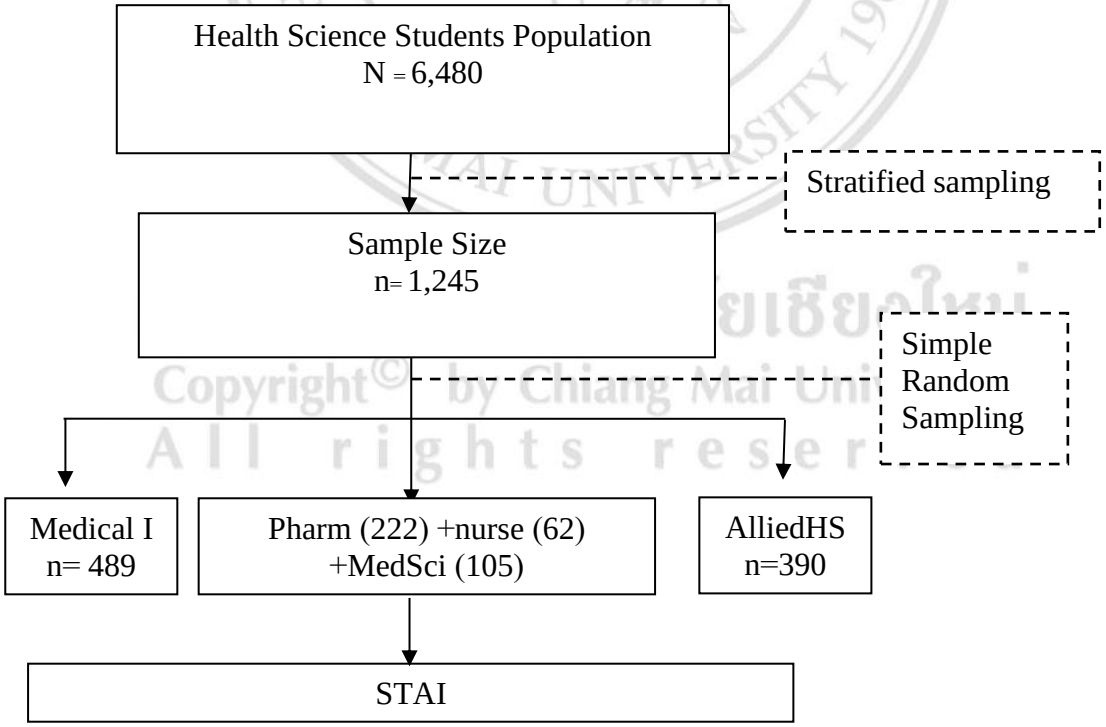

Figure 2.2 Flow diagram of part I study

2.1.3 Study Population

2.1.3.1 Participants for Anxiety Assessment

The data collection in this research was conducted on 1,245 out of 6,480 university students on stratification of faculty and academic year for a period of four weeks from October to November, 2016. The acute anxiety prevalence was determined among 1,245 health science students using the STAI form Y-I (STATE Anxiety) with a cut-off score of at least 40 or higher[138]. Drawing lots was a random sequence of number generated in excel used in each stratum simple random sampling. There were 539 out of 1,245 students who had anxiety score of at least 40 or higher (eligible for randomized control trial [RCT]).

2.1.3.2 Population and Sample

1) Population

The population of this study was the students who were studying in groups of Health Science schools in University of Phayao in 2016. The population comprised approximately 6,480 students.

2) Sample

The population of this study was students who were studying in the School of Medicine, School of Dentistry, School of Pharmacy, School of Nursing, School of Medical Sciences and School of Allied Health Science in University of Phayao in the academic year 2016.

An estimated sample size was examined using n4studies program[139] calculated based on the formula by Wayne W., D[140].

$$n = \frac{Np(1-p)z^2_{1-\frac{\alpha}{2}}}{d^2(N-1)+p(1-p)z^2_{1-\frac{\alpha}{2}}}$$

The output of the sample size calculation from n4Studies: For estimating the finite population proportion, Proportion (p) = 0.31, Error (d) = 0.03 Alpha (α) = 0.05, Z (0.975) = 1.959964 Sample size (n) = 769 were needed. The appropriate sample size of this study was 810. The stratified sampling by school, degree of program and year, was used to recruit the sample.

2.1.4 Research Instruments

The instrument for collecting data consisted of a questionnaire with two main parts, as detailed below:

2.1.4.1 Personal data consisted of sex, age, marital status, education level, personal health history, income and sufficiency of income.

2.1.4.2 Strait Trait Anxiety Inventory (STAI)

The State Trait Anxiety Inventory (STAI) form Y, created by Spillberger[141], has been translated into Thai by Darawan Tapinta[142]. The Thai version is widely used among Thai people. The STAI is a tool extensively adopted to assess trait and state anxiety. This measure is appropriate for screening of anxiety and for differentiation between anxiety and depressive syndromes. It is also generally employed in studies to indicate distress in caregivers. Form Y, which is the most widely used version, comprises of 20 items to assess trait anxiety and 20 to assess state anxiety. Sample items in state anxiety are: "I am tense; I am worried" and "I feel calm; I feel secure." The sample items for trait anxiety are: "I worry too much over something that really doesn't matter" and "I am content; I am a steady person." All items are rated on a 4-point scale from "Almost Never" to "Almost Always", with higher scores indicating greater anxiety. The STAI is proper for people who have at least a sixth-grade reading level.

Internal consistency coefficients for the scale were between .86 and .95 with test-retest reliability coefficients of between .65 and .75 in an interval of 2 months. Test-retest coefficients in the present study was between .69 and .89. Substantial evidence has established its construct and concurrent validity and suggested that this measure has sensitivity in predicting distress in caregivers through time, varying based on alterations in support and personal qualities.

2.1.5 Data Collection

This study was carried out in 6,480 Phayao University students in the academic year 2016 who studied in health science faculties. The 810 sample size was calculated from Wayne W.D[140] formula and the researcher recruited 1,245 participants by stratified sampling. All subjects in each class represented the population. Then, the samples from all groups by weight were divided by population. The samples were 489 Medicine students, 222 Pharmacy students, 106 Medical Sciences students, 62 Nursing students and 390 Allied Health Science students. The subjects, who were recruited with simple random sampling, were asked to answer the questionnaire (STAI Form Y) to determine

the prevalence of anxiety in the population.

2.1.6 Data Analysis

The percentage and frequency were used for analysis of the personal data.

2.2 Part II: Randomized Control Trial

2.2.1 Objectives

2.2.1.1 To investigate the effects of superimposed binaural beat on anxiety in university student.

2.2.1.2 To compare the effects of superimposed binaural beat and music listening on anxiety in university students.

2.2.2 Study Design

The randomized controlled trial (RCT) with three groups pretest-posttest was used to examine the effectiveness of binaural beat on anxiety in university health sciences students. The participants were randomly assigned into two experimental groups and one control group.

2.2.3 Study Population

2.2.3.1 Population

The population of this study comprised of the students who were studying in groups of Health Sciences schools in University of Phayao in academic year 2016 and met the criteria of anxiety with a cut-off score of 40 or higher. The population consisted of approximately 539 students.

2.2.3.2 Sample

The sample of this study consisted of students who were studying in School of Medicine, School of Dentistry, School of Pharmacy, School of Nursing, School of Medical Sciences and School of Allied Health Sciences in University of Phayao in academic year 2016 and had a score on the Strait-Trait Anxiety Inventory (STAI) that was higher than the mean score.

The sample size was calculated using n4studies program[139] based on the formula by Wayne W., D[140].

$$n = \frac{Np(1-p)z^2_{1-\frac{\alpha}{2}}}{d^2(N-1)+p(1-p)z^2_{1-\frac{\alpha}{2}}}$$

The output of the sample size calculation from n4Studies: Based on a randomized controlled trial with continuous outcome, the mean in a binaural beat group was 19.20 (SD = 14.55); the mean in a music listening group was 28.00 (SD = 14.33; Ratio (control/treatment) = 1.00 Alpha (α) = 0.05, Z (0.975) = 1.959964 Beta (β) = 0.20, Z (0.800) = 0.841621. The sample size was 43 for binaural beat group, and 43 for music listening group.

The output of the sample size calculation from n4Studies: For a randomized controlled trial with continuous outcome, the mean in a binaural beat group was 19.20 (SD = 14.55) ; the mean in a control group was 36.60 (SD = 13.09; Ratio (control/treatment) = 1.00 Alpha (α) = 0.05, Z (0.975) = 1.959964 Beta (β) = 0.20, Z (0.800) = 0.841621). The sample size was 10 for binaural beat group, and 10 for control group.

The output of the sample size calculation from n4Studies: For a randomized controlled trial with continuous outcome, the mean in a music listening group was 28.00 (SD = 14.33) ; the mean in a control group was 36.60 (SD = 13.09; Ratio (control/treatment) = 1.00 Alpha (α) = 0.05, Z (0.975) = 1.959964 Beta (β) = 0.20, Z (0.800) = 0.841621) The sample size was 40 for treatment group and 40 for control group.

Thus, the sample required was 43 participants. Total sample was 129 participants. With an additional 5% for the loss or denial of study of the sample, the appropriate sample size of this study was 135, divided into 45 participants for the experimental and 45 for the control groups. The block randomization was used to divide the participants into three groups. The participants and the researcher were blinded from the experimental (double-blind). After doing the anxiety test, there were 539 samples of anxiety and 352 met the inclusion criteria for this study. Then, 135 participants were randomly assigned to RCT and divided into 45 samples for each of the binaural beat group, music listening group and control group. During the experiment, one sample in the control group withdrew from study due to physical illness. Therefore, the number of samples in the control group was 44.

1) Inclusion criteria**:** In this study, the sample was selected according to the following admission conditions.

1.1) Being students in Health Sciences Program and had anxiety according to high STAI.

1.2) Aged over 18 years

1.3) Having no psychiatric condition such as depression

1.4) Not currently taking psychiatropic medications

1.5) Having no hearing problem

1.6) Willing to participate in the study

1.7) Able to participate until the completion of the trial

2) Exclusion criteria**:** In case of additional conditions after entering the trial, the sample had to be eliminated.

2.1) Currently having loss and grief condition such as loss of significant others

2.2) Having acute illness that required treatment by specialists

2.3) Consuming alcohol

2.4) Being under any treatment for anxiety

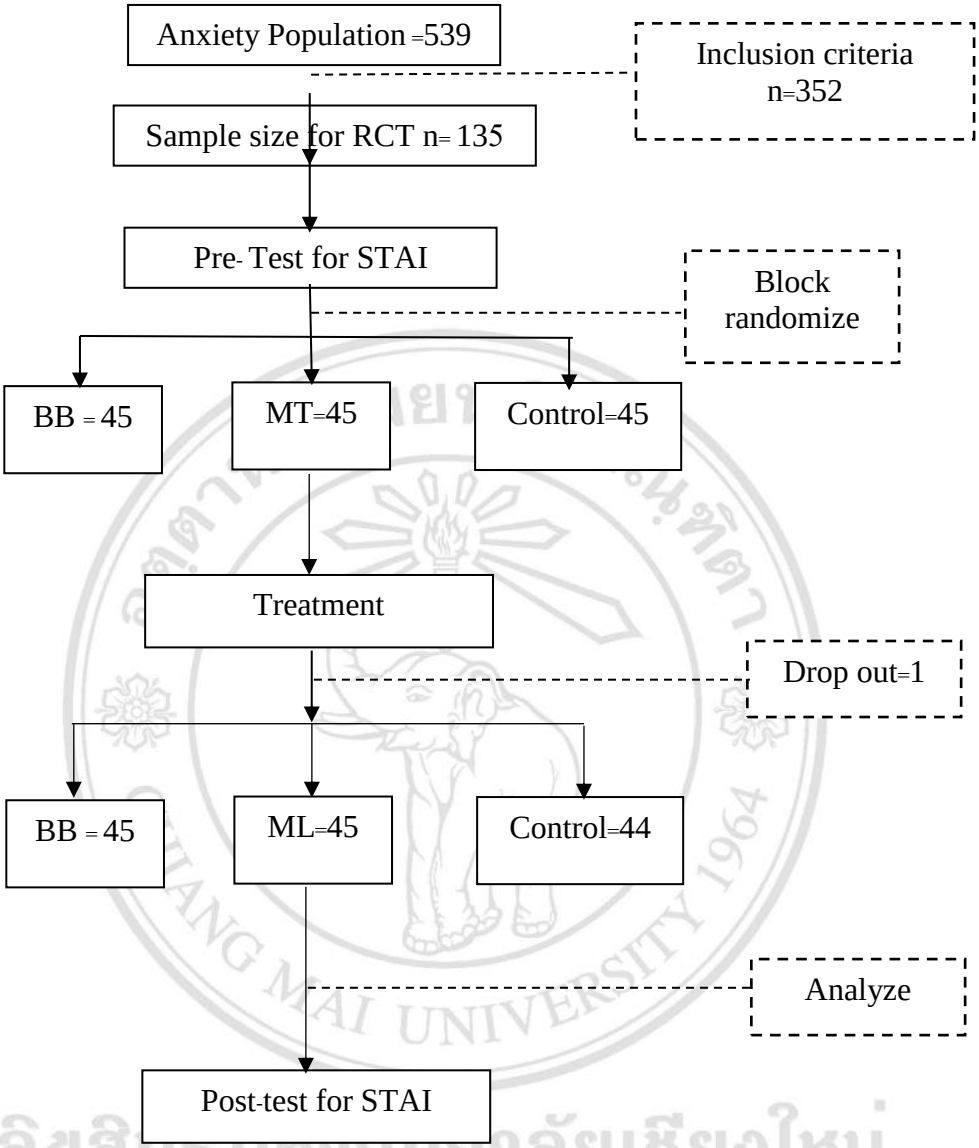

Figure 2.3 Flow diagram of phase II study

There were 539 samples of anxiety and 352 met the inclusion criteria for this study. Then, 135 students were randomly recruited for RCT and divided into 45 participants for binaural beat group, 45 participants for music listening group and 45 participants for control group. During the experiment, one sample in the control group withdrew from study due to physical illness. As a result, the number of sample in the control group was 44. All of the sample students were assessed with STAI before and after treatment each day.

		Posttest						
		Pretest	D1	D2	D3	D4	D5	
	Binaural Beat		x1	x2	x3	x4	x5	x6
Randomization	Music listening	y1	y2	y3	y4	y5	y6	
	Control group		z1	z2	z3	z4	z5	z6

D1 = experiment in day 1

D2 =experiment in day 2

D3 = experiment in day 3

D4 = experiment in day 4

D5 = experiment in day 5

X1 = 1st measurement of STAI in Binaural Beatgroup

X2 = 2nd measurement of STAI in Binaural Beatgroup

X3 = 3rd measurement of STAI in Binaural Beatgroup

X4 = 4th measurement of STAI in Binaural Beatgroup

X5 = 5 th measurement of STAI in Binaural Beatgroup

X6 = 6 th measurement of STAI in Binaural Beatgroup

y1= 1 st measurement of STAI in music listening group

y2= 2 nd measurement of STAI in music listening group

y3= 3 rd measurement of STAI music listening group

y4= 4 th measurement of STAI in music listening group

y5= 5 th measurement of STAI in music listening group

y6= 6 th measurement of STAI music listening group

z1= 1 st measurement of STAI in control group

z2= 2 nd measurement of STAI in control group

z3= 3 rd measurement of STAI in control group

z4= 4 th measurement of STAI in control group

z5= 5 th measurement of STAI in controlgroup

z6= 6 th measurement of STAI in control group

Figure 2.4 The study design

2.2.4 Research Instruments

2.2.4.1 The intervention consisted of three groups as follows:

1) Binaural beat group

1.1) Superimposed binaural beat creation

The superimposed binaural beat innovation in the present study adopted Thai Lanna music such as Long Maeping and Soy Wiang Ping songs, which were familiar to students in northern Thailand. Thai Lanna music was embedded with superimposed binaural beats whose frequency of the sound waves of each instrument, including Thai flutes, Sa-lor, Seung and electone, had been adjusted to have the left and the right frequency difference of 10 Hz and supplemented with one track of pure binaural beat tone of 10 Hz, produced by Jakkrit Klaphajone, which was licensed by the Copyright Office on April 29th, 2015. Lanna songs, including Long Mae Ping, and Soy Wiang Ping were played with an MP3 player with a stereo headset using continuous loop recording methods for 20 minutes of playing time. The song was pilot-tested to the preference of students at University of Phayao, who were not included in the sample of 1,250 students. The pilot study showed that 89.91% of the sample group preferred to listen to Lanna Thai music. Therefore, the preference of listening to Thai Lanna music was not a limitation for this study. The sample group and the researcher did not know the names of the songs or the type of sound that were heard.

Additional binaural beats were synthesized on the basis of frequency shifting of the sound waves from each traditional Thai musical instrument, except the drum sounds (due to their extremely low frequency), apart from the original binaural beat which was created by the standard method of pure-tone sine wave frequency differentiation via a self-hypnosis and relaxation machine (S.H.A.R.M., Cyber Team Ltd., USA) (Version 2.4). The continuous sounds, namely strings and organs, were also arranged to be inserted into all songs in order to render continuous frequency difference between the ears with the least interruption between the songs. All eligible tracks of each musical instrument were set to produce 10 Hz differences between one ear with lower carrier frequency and the other with higher carrier frequency. The therapeutic frequency of 10 Hz was sustained for at least 20 minutes to ensure enough time to entrain the brainwave at the alpha level (Chiang Mai University copyright on the synthesis of superimposed binaural beats).

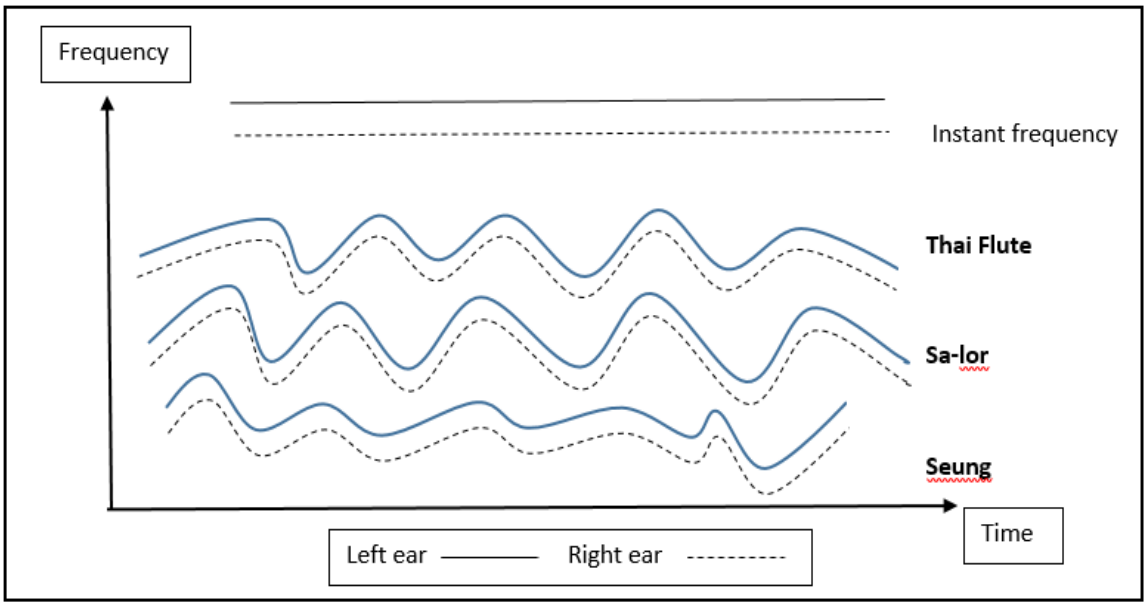

Figure 2.5 Creation of superimposed binaural beat

The figure shows the difference between left and right frequency in each instrument in Thai Lanna music, namely Thai-flute, Sa-lor, and Seung, and instant frequency with 10-Hz difference for the whole 20 minute-song.

1.2) The participants of a binaural beat group received music embedded with binaural beat with 10 Hz difference between left and right frequency in each musical instrument. The music received has been made continuously for 20 minutes. The samples were arranged to listen to music using stereo headphones under general relaxation with relaxing chairs in a quiet room where the temperature was adjusted appropriately. Every day after class, the participants participated in a 20-minute session a day, for five days. The participants were assessed for anxiety score at the end of each session using the STAI. Experimental instruments in this study were as follows:

1.2.1) Thai traditional music played with MP3 player and headphones. This music was recommended for anxiety. The titles of the songs were blinded from the participants and the researcher. Each session took 20 minutes.

1.2.2) Thai traditional music with binaural beat in alpha electroencephalogram range (10 Hz), played with MP3 player and headphones. This binaural beat was recommended for anxiety. The titles of the songs were blinded from the participants and the researcher. Each session took 20 minutes.

2) The music listening group

The participants of a music listening group received Thai Lanna music that was played continuously for 20 minutes using stereo headphones under general relaxation with relaxing chairs in a quiet room where the temperature was adjusted appropriately. Each day after class, the participants participated in a 20-minute session a day, for five days. The participants were assessed for anxiety score at the end of each session using the STAI.

3) The control group

The participants in the control group were given MP3 player and stereo headphones without any pre-loaded music under general relaxation with relaxing chairs in a quiet room where the temperature was adjusted appropriately. Like the experimental groups, they participated in one session a day for 5 days. The researcher met the control group in order to explain the details of the research and request their cooperation. The participants were assessed for anxiety score at the end of each session using the STAI.

All three groups received general relaxation treatment, which involved resting in a relaxed chair in a room with a comfortable temperature and wearing stereo headphones; this treatment was a basic therapy received by everyone and prevented confounders. The superimposed binaural beat, music listening and control groups listened to Thai Lanna music with superimposed binaural beat tones (with 10 Hz difference), Thai Lanna music without the superimposed binaural beat and blank audio, respectively. They received daily 20-minute treatments for five consecutive days. However, sleep during treatment can affect the perception of music. The researcher therefore controlled the sample's possibility of falling asleep during treatment by using a short period of time to receive a treatment and request for cooperation in listening to music attentively.

2.2.4.2 The instrument for this research was The State-Trait Anxiety Inventory (STAI). This questionnaire comprises 20 items to assess trait anxiety and 20 to assess state anxiety. Assessments were conducted on Day 1 before getting treatment and Day 5 after getting treatment.

2.2.5 Data collection

The steps of data collection were as follows:

2.2.5.1 The researcher contacted the teacher of Student Affairs Department to describe the objectives and procedure of this research.

2.2.5.2 The researcher contacted the class teachers to make an appointment to collect data every day after class, one session a day, for five days. Thus, there were five 20-minute sessions in total.

2.2.5.3 The researcher contacted the participants to explain about the purposes and benefits of the research, and ask for their informed consent to carry out the research.

2.2.5.4 The researcher screened the students for epilepsy or severe heart disease or depressive symptoms (exclusion criteria before sampling for RCT).

2.2.5.5 The students (134 of 352 students) were randomly selected (a random sequence of numbers was generated in computer) to participate in the double-blinded RCT (neither the researcher nor the participants knew what treatment was received).

2.2.5.6 According to block randomization, the subjects were assigned to one of three of the following treatment groups: superimposed binaural beat (SBB; 45 students), music listening (ML; 45 students), and blank audio (Control; 44 students).

2.2.5.7 The students's anxiety levels were measured by self-administered STAI form-Y (STAI-S) before treatment.

2.2.5.8 The students of a binaural beat group and music listening group participated in a 20-minute session a day, for five days after class. There were five sessions in total.

2.2.5.9 The participants in the control group were given MP3 player without any pre-loaded music. Like the experimental group, they participated in one session a day, for five days. There were five sessions in total.

2.2.5.10 All three groups received general relaxation treatment, which involved resting in a relaxed chair in a room with comfortable temperature and wearing stereo headphones; this treatment was a basic therapy received by everyone and prevented confounders.

2.2.5.11 The participants were excluded if any complications arose, including anxiety events or other treatments.

2.2.5.12 The students in the three groups were assessed for anxiety score at the end of each session using the STAI.

2.2.5.13 The students' anxiety levels were measured using self-administered STAI form-Y (STAI-S) after treatment.

2.2.5.14 The researchers prevented the interference of time- dependent confounders (alcohol use, receipt of other treatments and taking anti-anxiety medication) and major confounders (physical illness or tragic events causing anxiety) by notifying all participants at the recruitment stage and monitoring using a daily questionnaire. Every day of study, the sample were screened for depression using the 2Q test tool, and for other treatments with psychiatric drugs, drinking alcohol, coping with serious events that caused anxiety to increase. If the sample has such factors, they were excluded from this study.

2.2.6 Data Analysis

Descriptive analysis included proportion and median (range). Univariate analysis included Fisher's exact test, Chi square testing and Kruskal-Wallis testing, depending on the data distribution. A p-value of below 0.05 was considered as statistically significant. Data management and analyses were performed using Epi Info for Windows (Version 3.5.4) (Centers for Disease Control and Prevention, Atlanta, GA) and STATA version 11 (Statacorp LP. College Station, TX).

2.2.7 Human Ethical Approval

All methods were carried out in accordance with relevant guidelines and regulations. All experimental protocols were approved by the Ethics Committee of the Faculty of Medicine, Chiang Mai University, and cooperation was received in collecting data from School of Health Science, University of Phayao (Study Code: COM-2559-03951/Research ID: 3951, Ethics Approval Number 319/2016). The research assistants asked each participant directly about their willingness to be a study sample, and then the researcher informed every participant about the following six aspects of the study in order to give them comprehensible information, which allowed them to make un- coerced choices: (1) the purpose of study, the security, the confidentiality, and the content of the

program; (2) there would be no effect on them if they did not participate after being informed, or if they wanted to withdraw from the program at any time; (3) the potential benefits of participation in the study, such as receiving relaxation treatment for anxiety; (4) the data collected would be presented as an overview without indicating who the participants were during and after the study process; (5) they would receive money (100 baht) from participating in the program; and (6) the informed consent was taken after a participant agreed to participate. If they did not agree, they would receive regular care without unfair treatment.

CHAPTER 3

RESULTS

This research was conducted to examine the effects of binaural beat on anxiety and to compare effects of binaural beat and music listening on anxiety in university health sciences students. The results were reported in two parts are as follows:

3.1 The prevalence of anxiety in university health sciences students

3.2 The effects of binaural beat on anxiety in university health sciences students

3.2.1 Baseline characteristics

3.2.2 Comparison of anxiety scores before and after the experiment

3. 2. 3 Comparison of the effects of binaural beat and music listening on anxiety in university health sciences students

3.2.4 Anxiety level by treatments

3.1 Part 1: The prevalence of anxiety in university health sciences students

3.1.1 Baseline Characteristics of Population

The study population consisted of 6,480 students in the schools of health sciences. The sample consisted of 1,245 students who were selected using stratified sampling and simple random sampling methods. Table 1 shows the sample of 1,245 students in University of Phayao who studied in the schools of health sciences. The result showed that there were 174 males (13.98%) and 1,071females (86.02%). Classified by academic year, there were 451 (36.22%), 462 (37.11%), 316 (25.38%), and 16 (1.29%) students in the first, second, third, and fourth year respectively. Considering the schools of study, 489(39.28%), 222 (17.83%), 62 (4.98%), 106 (8.51%), and 366 (29.40%) students were in School of Medicine, School of Pharmacy, School of Nursing, School of Medical Science, and School of Allied Health Science.

Table 3.1 Baseline characteristics of population

	Characteristics	**Frequency (n=1,245)**	**Percent ages**
Gender	male	174	13.98
	female	1071	86.02
	total	1245	100.00
Year	year1	451	36.22
	year 2	462	37.11
	year 3	316	25.38
	year 4	16	1.29
	total	1245	100.00
Faculty	Medicine	489	39.28
	Phamacy	222	17.83
	Nursing	62	4.98
	Medical Sciences	106	8.51
	Allied Health Science	366	29.40
	Total	**1,245**	**100.00**

3.1.2 Prevalence of university health sciences student's anxiety

Out of 1,245 students from the schools of health sciences, 539 students met the anxiety criterion. The prevalence was 43.29%. **Table 2** shows the prevalence of anxiety in the sample of the population of approximately 1,245 University of Phayao students who were studying in the schools of health sciences. The study demonstrated that the rate of anxiety in females (43.42%) was higher than that of males (42.53%). Classified by year, the highest anxiety level was observed among the second-year students (49.13%) while students with the lowest anxiety level were the fourth-year students (6.25%). The group with the highest level of anxiety was the students in School of Medical Sciences (53.77%) and the students with the lowest anxiety level were those in School of Nursing (19.35%).

Table 3.2 Prevalence of university health science student's anxiety

		Students	**Anxiety**	**No anxiety**
		n	**n (%)**	**n (%)**
Gender	Male	174	74 (42.53)	100 (57.47)
	Female	1071	465 (43.42)	606 (56.58)
Year	1	451	164 (36.36)	287 (63.64)
	2	462	227 (49.13)	235 (50.87)
	3	316	147 (46.52)	169 (53.48)
	4	16	1 (6.25)	15 (93.75)
Faculty	Medicine	489	240 (49.08)	249 (50.92)
	Phamacy	222	75 (33.78)	147 (66.22)
	Nursing	62	12 (19.35)	50 (80.65)
	Medical Sciences	106	57 (53.77)	49 (46.23)
	Allied Health Science	366	155 (42.35)	211 (57.65)

* anxiety=Stai≥40

3.2 Part 2: The effects of binaural beat on anxiety in university health sciences students

3.2.1 Baseline characteristics

Of the 134 students with anxiety enrolled in the study, there were 45, 45, and 44 students with anxiety in SBB, ML, and control groups respectively. The majority of them were females and studied in the first year (Table 3). They were similar based on demographic characteristics (Table 3). The median trait anxiety scores of SBB, ML, and control groups were 43.00 (Range: 34.00 to 69.00), 43.00 (Range: 35.00 to 62.00), and 43.50 (Range: 32.00 to 64.00) respectively.

Table 3.3 Baseline characteristics of the participants by treatment groups

Variables	**Treatment groups***		
	SBB	**ML**	**Control**
	n=45	**n=45**	**n=44**
Gender (n (%))			
Male	6 (13.33)	6 (13.33)	8 (18.18)
Female	39 (86.67)	39 (86.67)	36 (81.82)
Year			
1	17 (37.78)	21 (46.67)	18 (40.91)
2	15 (33.33)	11 (24.44)	10 (22.73)
3	12 (26.67)	12 (26.67)	16 (36.36)
4	1 (2.22)	1 (2.22)	0 (0.00)
Faculty n (%)			
Medicine	27 (60.00)	26 (57.77)	26 (59.09)
Pharmacy	2 (4.44)	3 (6.67)	4 (9.09)
Nursing	4 (8.89)	4 (8.89)	3 (6.82)
Medical Science	2 (4.44)	3 (6.67)	3 (6.82)
Allied Health Science	10 (22.23)	9 (20.00)	8 (18.18)

* SBB = Superimposed binaural beat; ML = music listening ; Control = blank audio

3.2.2 Comparison of anxiety scores before and after the experiment

The mean scores of anxiety before and after the experiment of the 45 samples of binaural beat group who received music embedded with binaural beat were 44.00 and 25.56 (SD. = 6.37 and 4.35). Comparing before and after the experiment, it was found that the mean score of anxiety after the experiment was significantly lower than before the experiment ($p < .01$) as shown in Table 4.

Table 3.4 Differences in Anxiety Score Between at the Beginning and at the End of the Program (BB) by Wilcoxon Signed – Rank Test

	N	At the baseline median (Q1-Q3)	At the end median (Q1-Q3)	**Z**	*P-value*
Anxiety	45	45.49 (41.00-46.00)	25.56 (22.00-29.00)	-5.845	<.0001

3.2.3 Comparison of the effects of binaural beat and music listening on anxiety in university health science students

During treatment period, there were no reports of alcohol use, receiving other treatments, taking anti-anxiety medication, physical illness, and tragic events. The median difference of STAI-S score between after and before treatments of SBB, ML, and control were -20.00, -16.00, and -15.00, subsequently. When comparing the median differences between groups, pairs of SBB versus control and SBB versus ML, there were statistically significant differences (Table 5).

Table 3.5 Anxiety Levels Among Participants by Treatment Groups

Treatment groups	Difference in STAI-S Scores* Median (Range)	*P-value*
Superimposed binaural beat	-20.00 (-3.00 to -40.00)	SBB versus ML: 0.02**
ML	-16.00 (1.00 to -32.00)	ML versus Control: 0.81
Control	-15.00 (0 to-50.00)	Control versus SBB: 0.04**

* Difference in median STAI-S Scores between after and before treatment

** Statistically significant difference using Kruskal-Wallis test

3.2.4 Reached anxiety level rate by treatments

The students were defined as having acute anxiety when their anxiety scores were at least 40 scores or higher. Thus, the participants who had anxiety scores after treatment lower than 40 were considered as normal. All participants (100.00%) in SBB group, 43 participants (95.56%) in ML group, and 37 participants (84.09%) in control group were cured after completing 5-day treatment sessions, with statistical significance (Table 6).

Table 3.6 Comparison of anxiety normal rates after completed treatment of superimposed binaural beat, ML, and control groups

Treatment Group	n	normal n (%)	*P-value**
Superimposed binaural beat	45	45 (100.00)	0.045
ML	45	43 (95.56)	
Control	44	37 (84.09)	

* Statistical significance by Fisher's exact test

CHAPTER 4

DISCUSSION AND SUGGESTIONS

This study was conducted among the 6,480 university students who were studying in Health Science program at University of Phayao in the academic year 2016. The purposes were to determine the prevalence of anxiety in university students and to investigate the effects of binaural beat on anxiety in university students and to compare effects of binaural beat and music listening on anxiety in university students. Data were collected between October and November, 2017.

The interventions were the binaural beat, music listening and general relaxation. The measurement was the self-assessment STAI questionnaire that also included a demographic questionnaire. Descriptive statistics were analyzed using percentage, frequency, mean, and standard deviation. The comparison of effectiveness between the interventions was determined by Chi-square, Independence t-test and one-way ANOVA. The results were summarized as follows:

4.1 Conclusion and Discussion

This study aimed to determine the prevalence of anxiety in university students, to investigate the effects of binaural beat on anxiety, and to compare the effects of binaural beat and music listening on anxiety in university students.

4.1.1 Prevalence of anxiety in university students

Population comprised 6,480 students who were studying in schools of health sciences in University of Phayao, of whom 1,245 students were selected as the study sample. The results showed that the prevalence of anxiety in university students was 43.29 %, which means that nearly half of all students in the university were anxious. In particular, students in the field of health sciences had to study hard both about theory and practice, as well as the aspects of patients. In addition, the teachers and people in the society expected that the students would be the ones to help others in the future. This was consistent with the study by Bundasak conducted to examine the influencing factors on third- year nursing students' anxiety while practicing in intensive care unit in Boromarajonani College of Nursing Pha – Phutthabat, which found that 99% of the nursing students had a moderate level of anxiety, and 32% had a high level of anxiety. Female students were more anxious than male because in Thai society women could find less anxiety-free sources than men. The second-year students were the most anxious since it was a year required to study professional knowledge, which was difficult. Therefore, the anxiety among the students is an urgent issue that needs to be solved. A very high level of anxiety among nursing students was particularly in the period of work training or practicum. These students were anxious while performing practice due to unfamiliarity with the ward and fear of causing patient death, deficiency of caring knowledge, fear of meeting teachers, and unfamiliarity with the ward equipment [143].

4.1.2 The effects of binaural beat on anxiety and comparison of effects of binaural beat and music listening on anxiety in university students.

A study of the effects of SBB on anxiety in university students was conducted on a group of students studying in the Faculty of Medical Science, Phayao University, who had anxiety (Score of anxiety over 40 points). Of the 539 students, 352 met the inclusion criteria; 135 were randomly selected and then divided into three groups of SBB group (45 students), music listening group (45 minutes), and control group (45 students). In this

study, the median were statistically analyzed because the data of anxiety score from the samples were unevenly distributed, making it impossible to use mean statistical analysis. The level of anxiety decreased with statistical significance of .05. It was believed that SBB waves of 10 Hz could induce brain waves into alpha waves, which is a wave of relaxation. Consistent with the study by Lane which reported that binaural auditory beats could affect psychomotor activities and affective or mood.

The superimposed binaural beat by Thai Lanna music was suitable for university students because almost all of the samples lived in the north of Thailand, and were familiar and preferred to listen to Lanna Thai music. Therefore, the preference of listening to Thai Lanna music was not a limitation for this study. From the comparison of the anxiety reduction between SBB group and ML group as compared to control group, the results showed that the SBB group had significantly lower anxiety than ML group and control group at .05. For the anxiety curing rate, all of the participants receiving SBB had a lower level of anxiety (100%) while anxiety was reduced by 95.56% and 84.09%, respectively for ML and control group. The result showed that SBB could reduce anxiety better than ML and regular relaxation.

Many studies have shown that BB has been used to reduce anxiety, with both effective results in decreasing anxiety level[26-29] and ineffective results[30]. There has been no study to use BB with music having adjusted frequency of the sound in each instrument, 10 Hz difference between the left and the right spectrum with pure binaural beat tone 1 track before. In the present study, the effect of combining the additional novelty created with superimposed binaural beats (SBB) and the original binaural beat was believed to enhance the power of brainwave entrainment in subjects who listened continuously to this music. The results revealed that all participants of SBB group were cured, whereas other groups were not. The STAI-S scores reduced quite dramatically in SBB group (Median -20.00), which were statistically significantly different from those of the control group. In contrast, STAI-S scores of ML group were not statistically significant when comparing to those of control group. The explanation for ML's effect is that when music composition passes into the nervous system, neurotransmitter, and limbic system, it causes emotional changes[27] including the functioning of the parasympathetic nervous system such as slowing the heart rate, dilating blood vessel and lowering blood pressure[137]. Brain responses to binaural beat were dynamic processes due to the exposure duration, and

brainwave activity was entrained by binaural beat. SBB range of 10 Hz embedded in music could entrain the human brain wave to the same wave length of SBB, which is the same wave length of alpha[144]. Alpha wave length reflects the relaxation state. Like other non-phamacotherapy therapy methods, meditation is the practice of calming the mind and tuning down the number of random thoughts that pass through it. A regular meditation practice has been shown to reduce stress and anxiety, slow down the rate of brain aging and memory loss, promote emotional health, and lengthen attention span. Practicing meditation regularly can be quite difficult, so people have looked to technology for help. Binaural beats between 1 and 30 Hz are alleged to create the same brainwave pattern that one would experience during meditation. When people listen to a sound with a certain frequency, the brain waves will synchronize with that frequency. The theory is that binaural beats can help create the frequency needed for the brain to create the same waves commonly experienced during a meditation practice. The use of binaural beats in this way is sometimes called brainwave entrainment technology.

A previous study used original BB produced from the same machine to investigate the anxiolytic effects of BB among patients undergoing cataract operation. Patients were divided into three groups via block randomization, which were BB, ML, and a control group (blank audio). They received treatment during 20-minute operation. Their anxiety was assessed using STAI-S before and after operation. Patients in the ML group and BB group showed significant reduction of STAI-S scores compared with the control group. However, the difference was not significant between the ML and BB groups. The STAI-S score of ML group was -7.00 and that of BB group was - 9.00[28]. In contrast, in the present study, SBB showed higher different scores (-20.00). The effect of combining the additional novelty created with binaural beats (pitch shifting of the sound wave of each instrumental music track) and the original BB was believed to enhance the power of brainwave entrainment in the participants.

It is thus recommended that policy makers and potential interventions of reducing anxiety in university students use the methods that are appropriate for adolescent's context. The SBB may reduce the use of anxiety-relieving medication, the cost and the side effects of the medical treatment. It can also be performed on a large number of target groups in the situation of limited numbers of student affair officers like almost all universities in developing countries. It is worth exploring the possibility of using SBB in other groups of population.

In conclusion, this double-blinded RCT illustrated that the superimposed binaural beats could reduce anxiety in university students and its effects were better than those of ML and general relaxation methods. The findings of this study are useful for policy makers and potential interventions for reducing anxiety in university students.

4.2 Limitations of the study

Regarding the limitation, since this study was conducted to examine anxiety among specific students studying in the field of health sciences who had a high level of anxiety, it may not be appropriate to generalize to other populations. In addition, in this study, there was no restriction on the Lanna music preference of the sample group because the sample group comprised students of Phayao University that is located in the north of Thailand. Most students who were the study samples were living in the north, familiar and usually listening to Lanna Thai music. However, if this tool is to be used in other samples, the influence of preference factor of Thai Lanna songs in the sample in other regions should be taken into account. The kind of music is important for the level of anxiety. The advantages of this study were study design, large sample size and double-blinded method. It was RCT with time-dependent confounder control to provide the immediate intervention in the least amount of time that would be effective in reducing anxiety levels. Thus, these dependent confounders had no effect on the anxiety levels. The samples were recruited using simple random sampling technique, so that all of the samples had similar characteristics. Double-blinding was performed on the researcher and the participants to prevent the selection and the information biases. The major confounding variables were monitored every day in the study period so it was believed that the results of the experiments were based on the power of the SBB.

4.3 Suggestions

4.3.1 Suggestions for implementations

The findings of this study are useful for policy makers and potential intervention for reducing anxiety in university students using the appropriate methods for an adolescent context. The SBB may reduce the use of anxiety-relieving medication, the cost and the side effects of the medical treatment. It can also be done at a large number of

target groups in the situation with limited numbers of student affair officers like in most universities in developing countries. It is worth exploring the potential of using SBB in other groups of population.

4.3.2 Suggestions for the further study

The future research should: (a) be conducted across different university student population segments such as social science students or science and technology students to relieve anxiety or the other mental problems; (b) be carried out with a larger sample size to conduct an intervention and control condition in different settings for a greater apparent effectiveness of the intervention; (c) be conducted using SBB to treat other mental health problems such as anxiety, depression, aggression, or even learning disorder in adolescents and develop the intervention tools that are appropriate for other populations, such as older adults and older adults.

REFERENCES

1. Lepine JP. The epidemiology of anxiety disorders: prevalence and societal costs. The Journal of Clinical Psychiatry. 2002;63 Suppl 14:4-8.
2. University of Queensland. Globally, 1 in 13 suffers from anxiety 2012 [Available from: https://www.futurity.org/globally-1-in-13-suffers-from-anxiety/.
3. The National Institute of Mental Health (NIMH). Any Anxiety Disorder 2010 [cited 2015 Apirl 6]. Available from: https://www.nimh.nih.gov/health/statistics/any-anxiety-disorder.shtml.
4. Dahlin M, Joneborg N, Runeson B. Stress and depression among medical students: a cross-sectional study. Medical Education. 2005;39(6):594-604.
5. Sreeramareddy CT, Shankar PR, Binu VS, Mukhopadhyay C, Ray B, Menezes RG. Psychological morbidity, sources of stress and coping strategies among undergraduate medical students of Nepal. BMC medical education. 2007;7:26.
6. Grasgreen A. College counseling dircctors survey finds salary disparity students with anxiety other psychological problems2011.
7. Saipanish R. Stress among medical students in a Thai medical school. Medical Teacher. 2003;25(5):502-6.
8. Shamsuddin K. Correlate of depression, anxiety and stress among Malaysian university students. . Asian journal of Psychiatry. 2013;6(4):318-23.
9. Yusoff MS, Abdul Rahim AF, Baba AA, Ismail SB, Mat Pa MN, Esa AR. Prevalence and associated factors of stress, anxiety and depression among prospective medical students. Asian Journal of Psychiatry. 2013;6(2):128-33.
10. Association ACH. American College Health Association National College Health Assessment Spring 2006 Reference Group data report (abridged). Journal of American College Health : J of ACH. 2007;55(4):195-206.
11. Alzahem AM, van der Molen HT, Alaujan AH, Schmidt HG, Zamakhshary MH. Stress amongst dental students: a systematic review. European Journal of Dental Education. 2011;15(1):8-18..

12. Galbraith ND, Brown KE. Assessing intervention effectiveness for reducing stress in student nurses: quantitative systematic review. Journal of Advanced Nursing. 2011;67(4):709-21.
13. Vaez M, Ponce de Leon A, Laflamme L. Health-related determinants of perceived quality of life: a comparison between first-year university students and their working peers. Work (Reading, Mass). 2006;26(2):167-77.
14. Grasgreen A. Students rate mental health services.2012. Available from: http://www.insidehighered.com/news/2012/10/30/colleges-dontalways-help-mental-health-issues-student-surveyshows.
15. Sherina MS, Rampal L, Kaneson N. Psychological stress among undergraduate medical students. The Medical Journal of Malaysia. 2004;59(2):207-11
16. Sohail N. Stress and academic performance among medical students. Journal of the College of Physicians and Surgeons--Pakistan : JCPSP. 2013;23(1):67-71.
17. Department of Mental Health. Annual Report of Department of Mental Health Fiscal year 2009-2011. 2013.
18. Shamsuddin K, Fadzil F, Ismail WS, Shah SA, Omar K, Muhammad NA, et al. Correlates of depression, anxiety and stress among Malaysian university students. Asian Journal of Psychiatry. 2013;6(4):318-23.
19. Galambos R, Makeig S, Talmachoff PJ. A 40-Hz auditory potential recorded from the human scalp. Proceedings of the National Academy of Sciences of the United States of America. 1981;78(4):2643-7.
20. Engelien A, Schulz M, Ross B, Arolt V, Pantev C. A combined functional in vivo measure for primary and secondary auditory cortices. Hearing research. 2000;148(1-2):153-60.
21. John MS, Lins OG, Boucher BL, Picton TW. Multiple auditory steady-state responses (MASTER): stimulus and recording parameters. Audiology : official organ of the International Society of Audiology. 1998;37(2):59-82.
22. Lins OG, Picton TW. Auditory steady-state responses to multiple simultaneous stimuli. Electroencephalography and Clinical Neurophysiology. 1995;96(5):420-32.

23. Rutschmann J, Rubinstein L. Binaural beats and binaural amplitude-modulated tones: successive comparison of loudness fluctuations. The Journal of the Acoustical Society of America. 1965;38(5):759-68.
24. Tobias JV. Application of a "Relative" Procedure to a Problem in Binaural Beat Perception. REP 63-17. [Report] Civil Aeromedical Research Institute (US). 1963:1-8.
25. McConnell PA, Froeliger B, Garland EL, Ives JC, Sforzo GA. Auditory driving of the autonomic nervous system: Listening to theta-frequency binaural beats post-exercise increases parasympathetic activation and sympathetic withdrawal. Frontiers in psychology. 2014;5:1248.
26. Padmanabhan R, Hildreth AJ, Laws D. A prospective, randomised, controlled study examining binaural beat audio and pre-operative anxiety in patients undergoing general anaesthesia for day case surgery. Anaesthesia. 2005;60(9):874-7.
27. Weiland TJ, Jelinek GA, Macarow KE, Samartzis P, Brown DM, Grierson EM, et al. Original sound compositions reduce anxiety in emergency department patients: a randomised controlled trial. The Medical Journal of Australia. 2011;195(11-12):694-8.
28. Wiwatwongwana D, Vichitvejpaisal P, Thaikruea L, Klaphajone J, Tantong A, Wiwatwongwana A. The effect of music with and without binaural beat audio on operative anxiety in patients undergoing cataract surgery: a randomized controlled trial. Eye (London, England). 2016;30(11):1407-14.
29. Isik BK, Esen A, Buyukerkmen B, Kilinc A, Menziletoglu D. Effectiveness of binaural beats in reducing preoperative dental anxiety. The British journal of Oral & Maxillofacial Surgery. 2017;55(6):571-4.
30. Le Scouarnec RP, Poirier RM, Owens JE, Gauthier J, Taylor AG, Foresman PA. Use of binaural beat tapes for treatment of anxiety: a pilot study of tape preference and outcomes. Alternative Therapies in Health and Medicine. 2001;7(1):58-63.
31. Foster DS. EEG and subjective correlates of alpha frequency binaural beats stimulation combined with alpha biofeedback 1990.

32. The National Institute of Mental Health (NIMH). Any Anxiety Disorder Among Adults 2015 2017 [Available from: https://www.nimh.nih.gov/health/statistics/any-anxiety-disorder.shtml.
33. Kittirattanapaiboon P, Kongsuk T, Pengjuntr W, Leejongermpoon J, Chutha W, Kenbubpha K. Epidemiology of psychiatric comorbidity in Thailand: a national study 2008. Journal of Mental Health of Thailand. 2013;21(1):1-14.
34. Horwitz EK, Horwitz MB, Cope J. Foreign Language Classroom Anxiety. The Modern Language Journal. 1986;70(2):125-32.
35. Spielberger CD, Gorsuch RL, Lushene RE. Manual for the State-Trait Anxiety Inventory (Form X) (self-evaluation questionnaire). 1970.
36. Beck AT. Cognitive therapy and the emotional disorders. Oxford, England: International Universities Press; 1976. 356- p.
37. Beck AT, Epstein N, Brown G, Steer RA. An inventory for measuring clinical anxiety: psychometric properties. Journal of Consulting and Cinical Psychology. 1988;56(6):893-7.
38. Stress, depression and Alzheimer's disease: The triangle of obilion? [Internet]. Neurology Department, AHEPA Hospital. 2011 [cited 17 Apr 2018].
39. American Psychiatric Association. Diagnostic and statistical manual of mental disorders, 4th ed. Arlington, VA, US: American Psychiatric Publishing, Inc.; 1994. xxvii, 886-xxvii, p.
40. Speilberger C. Manual for the state-trait anxiety inventory (STAI-Form Y).1983.
41. MacIntyre PD. Language anxiety: A review of the research for language teachers. Affect in foreign language and second language learning: A practical guide to creating a low-anxiety classroom atmosphere. 1999;24:41.
42. Spielberger CD. Anxiety and behavior: Academic Press; 2013.
43. Leyden-Robinson L. The Stress Management Handbook: Strategies for Health and Inner Peace. Nuw Canaan. Keats Publishing. Inc; 1998.
44. Anderson RJ, Grigsby AB, Freedland KE, de Groot M, McGill JB, Clouse RE, et al. Anxiety and poor glycemic control: a meta-analytic review of the literature. International Journal of Psychiatry in Medicine. 2002;32(3):235-47.

45. Mantella RC, Butters MA, Amico JA, Mazumdar S, Rollman BL, Begley AE, et al. Salivary cortisol is associated with diagnosis and severity of late-life generalized anxiety disorder. Psychoneuroendocrinology. 2008;33(6):773-81.
46. Buchanan TW, al'Absi M, Lovallo WR. Cortisol fluctuates with increases and decreases in negative affect. Psychoneuroendocrinology. 1999;24(2):227-41.
47. Tennant C. Life events, stress and depression: a review of recent findings. The Australian and New Zealand Journal of Psychiatry. 2002;36(2):173-82.
48. Furr SR, Westefeld JS, McConnell GN, Jenkins JM. Suicide and depression among college students: A decade later. Professional Psychology: Research and Practice. 2001;32(1):97-100.
49. Arnett JJ. Conceptions of the transition to adulthood: Perspectives from adolescence through midlife. Journal of Adult Development. 2001;8(2):133-43.
50. Arnett JJ. Emerging adulthood: The winding road from the late teens through the twenties.2004.
51. Arnett JJ. Emerging adulthood: What is it, and what is it good for? Child Development Perspectives. 2007;1(2):68-73.
52. American College Health Association. merican College Health Association-National College Health Assessment: Reference Group Executive Summary Spring 2000. 2000.
53. Association ACH. American College Health Association-National College Health Assessment Spring 2008 Reference Group Data Report (abridged): the American College Health Association. Journal of American College Health : J of ACH. 2009;57(5):477-88.
54. Yan LL, Liu K, Matthews KA, Daviglus ML, Ferguson TF, Kiefe CI. Psychosocial factors and risk of hypertension: the Coronary Artery Risk Development in Young Adults (CARDIA) study. Jama. 2003;290(16):2138-48.
55. Emilien G, Durlach C, Lepola U, Dinan T. Anxiety disorders: Pathophysiology and pharmacological treatment: Springer Science & Business Media; 2002.
56. DuPont RL, Rice DP, Miller LS, Shiraki SS, Rowland CR, Harwood HJ. Economic costs of anxiety disorders. Anxiety. 1996;2(4):167-72.

57. Pirat Wongsritrakul. Educational Factors Affecting Stress and Anxiety of Students in Thonburi University. The report of the academic conference and Research, Sukhothai Thammathirat Open University 2011. 2012:124-35.
58. Kitipong Kattiya. A Study on Stress of Freashmen at Maejo University, Academic Year 2000. 2000.
59. Wittaya Pangauta. Anxiety and adaptation in the study of Mahasarakham University students. Journal of Education Mahasarakham University. 2014.
60. NongNut Tamkariwut. Stress Management Methods of King Mongkut's University of Technology North Bangkok. Journal of Industrial Technology. 2007;3(2).
61. Kohatsu W. Complementary and alternative medicine secrets: Hanley & Belfus; 2002.
62. Twenge JM. Generation Me: Why today's young Americans are more confident, assertive, entitled--and more miserable than ever before. New York, NY, US: Free Press; 2006. vii, 292-vii, p.
63. Griez EJ, Faravelli C, Nutt D, Zohar J. Anxiety disorders: an introduction to clinical management and research: Wiley; 2001.
64. KW H. Qualitative research in evidence-based rehabilitation. 2004.
65. Shapiro SL, Carlson LE, Astin JA, Freedman B. Mechanisms of mindfulness. Journal of Clinical Psychology. 2006;62(3):373-86.
66. Gullotta TP, Bloom M. Encyclopedia of primary prevention and health promotion: Springer Science & Business Media; 2003.
67. Beck AT, Steer RA. Manual for the Beck anxiety inventory. San Antonio, TX: Psychological Corporation. 1990.
68. Lam RW, Michalak EE, Swinson RP. Assessment scales in depression, mania and anxiety: Taylor & Francis London; 2005.
69. Wolitzky-Taylor K, Guillot CR, Pang RD, Kirkpatrick MG, Zvolensky MJ, Buckner JD, et al. Examination of Anxiety Sensitivity and Distress Tolerance as Transdiagnostic Mechanisms Linking Multiple Anxiety Pathologies to Alcohol Use Problems in Adolescents. Alcoholism, clinical and experimental research. 2015;39(3):532-9.

70. Manoth Lhotrakul. Diagnosis and treatment of anxiety patients. 2015. Available from: http://www.ramamental.com/generaldoctor/analys_cure_paranoid/.
71. Benton SA, Robertson JM, Tseng W-C, Newton FB, Benton SL. Changes in counseling center client problems across 13 years. Professional Psychology: Research and Practice. 2003;34(1):66-72.
72. Harmat L, Takacs J, Bodizs R. Music improves sleep quality in students. Journal of Advanced Nursing. 2008;62(3):327-35.
73. Psychology Foundation of Australia. Depression Anxiety Stress Scales(DASS). 2018. Available from: http://www2.psy.unsw.edu.au/dass/.
74. American Psychological Association. Understanding psychotherapy and how it works. 2016.
75. Leichsenring F, Biskup J, Kreische R, Staats H. The Guttingen study of psychoanalytic therapy: First results. The International Journal of Psychoanalysis. 2005;86:433–55.
76. American Psychological Association. Different approaches to psychotherapy20 January 2018. Available from: https://www.apa.org/topics/therapy/psychotherapy-approaches.
77. Centre for Addiction and Mental Health. Anti-Anxiety Medications (Benzodiazepines) 2012 [cited 2017 27 July]. Available from: https://www.camh.ca/en/health-info/mental-illness-and-addiction-index/anti-anxiety-medications-benzodiazepines.
78. Haworth CM, Wright MJ, Luciano M, Martin NG, de Geus EJ, van Beijsterveldt CE, et al. The heritability of general cognitive ability increases linearly from childhood to young adulthood. Molecular Psychiatry. 2010;15(11):1112-20.
79. Anderson SD. Exercise-induced bronchoconstriction. . Immunology and allergy clinics of North America. 2013;33(3):xv-xvii.
80. Stuhlmiller C, Tolchard B. Computer-assisted CBT for depression & anxiety: increasing accessibility to evidence-based mental health treatment. Journal of Psychosocial Nursing and Mental Health Services. 2009;47(7):32-9.

81. Olatunji BO, Cisler JM, Deacon BJ. Efficacy of cognitive behavioral therapy for anxiety disorders: a review of meta-analytic findings. The Psychiatric clinics of North America. 2010;33(3):557-77.
82. Hoffman AJ, Brintnall RA, von Eye A, Jones LW, Alderink G, Patzelt LH, et al. Home-based exercise: promising rehabilitation for symptom relief, improved functional status and quality of life for post-surgical lung cancer patients. Journal of Thoracic Disease. 2014;6(6):632-40.
83. James C, Stams GJ, Asscher JJ, De Roo AK, der Laan PH. Aftercare programs for reducing recidivism among juvenile and young adult offenders: a meta-analytic review. Clinical Psychology Review. 2013;33(2):263-74.
84. Cowan DS. Music therapy in the surgical arena. Music Therapy Perspectives. 1991;9(1):42-5.
85. American Music Therapy Association. History of Music Therapy.2018 18 March 2018.
86. Das S, Mukherjee A. Stress management with Music Therapy. International Journal of Emerging Trends & Technology in Computer Science. 2014;3.
87. Spencer J. A Historical Review of Music Therapy and the Department of Veterans Affairs. [Theses & Dissertations]. Rockville Centre, NY Molloy College; 2013.
88. Bussakorn Samrongthong, Warunee Chimyawong, Winai Kaewmunee, Panthipa Pongkasor. The music therapy. Nonthaburi: Department of Thai Traditiional and Alternative Medicine; 2008.
89. Marwick C. Music therapists chime in with data on medical results. Jama. 2000;283(6):731-3.
90. Cook JD. The therapeutic use of music: a literature review. Nursing forum. 1981;20(3):252-66.
91. Pichai PratYanusorn. Music therapy for psychiatry. Journal of Psychology Clinic. 1991;22.
92. Duangdaow Dulyyatham. Effects of music therapy on pain reduction in patients with femur fixation. Songkla: Prince of Songkla University; 2001.
93. Bungorn Kriadchasiyaphum. Effects of usiv on Anxiety Level in the Intraoperative Patients. Bangkok: Mahidol University; 1990.

94. Gardiner MF. Music, learning, and behavior: A case for mental stretching. Journal for Learning Through Music. 2000;1(1).
95. Dean J, Gross IL. Teaching basic skills through art and music. Phi Delta Kappan. 1992;73(8):613.
96. Chomnapa Kittisup. The Effect of Music on Pain Relief and Anxiety in Open Heart Surgery Patients. Bangkok: Mahidol University; 1994.
97. U-sa Suttisakorn. Music Development (IQ) Emotional Intelligence (EQ). Bangkok: Lan Publishing co., LTD.; 2011.
98. Somthawin Sanitchon. Alternative : The effect of Thai Northeastern Traditional Music on pain and anxiety in patients with open reduction and internal fixation. Khon Kaen Khon Kaen University; 2002.
99. Nit Bungamongkon. Basic psychology. Khon Kaen: Khon Kaen University; 1997.
100. Zahourek RP. Utilizing Ericksonian Hypnosis in Psychiatric-Mental Health Nursing Practice. Perspectives in Psychiatric Care. 2002;38:15-22.
101. Chlan L. Complementary/alternative therapies in nursing. 3, editor. New York: Springer.; 1998.
102. Hick F. The power of music. Nursing Time. 1992;88:72-4.
103. Winkelman M. Complementary therapy for addiction:“drumming out drugs”. American Journal of Public Health. 2003;93(4):647-51.
104. Olson SL. Bedside musical care: Application in pregnancy, childbirth, and neonatal care. JOGNN. 1998;27:569-75.
105. Todd T., . Endorphins and Analgesia.2007 2014 29 May. Available from: http://www.bangkok health.com/consult_htdoc/question.asp?gID=15221.
106. Sasithorn Pumduang. The Music Therapy. Songklanagarind Medical Journal 2005;23(3):185-91.
107. Guzzetta CE. Music therapy: Hearing the melody of the soul. Holistic nursing. 1995:670-98.
108. Gardner H. Frames of mind: The theory of multiple intelligences. . New York: Basic Books; 1983.

109. Muftuler LT, Hamamura M, Birgul O, Nalcioglu O. Resolution and contrast in magnetic resonance electrical impedance tomography (MREIT) and its application to cancer imaging. . Technology in Cancer Research and Treatment. 2004;3:599–609.
110. Fuster JM. Prefrontal neurons in networks of executive memory. Brain Research Bulletin. 2000;52:331-6.
111. Schmidt LA, Trainor LJ, Santesso DL. Development of frontal electroencephalogram (EEG) and heart rate (ECG) responses to affective musical stimuli during the first 12 months of post-natal life. Brain and Cognition Journal. 2003;52:27–32.
112. Yahaya A. The Role of Music and Young Children: The Brain Development.: University Technology Malaysia Institutional Repository; 2008.
113. Elbert T, Pantev C, Wienbruch C, Rockstroh B, Taub E. Increased Cortical Representation of the Fingers of the Left Hand in String Players. Science. 1995;270:305-7.
114. Draganski B, Gaser C, Busch V, Schuierer G. Neuroplasticity: Changes in grey matter induced by training. Nature. 2004;427:311-2.
115. Cockerton, Tracey, Moore, Simon, Norman, Dale. Cognitive test performance and background music. Perceptual & Motor Skills. 1997;85:1435-8.
116. Boltz M, Kantra S, Schulkind M. Effects of background music on the remembering of filmed events. Memory and Cognition. 1991;19:593-606.
117. Davidson CW, Powell LA. The effects of easy-listening background music on the on-task-performance of fifth-grade children. . Journal of Educational Research. 1986;80.
118. Lesiuk T. The effect of music listening on work performance. Psychology of Music. 2005;33:173-91.
119. Thompson WF, Schellenberg EG, Husain G. Arousal, mood, and the Mozart effect. Psychological Science. 2001;12:248–51.
120. Krout RE. Music listening to facilitate relaxation and promote wellness: Integrated aspects of our neurophysiological responses to music. The Arts in Psychotherapy 2007;34 134–41.

121. Bolwerk CA. Effects of relaxing music on state anxiety in myocardial infarction patients. Crit Care Nurs Q. 1990;13:63–72.
122. Chlan LL, Weinert CR, Heiderscheit A, Tracy MF, Debra J. Skaar P, Guttormson JL. Effects of patient-directed music intervention on anxiety and sedative exposure in critically ill patients receiving mechanical ventilatory support: A randomized clinical trial. Jama. 2013;309(22):2335-44.
123. A-tinuth Malakul N Ayutthaya. Anxiety and depression in dental students, Chulalongkorn University. Bangkok: Chulalongkorn University; 2003.
124. Lane JD, Kasian SJ, Owens JE, Marsh GR. Binaural Auditory Beats Affect Vigilance Performance and Mood. Center for Neuroacoustic Research. 1997.
125. Wahbeh H, Calabrese C, Zwickey H. Binaural beat technology in humans: a pilot study to assess psychologic and physiologic effects. Journal of alternative and complementary medicine (New York, NY). 2007;13(1):25-32.
126. Lane JD, Kasian SJ, Owens JE, Marsh GR. Binaural auditory beats affect vigilance performance and mood. Physiology & Behavior. 1998;63(2):249-52.
127. Dictionary of behavioral science, 2nd ed. Wolman BB, editor. San Diego, CA, US: Academic Press; 1989. xi, 370-xi, p.
128. Oster G. Auditory beats in the brain. Scientific American. 1973;229:94–102.
129. Swann R, Bosanko S, Cohen R, Midgley R, Seed KM. 92 in The brain—A user's manual. . New York: G. P. Putnam's Sons; 1982.
130. Smith JC, Marsh JT, Brown WS. Far-field recorded frequency-following responses: Evidence for the locus of brainstem sources. Electroencephalography and Clinical Neurophysiology. 1975;39:465–72.
131. Benton SA, Robertson JM, Tseng W-C, Newton FB, Benton SL. Changes in counseling center client problems across 13 years. Professional psychology: Research and Practice. 2003;34(1):66.
132. Ahmed I, Banu H, Al-Fageer R, Al-Suwaidi R. Cognitive emotions: depression and anxiety in medical students and staff. Journal of Critical Care. 2009;24(3):e1-7.
133. Eisenberg D, Hunt J, Speer N. Mental health in American colleges and universities: variation across student subgroups and across campuses. The Journal of Nervous and Mental Disease. 2013;201(1):60-7.

134. Mancevska S, Bozinovska L, Tecce J, Pluncevik-Gligoroska J, Sivevska-Smilevska E. Depression, anxiety and substance use in medical students in the Republic of Macedonia. Bratislavske lekarske listy. 2008;109(12):568-72.
135. Abdulghani HM, AlKanhal AA, Mahmoud ES, Ponnamperuma GG, Alfaris EA. Stress and Its Effects on Medical Students: A Cross-sectional Study at a College of Medicine in Saudi Arabia. Journal of Health, Population, and Nutrition. 2011;29(5):516-22.
136. Baldassin S, Alves TC, de Andrade AG, Nogueira Martins LA. The characteristics of depressive symptoms in medical students during medical education and training: a cross-sectional study. BMC medical education. 2008;8:60.
137. Wahbeh H, Calabrese C, Zwickey H, Zajdel D. Binaural beat technology in humans: a pilot study to assess neuropsychologic, physiologic, and electroencephalographic effects. Journal of Alternative and Complementary Medicine (New York, NY). 2007;13(2):199-206.
138. Kennedy BL, Schwab JJ, Morris RL, Beldia G. Assessment of state and trait anxiety in subjects with anxiety and depressive disorders. Psychiatric Quarterly. 2001;72:263-76.
139. Ngamjarus C. n4Studies: sample size calculation for an epidemiological study on a smart device. Siriraj Medical Journal. 2016;68(3):160-70.
140. Daniel WW. Biostatistics: A foundation for analysis in the health sciences, Sixth edition 1995. 780 p.
141. Spielberger CD, Gorsuch RL, Lushene RE. Manual for the State-Trait Anxiety Inventory (Form X) (self-evaluation questionnaire). 1970.
142. Darawan Tapinata. Reducing anxiety of staff nurses who care for AIDS patients as well: How to change thinking together with mindfulness training. Bangkok: Chulalongkorn University; 1991.
143. Thanapol Bandasak. Factors affecting anxiety of nursing students during intensive care unit practice. . Journal of the Clinical Medicine Center Phrapokklao Hospital 2017;34(1).
144. Kasprzak C. Influence of binaural beats on EEG signal. Acta physica polonica A. 2011;119(6):986-90.

LIST OF PUBLICATIONS

1. Chairinkam, W., Thaikruea, L., Klaphajone, J., Lerdtrakernnont, P. Effects of New Superimposed Binaural Beat on Anxiety in University Students in Thailand: A Randomize Controlled Trial. CMU Journal of Natural Science. Volume18 Number1 January-March, 2019

APPENDICES

APPENDIX A

คู่มือการศึกษาวิจัยผลของไบนูรัลบีทต่อความวิตกกังวล

สำหรับผู้ช่วยวิจัย

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ขั้นตอนการดำเนินการวิจัย

1. ชี้แจงทำความเข้าใจจุดประสงค์ของการศึกษาวิจัย ประโยชน์ของการศึกษา สิทธิประโยชน์ของกลุ่มตัวอย่างที่ได้รับ รวมถึงสิทธิและการคุ้มครองกลุ่มตัวอย่างหากไม่ประสงค์จะเข้าร่วมการศึกษา และขั้นตอนการดำเนินการเก็บข้อมูลแก่นักศึกษากลุ่มด้านวิทยาศาสตร์สุขภาพ เพื่อขอความยินยอมการเข้าร่วมวิจัย

2. แบ่งกลุ่มเพื่อทำการศึกษาระดับของความวิตกกังวลโดยใช้ The State Trait Anxiety Inventory [STAI] ทีละกลุ่ม ได้แก่

ครั้งที่ 1 กลุ่มคณะแพทยศาสตร์กลุ่มที่1 จำนวน 283 คน

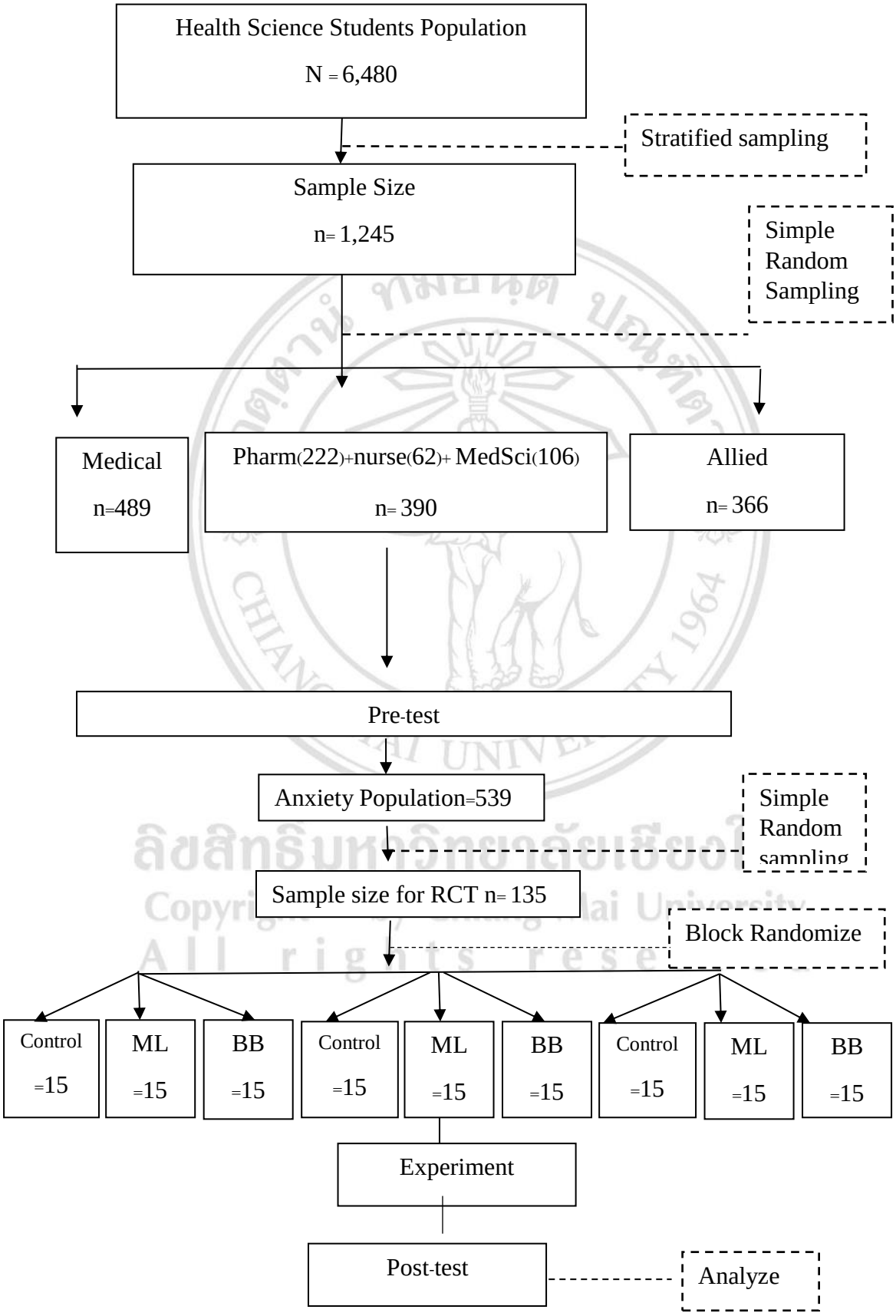
ครั้งที่ 2 กลุ่มคณะแพทยศาสตร์กลุ่มที่2 จำนวน 283 คน

ครั้งที่ 3 กลุ่มคณะเภสัชศาสตร์ คณะพยาบาลศาสตร์ คณะวิทยาศาสตร์การแพทย์ และคณะสหเวชศาสตร์ จำนวนรวม 244 คน

3. นัดหมายนักศึกษาที่มีคะแนนความวิตกกังวลอยู่ในระดับสูง จำนวน135คน แบ่งเป็น3กลุ่ม ได้แก่ กลุ่มไบนูลรัลบีท กลุ่มดนตรีบำบัด และกลุ่มควบคุม กลุ่มละ 45 คน เข้ารับโปรแกรมเป็นระยะเวลา 5 วัน วันละ 20 นาที

4. วัดระดับของความวิตกกังวลโดยใช้ The State Trait Anxiety Inventory [STAI form Y]

แผนภาพขั้นตอนการดำเนินการวิจัย



รูปแบบโปรแกรม

1. โปรแกรมที่ 1 กลุ่มไบนูรัล บีท

จะได้รับการบำบัดด้วยการผ่อนคลายและดนตรีบำบัดที่มีการสอดแทรกคลื่นเสียงที่เป็น binaural beat โดย จะได้รับเครื่องมือหรืออุปกรณ์ดังนี้

1.1 เครื่องเล่นMP 3 ที่มีเพลงไทยล้านนาที่มีการบิดความถี่ของคลื่นเสียงของเครื่องดนตรีแต่ละชิ้น ได้แก่ ขลุ่ย สะล้อ ซึง และอีเลคโทน ให้มีคลื่นความถี่ซ้าย และคลื่นความถี่ขวา ต่างกัน 10 Hz และเสริมด้วย pure binaural beat tone 10 Hz อีก1 track จัดทำโดย จักรกริช กล้าผจญ ซึ่งได้รับรองลิขสิทธิ์จากสำนักลิขสิทธิ์เมื่อวันที่ 29 เมษายน พศ.2558 เล่นเสียงโดยเครื่องเล่น MP3 และใช้หูฟังสเตอริโอชนิดครอบศีรษะ ไบนูรัลบีท ที่ใช้สอดแทรกในเพลงล้านนา ได้รับการพิสูจน์และทดสอบแล้วว่า เพลงดังกล่าวสามารถลดความวิตกกังวลได้ ระยะเวลาที่ใช้ในการเล่นเพลงประมาณ 20 นาที กลุ่มตัวอย่างและผู้ดำเนินการวิจัยจะไม่ทราบชื่อเพลงและชนิดของเสียงที่ได้รับฟัง

1.2 หูฟังสเตอริโอ ชนิดครอบศีรษะ

1.3 เก้าอี้ผ่อนคลาย

1.4 ห้องที่มีความเงียบสงบ ไม่มีเสียงรบกวน มีการปรับอุณหภูมิที่เย็นเหมาะสมจากเครื่องปรับอากาศ

2. โปรแกรมที่ 2 กลุ่มดนตรีบำบัด

จะได้รับการบำบัดด้วยการผ่อนคลายและดนตรีบำบัดโดยจะได้รับอุปกรณ์ดังนี้

2.1 เครื่องเล่น MP 3 บรรจุเพลงบรรเลงไทยล้านนาโดยไม่มีการบิดคลื่นความถี่ให้เปลี่ยนแปลงไปจากเดิม ใช้ระยะเวลา 20 นาที โดยเพลงบรรเลงดังกล่าวได้รับการทดสอบแล้วว่าสามารถลดความวิตกกังวลได้ ผู้ช่วยวิจัยและกลุ่มตัวอย่างจะไม่ทราบชื่อเพลงและชนิดของเสียงที่ได้รับ

2.2 หูฟังสเตอริโอ ชนิดครอบศีรษะ

2.3 เก้าอี้ผ่อนคลาย

2.4 ห้องที่เงียบสงบ ไม่มีเสียงรบกวน มีการปรับอุณภูมิที่เหมาะสมจากเครื่องปรับอากาศ

3. โปรแกรมที่ 3 กลุ่มควบคุม

จะได้รับการบำบัดการผ่อนคลาย และจะได้รับอุปกรณ์ดังนี้

3.1 เก้าอี้ผ่อนคลาย

3.2 ห้องที่เงียบสงบ ไม่มีเสียงรบกวน อุณหภูมิเหมาะสมจากเครื่องปรับอากาศ

3.3 หูฟังสเตอริโอชนิดครอบศีรษะ

3.4 เครื่องเล่นMP 3ที่มีไฟล์เสียงเปล่าแต่ไม่มีเสียงดนตรีใดๆ

แบบสอบถาม

คำชี้แจง

1. แบบสอบถามนี้เป็นแบบสอบถามความวิตกกังวลของท่าน เป็นการศึกษาเพื่อศึกษาผลของการใช้ binaural beat ในการลดภาวะวิตกกังวล เพื่อประโยชน์แก่นักศึกษาในอนาคตต่อไป
2. การศึกษาจะไม่ระบุชื่อ หรือข้อมูลส่วนตัวของท่านที่เป็นจำเพาะเจาะจงเกี่ยวกับตัวท่าน แต่จะเป็นการรวบรวมข้อมูลในภาพกว้าง เพื่อประกอบการวิเคราะห์เท่านั้น

ข้อมูลทั่วไป

1. เพศ
   ☐ ชาย ☐ หญิง
2. คณะวิชา
   ☐ แพทยศาสตร์ ☐ เภสัชศาสตร์ ☐ พยาบาลศาสตร์
   ☐ สหเวชศาสตร์ ☐ วิทยาศาสตร์การแพทย์
3. ชั้นปีที่
   ☐ ปี 1 ☐ ปี 2 ☐ ปี 3 ☐ ปี 4
   ☐ ปี 5 ☐ ปี 6 ☐ สูงกว่าปี 6

จงทำเครื่องหมาย ✓ในช่องที่ตรงกับความรู้สึกของท่านมากที่สุด

คำถาม	ใช่	ไม่ใช่	สำหรับผู้วิจัย
1. ใน 2 สัปดาห์ที่ผ่านมา รวมวันนี้ ท่านรู้สึก หดหู่ เศร้า หรือท้อแท้สิ้นหวัง หรือไม่			
2. ใน 2 สัปดาห์ที่ผ่านมา รวมวันนี้ท่านรู้สึก เบื่อ ทำอะไรก็ไม่เพลิดเพลิน หรือไม่			

แบบสอบถามภาวะวิตกกังวล STAI

คำชี้แจง แบบสอบถามนี้เป็นแบบสอบถามความวิตกกังวล มีทั้งหมด 2 ตอนๆละ 20 ข้อ รวมเป็น 40 ข้อ ขอให้ท่านตอบแบบสอบถามตามความรู้สึกที่แท้จริงของท่าน และโปรดตอบแบบสอบถามในทุกข้อ

ตอนที่ 1 (ข้อ 1-20)

คำแนะนำในการตอบคำถามข้อ1-20 ในข้อความด้านล่างต่อไปนี้เป็นข้อความที่ท่านจะบรรยายเกี่ยวกับตัวท่านเอง โปรดอ่านข้อความในแต่ละข้อและทำเครื่องหมาย✓ในช่องซึ่งอยู่ทางด้านขวาของข้อความ ซึ่งท่านพิจารณาว่าตรงกับความรู้สึกของท่านมากที่สุดใน*ขณะนี้*ข้อความต่อไปนี้ไม่มีคำตอบถูกหรือผิด ดังนั้นโปรดอย่าใช้เวลาในการพิจารณาคำตอบข้อใดข้อหนึ่งนานเกินควร แต่โปรดเลือกคำตอบที่ท่านคิดว่าบรรยายความรู้สึกของท่านในขณะนี้ได้ชัดเจนที่สุด เพราะคำตอบที่ได้จากท่านจะนำมาใช้ประโยชน์ต่อตัวท่านและวงการศึกษาต่อไป

ข้อ	รายการ	ระดับความรู้สึก				สำหรับผู้วิจัย
		ไม่เลย	มีบ้าง	ค่อนข้างมาก	มากที่สุด	
1	ข้าพเจ้ารู้สึกสงบ					
2	ข้าพเจ้ารู้สึกมั่นคง-ปลอดภัย					
3	ข้าพเจ้าเป็นคนเครียด					
4	ข้าพเจ้ารู้สึกเกร็งและเครียด					
5	ข้าพเจ้ารู้สึกสบายๆ					
6	ข้าพเจ้ารู้สึกอารมณ์เสีย					
7	ข้าพเจ้ารู้สึกวิตกกังวลกับสิ่งร้ายที่อาจเกิดขึ้น					
8	ข้าพเจ้ารู้สึกพึงพอใจ					
9	ข้าพเจ้ารู้สึกตื่นกลัว					
10	ข้าพเจ้ารู้สึกสะดวกสบาย					
11	ข้าพเจ้ารู้สึกมั่นใจในตนเอง					
12	ข้าพเจ้ารู้สึกตื่นเต้น					
13	ข้าพเจ้ารู้สึกกระสับกระส่าย					
14	ข้าพเจ้ารู้สึกลังเลใจ					
15	ข้าพเจ้ารู้สึกผ่อนคลาย					

ข้อ	รายการ	ระดับความรู้สึก				สำหรับผู้วิจัย
		ไม่เลย	มีบ้าง	ค่อนข้างมาก	มากที่สุด	
16	ข้าพเจ้ารู้สึกพอใจและมีความสุข					
17	ข้าพเจ้าวิตกกังวล					
18	ข้าพเจ้ารู้สึกสับสน					
19	ข้าพเจ้ารู้สึกมั่นคง					
20	ข้าพเจ้ารู้สึกว่าตนเองเป็นคนน่าคบ					

ตอนที่ 2 (ข้อ 21-40)

คำแนะนำในการตอบคำถามข้อ 21-40 ในข้อความด้านล่างต่อไปนี้เป็นข้อความที่ท่านจะบรรยายเกี่ยวกับตัวท่านเอง โปรดอ่านข้อความในแต่ละข้อและทำเครื่องหมาย ✓ในช่องซึ่งอยู่ทางด้านขวาของข้อความในแต่ละข้อ ซึ่งท่านพิจารณาแล้วว่าต*รงกับความรู้สึกทั่วๆไป* ของท่านมากที่สุด ข้อความต่อไปนี้ไม่มีคำตอบถูกหรือผิด ดังนั้นโปรดอย่าใช้เวลาในการพิจารณาคำตอบข้อใดข้อหนึ่งนานเกินควร แต่โปรดเลือกคำตอบที่ท่านคิดว่าตรงกับความรู้สึกของท่านมากที่สุด

ข้อ	รายการ	ระดับความรู้สึก				สำหรับผู้วิจัย
		ไม่เลย	มีบ้าง	ค่อนข้างมาก	มากที่สุด	
21	ข้าพเจ้ารู้สึกเป็นคนน่าคบ					
22	ข้าพเจ้ารู้สึกตื่นเต้นและกระวนกระวาย					
23	ข้าพเจ้ารู้สึกมีความพอใจในตนเอง					
24	ข้าพเจ้าอยากเป็นสุขเท่ากับที่คนอื่นๆเป็นอยู่					
25	ข้าพเจ้ารู้สึกเหมือนเป็นคนล้มเหลว					
26	ข้าพเจ้ารู้สึกปลอดโปร่ง					
27	ข้าพเจ้าสงบ-ใจเย็น-มีสติ					

ข้อ	รายการ	ระดับความรู้สึก				สำหรับผู้วิจัย
		ไม่เลย	มีบ้าง	ค่อนข้างมาก	มากที่สุด	
28	ข้าพเจ้ารู้สึกว่าปัญหามากขึ้นทุกทีจนสู้ไม่ไหว					
29	ข้าพเจ้ากังวลมากเกินไปในสิ่งที่จริงๆแล้วไร้สาระ					
30	ข้าพเจ้ารู้สึกเป็นสุข					
31	ข้าพเจ้ามีความคิดที่ทำให้ตนเองไม่สบายใจ					
32	ข้าพเจ้าขาดความมั่นใจในตนเอง					
33	ข้าพเจ้ารู้สึกมั่นคงปลอดภัย					
34	ข้าพเจ้าเป็นคนตัดสินใจได้ง่ายดาย					
35	ข้าพเจ้ารู้สึกมีความสามารถไม่เพียงพอ					
36	ข้าพเจ้าพึงพอใจและมีความสุข					
37	ข้าพเจ้ามีความรู้สึกวิตกกังวลในการที่ข้าพเจ้ามีความคิดที่ไร้สาระ					
38	ข้าพเจ้ายอมรับความผิดหวังได้อย่างจริงจัง					
39	ข้าพเจ้าเป็นคนมั่นคง					
40	เมื่อข้าพเจ้าคิดถึงสิ่งที่เกี่ยวข้องหรือสนในในระยะหลังๆนี้ ทำให้ข้าพเจ้าอยู่ในภาวะความตึงเครียดและสับสน					

STAI Scoring Key

Form Y-1	ไม่เลย	มีบ้าง	ค่อนข้างมาก	มากที่สุด	Form Y-2	ไม่เลย	มีบ้าง	ค่อนข้างมาก	มากที่สุด
1	*4*	*3*	*2*	*1*	**21**	*4*	*3*	*2*	*1*
2	*4*	*3*	*2*	*1*	**22**	*1*	*2*	*3*	*4*
3	*1*	*2*	*3*	*4*	**23**	*4*	*3*	*2*	*1*
4	*1*	*2*	*3*	*4*	**24**	*1*	*2*	*3*	*4*
5	*4*	*3*	*2*	*1*	**25**	*1*	*2*	*3*	*4*
6	*1*	*2*	*3*	*4*	**26**	*4*	*3*	*2*	*1*
7	*1*	*2*	*3*	*4*	**27**	*4*	*3*	*2*	*1*
8	*4*	*3*	*2*	*1*	**28**	*1*	*2*	*3*	*4*
9	*1*	*2*	*3*	*4*	**29**	*1*	*2*	*3*	*4*
10	*4*	*3*	*2*	*1*	**30**	*4*	*3*	*2*	*1*
11	*4*	*3*	*2*	*1*	**31**	*1*	*2*	*3*	*4*
12	*1*	*2*	*3*	*4*	**32**	*1*	*2*	*3*	*4*
13	*1*	*2*	*3*	*4*	**33**	*4*	*3*	*2*	*1*
14	*1*	*2*	*3*	*4*	**34**	*4*	*3*	*2*	*1*
15	*4*	*3*	*2*	*1*	**35**	*1*	*2*	*3*	*4*
16	*4*	*3*	*2*	*1*	**36**	*4*	*3*	*2*	*1*
17	*1*	*2*	*3*	*4*	**37**	*1*	*2*	*3*	*4*
18	*1*	*2*	*3*	*4*	**38**	*1*	*2*	*3*	*4*
19	*4*	*3*	*2*	*1*	**39**	*4*	*3*	*2*	*1*
20	*4*	*3*	*2*	*1*	**40**	*1*	*2*	*3*	*4*

แบบสอบถามภาวะความวิตกกังวล

สำหรับการศึกษาวิจัยเรื่อง ผลของไบนูรัลบีทต่อความวิตกกังวลของนักศึกษามหาวิทยาลัย

คำชี้แจง

1. แบบสอบถามนี้เป็นแบบสอบถามความวิตกกังวลของท่าน เป็นการศึกษาเพื่อศึกษาผลของการใช้ binaural beat ในการลดภาวะวิตกกังวล เพื่อประโยชน์แก่นักศึกษาในอนาคตต่อไป
2. การศึกษาจะไม่เปิดเผยชื่อ หรือข้อมูลที่จำเพาะเจาะจงเกี่ยวกับตัวท่าน แต่จะเป็นการรวบรวมข้อมูลในภาพกว้าง เพื่อประกอบการวิเคราะห์เท่านั้น

ข้อมูลทั่วไป

3. เพศ สำหรับผู้วิจัย

☐ (1)ชาย ☐ (2)หญิง Gender.(……..)

4. คณะวิชา

☐ 1.แพทยศาสตร์ ☐ 2.เภสัชศาสตร์ ☐ 3.พยาบาลศาสตร์ Fac (……)

☐ 4. สหเวชศาสตร์ ☐ 5. วิทยาศาสตร์การแพทย์

5. ชั้นปีที่

☐ 1. ปี1 ☐ 2. ปี2 ☐3. ปี3 ☐ 4. ปี4ขึ้นไป Year (……)

จงทำเครื่องหมาย ✓ในช่องที่ตรงกับความรู้สึกของท่านมากที่สุด

คำถาม	ใช่ (1)	ไม่ใช่ (2)	สำหรับผู้วิจัย
1. ใน 2 สัปดาห์ที่ผ่านมา รวมวันนี้ ท่านรู้สึก หดหู่ เศร้า หรือท้อแท้สิ้นหวังหรือไม่			D1= ( )
2.ใน 2 สัปดาห์ที่ผ่านมา รวมวันนี้ท่านรู้สึก เบื่อ ทำอะไรก็ไม่เพลิดเพลินหรือไม่			D2=( )
3.ท่านเคยมีประวัติความเจ็บป่วยเกี่ยวกับโรคลมชักบ้างหรือไม่			E= ( )
4.ท่านเคยมีประวัติเป็นโรคหัวใจรุนแรงหรือไม่			H= ( )

แบบสอบถามภาวะวิตกกังวล STAI

<u>คำชี้แจง</u> แบบสอบถามนี้เป็นแบบสอบถามความวิตกกังวล มีทั้งหมด 2 ตอนๆละ 20 ข้อ รวมเป็น 40 ข้อ ขอให้ท่านตอบแบบสอบถามตามความรู้สึกที่แท้จริงของท่าน และโปรดตอบแบบสอบถามในทุกข้อ

<u>ตอนที่ 1 (ข้อ 1-20)</u>

<u>คำแนะนำในการตอบคำถามข้อ1-20</u> ในข้อความด้านล่างต่อไปนี้เป็นข้อความที่ท่านจะบรรยายเกี่ยวกับตัวท่านเอง โปรดอ่านข้อความในแต่ละข้อและทำเครื่องหมาย✓ในช่องซึ่งอยู่ทางด้านขวาของข้อความ ซึ่งท่านพิจารณาว่าตรงกับความรู้สึกของท่านมากที่สุดใน*<u>ขณะนี้</u>* ข้อความต่อไปนี้ไม่มีคำตอบถูกหรือผิด ดังนั้นโปรดอย่าใช้เวลาในการพิจารณาคำตอบข้อใดข้อหนึ่งนานเกินควร แต่โปรดเลือกคำตอบที่ท่านคิดว่าบรรยายความรู้สึกของท่านในขณะนี้ได้ชัดเจนที่สุด

ข้อ	รายการ	ระดับความรู้สึก				สำหรับผู้วิจัย
		ไม่เลย	มีบ้าง	ค่อนข้างมาก	มากที่สุด	
1	ข้าพเจ้ารู้สึกสงบ					ST101= ( )
2	ข้าพเจ้ารู้สึกมั่นคง-ปลอดภัย					ST102= ( )
3	ข้าพเจ้าเป็นคนเครียด					ST103= ( )
4	ข้าพเจ้ารู้สึกเกร็งและเครียด					ST104= ( )
5	ข้าพเจ้ารู้สึกสบายๆ					ST105= ( )
6	ข้าพเจ้ารู้สึกอารมณ์เสีย					ST106= ( )
7	ข้าพเจ้ารู้สึกวิตกกังวลกับสิ่งร้ายที่อาจเกิดขึ้น					ST107= ( )
8	ข้าพเจ้ารู้สึกพึงพอใจ					ST108= ( )
9	ข้าพเจ้ารู้สึกตื่นกลัว					ST109= ( )
10	ข้าพเจ้ารู้สึกสะดวกสบาย					ST110= ( )
11	ข้าพเจ้ารู้สึกมั่นใจในตนเอง					ST111= ( )
12	ข้าพเจ้ารู้สึกตื่นเต้น					ST112= ( )
13	ข้าพเจ้ารู้สึกกระสับกระส่าย					ST113= ( )
14	ข้าพเจ้ารู้สึกลังเลใจ					ST114= ( )
15	ข้าพเจ้ารู้สึกผ่อนคลาย					ST115= ( )
16	ข้าพเจ้ารู้สึกพอใจและมีความสุข					ST116= ( )
17	ข้าพเจ้าวิตกกังวล					ST117= ( )
18	ข้าพเจ้ารู้สึกสับสน					ST118= ( )
19	ข้าพเจ้ารู้สึกมั่นคง					ST119= ( )
20	ข้าพเจ้ารู้สึกว่าตนเองเป็นคนน่าคบ					ST120= ( )

ตอนที่ 2 (ข้อ 21-40)

คำแนะนำในการตอบคำถามข้อ 21-40 ในข้อความด้านล่างต่อไปนี้เป็นข้อความที่ท่านจะบรรยายเกี่ยวกับตัวท่านเอง โปรดอ่านข้อความในแต่ละข้อและทำเครื่องหมาย ✓ ในช่องซึ่งอยู่ทางด้านขวาของข้อความในแต่ละข้อ ซึ่งท่านพิจารณาแล้วว่าต*รงกับความรู้สึกทั่วๆไป* ของท่านมากที่สุด ข้อความต่อไปนี้ไม่มีคำตอบถูกหรือผิด ดังนั้นโปรดอย่าใช้เวลาในการพิจารณาคำตอบข้อใดข้อหนึ่งนานเกินควร แต่โปรดเลือกคำตอบที่ท่านคิดว่าตรงกับความรู้สึกของท่านมากที่สุด

ข้อ	รายการ	ระดับความรู้สึก				สำหรับผู้วิจัย
		ไม่เลย	มีบ้าง	ค่อนข้างมาก	มากที่สุด	
21	ข้าพเจ้ารู้สึกเป็นคนน่าคบ					ST121= ( )
22	ข้าพเจ้ารู้สึกตื่นเต้นและกระวนกระวาย					ST122= ( )
23	ข้าพเจ้ารู้สึกมีความพอใจในตนเอง					ST123= ( )
24	ข้าพเจ้าอยากเป็นสุขเท่ากับที่คนอื่นๆเป็นอยู่					ST124= ( )
25	ข้าพเจ้ารู้สึกเหมือนเป็นคนล้มเหลว					ST125= ( )
26	ข้าพเจ้ารู้สึกปลอดโปร่ง					ST126= ( )
27	ข้าพเจ้าสงบ-ใจเย็น-มีสติ					ST127= ( )
28	ข้าพเจ้ารู้สึกว่าปัญหามากขึ้นทุกทีจนสู้ไม่ไหว					ST128= ( )
29	ข้าพเจ้ากังวลมากเกินไปในสิ่งที่จริงๆแล้วไร้สาระ					ST129= ( )
30	ข้าพเจ้ารู้สึกเป็นสุข					ST130= ( )
31	ข้าพเจ้ามีความคิดที่ทำให้ตนเองไม่สบายใจ					ST131= ( )
32	ข้าพเจ้าขาดความมั่นใจในตนเอง					ST132= ( )
33	ข้าพเจ้ารู้สึกมั่นคงปลอดภัย					ST133= ( )
34	ข้าพเจ้าเป็นคนตัดสินใจได้ง่ายดาย					ST134= ( )
35	ข้าพเจ้ารู้สึกมีความสามารถไม่เพียงพอ					ST135= ( )
36	ข้าพเจ้าพึงพอใจและมีความสุข					ST136= ( )
37	ข้าพเจ้ามีความรู้สึกวิตกกังวลในการที่ข้าพเจ้ามีความคิดที่ไร้สาระ					ST137= ( )

ข้อ	รายการ	ระดับความรู้สึก				สำหรับผู้วิจัย
		ไม่เลย	มีบ้าง	ค่อนข้างมาก	มากที่สุด	
38	ข้าพเจ้ายอมรับความผิดหวังได้อย่างจริงจัง					ST138= ( )
39	ข้าพเจ้าเป็นคนมั่นคง					ST139= ( )
40	เมื่อข้าพเจ้าคิดถึงสิ่งที่เกี่ยวข้องหรือสนในในระยะหลังๆนี้ ทำให้ข้าพเจ้าอยู่ในภาวะความตึงเครียดและสับสน					ST140= ( )

.....ขอขอบคุณ.....

แบบสอบถาม STAI ครั้งที่2 IDS(……..) IDR(……..) (T……B……)

แบบสอบถามภาวะความวิตกกังวล

สำหรับการศึกษาวิจัยเรื่อง ผลของไบนูรัลบีทต่อความวิตกกังวลของนักศึกษามหาวิทยาลัย

คำชี้แจง

1. แบบสอบถามนี้เป็นแบบสอบถามความวิตกกังวลของท่าน เป็นการศึกษาเพื่อศึกษาผลของการใช้ binaural beat ในการลดภาวะวิตกกังวล เพื่อประโยชน์แก่นักศึกษาในอนาคตต่อไป
2. การศึกษาจะไม่เปิดเผยชื่อ หรือข้อมูลที่จำเพาะเจาะจงเกี่ยวกับตัวท่าน แต่จะเป็นการรวบรวมข้อมูลในภาพกว้าง เพื่อประกอบการวิเคราะห์เท่านั้น

จงทำเครื่องหมาย ✓ในช่องที่ตรงกับความรู้สึกของท่านมากที่สุด

คำถาม	ใช่(1)	ไม่ใช่(2)	สำหรับผู้วิจัย
1. ใน1วันที่ผ่านมาท่านดื่มเครื่องดื่มแอลกอฮอล์เพื่อลดความวิตกกังวลหรือไม่			EA2=( )
2.. ใน1วันที่ผ่านมาท่านได้รับการบำบัดอื่นๆเพื่อลดความวิตกกังวลหรือไม่			ET2=( )
3.. ใน1วันที่ผ่านมาท่านได้รับยาเพื่อลดความวิตกกังวลบ้างหรือไม่			EMd2=( )
4.. ใน1วันที่ผ่านมาท่านมีความเจ็บป่วยฉุกเฉินใดๆจนต้องพบแพทย์หรือไม่			EIl2=( )
5.. ใน1วันที่ผ่านมาท่านมีเหตุการณ์ที่ทำให้เกิดความวิตกกังวลเพิ่มขึ้นหรือไม่			EEv2=( )

ข้อมูลสัญญาณชีพ

ระยะเวลา	BP(mmHg)	Pulse (t/m)
ก่อนการทดลอง	**BPs2Pr = BPd2Pr=**	**Pulse2Pr=**
หลังการทดลอง	**BPs2Po = BPd2Po=**	**Pulse2Po=**

แบบสอบถามภาวะวิตกกังวล STAI

<u>คำชี้แจง</u> แบบสอบถามนี้เป็นแบบสอบถามความวิตกกังวล มีทั้งหมด 20 ข้อ ขอให้ท่านตอบแบบสอบถามตามความรู้สึกที่แท้จริงของท่าน และโปรดตอบแบบสอบถามในทุกข้อ

<u>คำแนะนำในการตอบคำถามข้อ1-20</u> ในข้อความด้านล่างต่อไปนี้เป็นข้อความที่ท่านจะบรรยายเกี่ยวกับตัวท่านเอง โปรดอ่านข้อความในแต่ละข้อและทำเครื่องหมาย✓ในช่องซึ่งอยู่ทางด้านขวาของข้อความ ซึ่งท่านพิจารณาว่าตรงกับความรู้สึกของท่านมากที่สุดใน*<u>ขณะนี้</u>* ข้อความต่อไปนี้ไม่มีคำตอบถูกหรือผิด ดังนั้น โปรดอย่าใช้เวลาในการพิจารณาคำตอบข้อใดข้อหนึ่งนานเกินควร แต่โปรดเลือกคำตอบที่ท่านคิดว่าบรรยายความรู้สึกของท่านในขณะนี้ได้ชัดเจนที่สุด

ข้อ	รายการ	ระดับความรู้สึก				สำหรับผู้วิจัย
		ไม่เลย	มีบ้าง	ค่อนข้างมาก	มากที่สุด	
1	ข้าพเจ้ารู้สึกสงบ					ST201= ( )
2	ข้าพเจ้ารู้สึกมั่นคง-ปลอดภัย					ST202= ( )
3	ข้าพเจ้าเป็นคนเครียด					ST203= ( )
4	ข้าพเจ้ารู้สึกเกร็งและเครียด					ST204= ( )
5	ข้าพเจ้ารู้สึกสบายๆ					ST205= ( )
6	ข้าพเจ้ารู้สึกอารมณ์เสีย					ST206= ( )
7	ข้าพเจ้ารู้สึกวิตกกังวลกับสิ่งร้ายที่อาจเกิดขึ้น					ST207= ( )
8	ข้าพเจ้ารู้สึกพึงพอใจ					ST208= ( )
9	ข้าพเจ้ารู้สึกตื่นกลัว					ST209= ( )
10	ข้าพเจ้ารู้สึกสะดวกสบาย					ST210= ( )
11	ข้าพเจ้ารู้สึกมั่นใจในตนเอง					ST211= ( )
12	ข้าพเจ้ารู้สึกตื่นเต้น					ST212= ( )
13	ข้าพเจ้ารู้สึกกระสับกระส่าย					ST213= ( )
14	ข้าพเจ้ารู้สึกลังเลใจ					ST214= ( )
15	ข้าพเจ้ารู้สึกผ่อนคลาย					ST215= ( )
16	ข้าพเจ้ารู้สึกพอใจและมีความสุข					ST216= ( )
17	ข้าพเจ้าวิตกกังวล					ST217= ( )
18	ข้าพเจ้ารู้สึกสับสน					ST218= ( )
19	ข้าพเจ้ารู้สึกมั่นคง					ST219= ( )
20	ข้าพเจ้ารู้สึกว่าตนเองเป็นคนน่าคบ					ST220= ( )

ที่ ศธ 0512.11/ 0533

คณะพยาบาลศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย
อาคารบรมราชชนนีศรีศตพรรษ ชั้น 11
ถนนพระราม 1 แขวงวังใหม่ เขตปทุมวัน
กรุงเทพฯ 10330

30 มีนาคม 2559

เรื่อง อนุญาตให้ใช้เครื่องมือวิจัย

เรียน หัวหน้าภาควิชาเวชศาสตร์ชุมชน คณะแพทยศาสตร์ มหาวิทยาลัยเชียงใหม่

อ้างถึง หนังสือ ภาควิชาเวชศาสตร์ชุมชน คณะแพทยศาสตร์ มหาวิทยาลัยเชียงใหม่ ที่ ศธ 6393 (8).16/133 ลงวันที่ 4 มีนาคม 2559 เรื่อง ขออนุญาตใช้เครื่องมือในการทำวิทยานิพนธ์

ตามหนังสือที่อ้างถึง แจ้งว่า นายวุฒิชัย ไชยรินคำ นักศึกษาปริญญาเอก สาขาวิชาเวชศาสตร์ชุมชน คณะแพทยศาสตร์ มหาวิทยาลัยเชียงใหม่ กำลังดำเนินการพัฒนาวิทยานิพนธ์ เรื่อง "ผลของไบนูรัล ต่อความวิตกกังวลในนักศึกษามหาวิทยาลัย" มีความประสงค์จะขออนุญาตใช้เครื่องมือวิจัย คือ แบบทดสอบ STAI ฉบับแปลภาษาไทย ซึ่งเป็นส่วนหนึ่งของวิทยานิพนธ์ เรื่อง "การลดความวิตกกังวลของพยาบาลประจำการที่ดูแลผู้ป่วยโรคเอดส์ด้วยวิธีการปรับเปลี่ยนความคิดร่วมกับการฝึกสติ " ของ รองศาสตราจารย์ ดร. ดาราวรรณ ตันปินตา นั้น คณะพยาบาลศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย ยินดีและอนุญาตให้ใช้เครื่องมือวิจัยดังกล่าวได้ โดยขอให้ผู้ใช้แจ้งผลการวิจัยและข้อเสนอแนะในการปรับปรุงเครื่องมือ ให้คณะพยาบาลศาสตร์ทราบด้วย

จึงเรียนมาเพื่อโปรดทราบ

ขอแสดงความนับถือ

(รองศาสตราจารย์ ดร. จิราพร เกศพิชญวัฒนา)
รองคณบดี
ปฏิบัติการแทนคณบดีคณะพยาบาลศาสตร์

ฝ่ายวิชาการ
โทร. 0-2218-1129 โทรสาร. 0-2218-1130

APPENDIX B

PUBLICATION

Effects of Newly-Developed Superimposed Binaural Beat on Anxiety in University Students in Thailand: A Randomised Controlled Trial

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ABSTRACT

This study aimed to investigate the effects of superimposed binaural beat in reducing anxiety among university students and to compare the effects of superimposed binaural beat to those of receptive music listening and relaxation treatment. The 134 participants who participated in the double-blind randomised controlled trial were randomly selected from 539 students with anxiety. According to block randomisation, the participants were assigned to superimposed binaural beat (n = 45), receptive music listening (n = 45), and blank audio (Control, n = 44) groups. All three groups received general relaxation treatment in 20-minute daily sessions over a period of 5 consecutive days. The median differences in anxiety level were measured by the self-administered State-Trait Anxiety Inventory form-Y before and after treatment for the superimposed binaural beat, music listening, and control groups at -20.00, -16.00, and -15.00, respectively. The differences between the superimposed binaural beat group and the control (P = 0.04) and music listening (P = 0.02) groups were statistically significant. Anxiety levels were effectively reduced in 100% of participants in the superimposed binaural beat group, which was higher than the rate in the control group (84.09%: P < 0.01). Superimposed binaural beat-based interventions may reduce anxiety in university students more effectively than the music listening and general relaxation methods. The research findings are potentially beneficial for policymakers and for developing interventions aimed at reducing anxiety in university students.

Keywords: Anxiety, Student, Music listening, Superimposed binaural beat, Relaxation, Randomised controlled trial, Effect

INTRODUCTION

Anxiety problems in university students have been increasing due to academic pressure such as graduation expectation, academic achievement and financial problems (Saipanich, 2003; Vaez et al., 2006; Shamsuddin et al., 2013; Yusoff et al., 2013). Study in the United States found 12.00% of students to have experienced anxiety issues in the previous year. Over 50% of university students reported feeling hopeless and overwhelming anxiety over the past 12 months (Regehr et al., 2013). In Egypt, medical students have indicated that anxiety has great impact on well-being in terms of studying for and participating in examinations (Yusoff et al., 2013). These negative effects bring concern physical and mental problems as the data claimed by the health care centre of each university, where increasing numbers of students are requesting services (Alzahem et al., 2011; Galbraith and Brown, 2011). Moreover, 11.40% of university students were found to require psychological help from university counselling centres, and this number is likely to increase (Grasgreen, 2012). Approximately 40.00% of university students have stated that their mental health problems required psychological help beginning with anxiety, which is one of the main causes of mental health problems. Anxiety is recognised by medical professionals as a causal factor of mental health problems (Grasgreen, 2011). In Thailand, anxiety has a negative impact on the academic performance and emotions of medical students (Saipanich, 2003).

Common anxiety treatments include medication, which is associated with both physical and economic short- and long-term burdens (Department of Mental Health, 2013). Anxiety-relief medication is commonly used to help reduce anxiety. Other treatments such as muscle relaxation, listening to music, and psychotherapy, which requires specialist guidance, are available, but might be inconvenient to access. One study indicated that music was able to reduce anxiety (Shamsuddin et al., 2013) and there has been an evolution in the application of music with a binaural beat.

Binaural beat arises from the interaction of bilateral input at higher levels of the ascending auditory pathway (Tobias, 1963; Rutschmann and Rubinstein, 1965). The mechanism of action is two-way with effects on the limbic system, which regulates mood, and on brainwave entrainment. Binaural beat is reportedly generated within the brain. The superior olivary complex is believed to be the first nucleus to receive auditory information from both sides of the ears and binaurally activated phase-sensitive neurons are also found in the inferior colliculus (Spitzer and Semple, 1998; Schwarz and Taylor, 2005). The fluctuation in frequency equals the difference in the two pure tones presented. However, a classic study reported that the maximum difference in two tones that humans can perceive as a beat is 35 Hz; otherwise, two separate pure tones are perceived instead (Oster, 1973).

Listening to 7–10 Hz binaural beats may be beneficial in reducing mild anxiety (Le Scouarnec et al., 2001; Wahbeh et al., 2007) and improving self-reported relaxation (McConnell et al., 2014). For clinical interventions, binaural beat has the potential of decreasing acute preoperative anxiety in patients undergoing general surgery (Padmanabhan et al., 2005) and reducing anxiety in moderately-anxious patients in the emergency department by 10–15% (Weiland et al., 2011). Binaural beat embedded in music listening may have benefits in music interventions alone by decreasing anxiety in patients undergoing operative cataract surgery (Wiwatwongwana et al., 2016) and may be useful in reducing preoperative anxiety in dental

surgery (Isik et al., 2017). However, another study found that binaural beat showed positive effects on anxiety among anxious populations, but the difference was statistically insignificant (Le Scouarnec et al., 2001).

Superimposed binaural beat is a new binaural beat technique in which additional binaural beats are synthesised on the basis of frequency shifting of the sound waves from each traditional Thai musical instrument, except for drum sounds (due to their extremely low frequency), in addition to the original binaural beats created by the standard method of pure-tone sine wave-frequency differentiation. It is expected that superimposed binaural beat's quality and efficiency will be better than that of traditional binaural beat. Currently, traditional binaural beats are used to reduce anxiety in patients in clinical trials, but none of these trials have employed superimposed binaural beats.

This study aimed to investigate the effects of superimposed binaural beats on reducing anxiety among university students and to compare the effects of superimposed binaural beat to the effects of music listening and relaxation treatment.

METHODS

Participants for anxiety assessment

The data collection of this research was conducted with a sample of 1,245 from among 6,480 university students based on stratification of faculty and academic year over a 4-week period from October to November 2016. The prevalence of acute anxiety was determined among 1,245 health-science students using the State-Trait Anxiety Inventory (STAI) form Y-I (state anxiety) with a cut-off score of 40 or higher (Kennedy et al., 2001). After drawing lots, a random sequence of numbers was computer generated and used in each stratum of simple random sampling. Overall, 539 of 1,245 students had anxiety scores of 40 or higher (eligible for the randomised control trial (RCT)).

Participants for the RCT

No student had a history of epilepsy, severe heart disease, or depressive symptoms (which were the exclusion criteria applied before sampling for the RCT) and 134 of 539 students were randomly selected (a random sequence of numbers was computer generated) to participate in the double-blind RCT (neither the researcher nor the participants knew what treatment was received). According to block randomisation, the participants were assigned to one of three of the following treatment groups: superimposed binaural beat (45 students), music listening (45 students), and blank audio (44 students). All three groups received general relaxation treatment, which involved resting while sitting in a comfortable chair in a room at a pleasant temperature and wearing stereo headphones; this treatment is basic therapy received by everyone and prevents confounders.

The superimposed binaural beat, music listening, and control groups listened to Thai Lanna music with superimposed binaural beat tones (with 10 Hz difference), Thai Lanna music without superimposed binaural beat, and blank audio, respectively. They received 20-minute daily treatments for 5 consecutive days. The participants were excluded if any complications

arose, including anxiety events or other treatments. Anxiety levels were measured by the self-administered STAI Form-Y (STAI-S) before and after treatment. The STAI-S is a 20-item self-reported measure of state or current anxiety; all items were rated on a 4-point scale. Internal consistency coefficients for the scale range from 0.86 to 0.95; test-retest reliability coefficients range from 0.65 to 0.75 over a 2-month interval (Spielberger et al., 1983; Julian, 2011). The researchers prevented the interference of time-dependent confounders (alcohol use, receipt of other treatments, and use of anti-anxiety medication) and major confounders (physical illness or tragic events causing anxiety) by notifying all participants at the recruitment stage and monitoring using a daily questionnaire.

Superimposed binaural beat Creation

The superimposed binaural beat innovation in the present study used Thai Lanna music, which is familiar to students in northern Thailand. Additional binaural beats were synthesised on the basis of frequency shifting of the sound waves from each traditional Thai musical instrument, except the drum sounds (due to their extremely low frequency), apart from the original binaural beat, which was created by the standard method of pure-tone sine wave frequency differentiation via a self-hypnosis and relaxation machine (SHARM, Cyber Team Ltd., USA) (Version 2.4). The continuous sounds, namely, strings and organs, were also arranged to be inserted into all songs in order to render continuous the frequency difference between the ears with the least interruption between the songs. All eligible tracks of each musical instrument were set to produce 10-Hz differences between one ear with a lower carrier frequency and the other with a higher carrier frequency. The therapeutic frequency of 10 Hz was sustained for at least 20 minutes to ensure sufficient time to entrain the brainwaves at the alpha level (Chiang Mai University copyright on the synthesis of superimposed binaural beats).

Statistical analysis

Descriptive analysis included frequency, percentage and mean. Univariate analysis included Fisher's exact test and the chi-squared and and Kruskal-Wallis tests, depending on the data distribution. A *P*-value of below 0.05 was considered statistically significant. Data management and analyses were performed by using Epi Info for Windows (Version 3.5.4; Centers for Disease Control and Prevention, Atlanta, GA) and STATA version 11 (Statacorp LP. College Station, TX).

Ethical consideration

All methods were carried out in accordance with relevant guidelines and regulations. All experimental protocols were approved by the Ethics Committee of the Faculty of Medicine, Chiang Mai University, and cooperation was received in collecting information from the School of Health Science, University of Phayao, (Study Code: COM-2559-03951/ Research ID: 3951 Ethics Approval Number 319/2016). Informed consent was obtained from all participants.

RESULTS

Baseline characteristics

One hundred and thirty-four students with anxiety were enrolled in the study. The participants were subsequently assigned to the superimposed binaural beat, music listening, and control groups with 45, 45, and 44 students with anxiety in each group, respectively. Most participants were first-year female students (Table 1). The participants were comparable in terms of demographic characteristics (Table 1). The median trait anxiety scores of the superimposed binaural beat, music listening, and control groups were 43.00 (range: 34.00 to 69.00), 43.00 (range: 35.00 to 62.00), and 43.50 (range: 32.00 to 64.00), respectively.

Table 1. Baseline characteristics of the participants by treatment group.

Variables	Group*		
	SBB n = 45	ML n = 45	Control n = 44
Sex n (%)			
Male	6 (13.33)	6 (13.33)	8 (18.18)
Female	39 (86.67)	39 (86.67)	36 (81.82)
Year			
1	17 (37.78)	21 (46.67)	18 (40.91)
2	15 (33.33)	11 (24.44)	10 (22.73)
3	12 (26.67)	12 (26.67)	16 (36.36)
4	1 (2.22)	1 (2.22)	0 (0.00)
Faculty n (%)			
Medical	27 (60.00)	26 (57.77)	26 (59.09)
Pharmaceutical	2 (4.44)	3 (6.67)	4 (9.09)
Nursing	4 (8.89)	4 (8.89)	3 (6.82)
Medical Science	2 (4.44)	3 (6.67)	3 (6.82)
Allied Health Science	10 (22.23)	9 (20.00)	8 (18.18)

Note: SBB = Superimposed Binaural Beat; ML = Busic Listening; Control = Blank audio.

Effects of treatment on anxiety levels

During the treatment period, there were no reports of alcohol use, receipt of other treatments or anti-anxiety medication, physical illness, or tragic events. The median difference in the STAI-S score between after and before treatments of the superimposed binaural beat, music listening, and control groups was -20.00, -16.00, and -15.00, respectively. When comparing the median differences among the groups, the superimposed binaural beat group versus the control group and the superimposed binaural beat group versus the music listening group had statistically significantly different scores (Table 2).

Table 2. Anxiety levels among participants by treatment group.

Groups	Different STAI-S scores* median (range)	*P*-value
SBB	-20.00 (-3.00 to -40.00)	SBB versus ML: 0.02**
ML	-16.00 (1.00 to -32.00)	ML versus Control: 0.81
Control	-15.00 (0 to-50.00)	Control versus SBB: 0.04**

Note: SBB = Superimposed Binaural Beat; ML = Music Listening; Control = Blank audio; * Different median STAI-S pre- and post-test scores; ** Statistically significant difference using Kruskal-Walis test.

Anxiety level rates reached by treatments

The students were considered to have acute anxiety when their anxiety scores were 40 points or higher. Thus, the participants who had anxiety scores lower than 40 points after treatment were considered as normal. All participants (100.00%) in the superimposed binaural beat group, 43 participants (95.56%) in the music listening group, and 37 participants (84.09%) in the control group experienced reduced anxiety at the end of the 5-day treatment period, (see Table 3).

Table 3. Comparison of anxiety normal rates after completed treatment in the SBB, ML, and control Groups.

Groups	n	Normal n (%)	*P*-value*
SBB	45	45 (100.00)	0.045
ML	45	43 (95.56)	
Control	44	37 (84.09)	

Note: SBB = Superimposed Binaural Beat; ML = Music Listening; Control = Blank audio; * Statistical significance by Kruskal-Wallis test.

DISCUSSION

Binaural beat has been used to reduce anxiety levels in numerous studies (Padmanabhan et al., 2005; Weiland et al., 2011; Wiwatwongwana et al., 2016; Isik et al., 2017), yielding both effective and ineffective results (Le Scouarnec et al., 2001). No previous study has used binaural beat with music by shifting the frequency of the sound of each instrument, using a 10-Hz difference between the left and right spectrums with pure binaural beat tones on one track. In the present study, combining the additional superimposed binaural beat innovation with the original binaural beat was expected to enhance the power of brainwave entrainment in participants who listened to this music continuously. The results revealed that all participants in the superimposed binaural beat group experienced reduced anxiety, whereas fewer participants improved in the other two groups. The STAI-S scores decreased dramatically in the superimposed binaural beat group (median -20.00), and the difference was statistically

significant compared to the control group scores. At the same time, the difference in STAI-S scores between the music listening and the control groups was not statistically significant. The reasons proposed for the effects of music listening include music composition passing into the nervous system, neurotransmitters and limbic system resulting in both physical and emotional changes (Weiland et al., 2011) including parasympathetic nervous-system activation such as slowing the heart rate, dilating blood vessels, and lowering blood pressure (Wahbeh, et al., 2007). The alpha wavelength reflects the relaxation state.

Original binaural beat produced by the machine mentioned in previous study, was also used in this study to investigate the anxiolytic effects of binaural beat among patients undergoing cataract operations. The patients in the music listening and binaural beat groups showed significantly lower STAI-S scores compared with the control group. However, the difference between the music listening and superimposed binaural beat groups was statistically insignificant. The mean STAI-S score of the music listening group was -7.00 and that of the superimposed binaural beat group was -9.00 (Wiwatwongwana et al., 2016). Although the findings of the present study indicated that the superimposed binaural beat group showed higher different scores was believed to enhance the power of brainwave entrainment. There are some studies used superimposed binaural beat to reduce anxiety in some patients (Padmanabhan et al., 2005; Wiwatwongwana et al., 2016). However there is no study in university student before, the result of this study will be useful for decreasing anxiety in students population.

The limitation of this study might be that the study explored anxiety among a subgroup of students studying in the field of health science with high anxiety. Therefore, it may not be appropriate to generalise the findings to other populations. The advantages of this study were the research design, large sample size, and double-blind methodology. The study was an RCT with time-dependent confounder control to provide immediate interventions in the least amount of time for effectively reducing anxiety levels. Thus, we contest that these dependent confounders had no effect on the anxiety levels. The participants were selected by simple random sampling to ensure highly homogenous characteristics. The RCT was double-blind to prevent selection and information biases. The major confounding variables were monitored daily during the study period. It is believed that the results of the experiments were due to the power of the superimposed binaural beat.

The findings of this study are potentially useful for policymakers and for developing interventions aimed at reducing anxiety in university students by tailoring the methodology to an adolescent context. Superimposed binaural beat-based interventions may reduce anxiety-relief medication use, as well as the cost and side effects of medical treatment. This type of intervention can also be conducted in large numbers of target groups in settings with few student-affair officers, as is the case in nearly all universities in developing countries. It is worth exploring the possibility of using superimposed binaural beat paradigms in other population groups.

In conclusion, the findings of this double-blind RCT illustrate that superimposed binaural beat-based interventions may reduce anxiety in university students more effectively than the music listening and general-relaxation methods. These findings will potentially contribute to inexpensive and safe treatment options to address high demands in university settings.

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REFERENCES

Alzahem, A.M., Van der Molen, H.T., Alaujan, A.H., Schmidt, H.G., and Zamakhshary, M.H. 2011. Stress among dental students: a systematic review. European Journal of Dental Education. 15(1): 8-18. https://doi.org/10.1111/j.1600-0579.2010.00640.x

American Psychology Association. 2017. Anxiety American Psychological Association. Washington, USA.

Dahlin, M.J., Joneborg, N., and Runeson, B. 2005. Stress and depression among medical students: a cross sectional study. Medical Education. 39: 594-604. https://doi.org/10.1111/j.1365-2929.2005.02176.x

Department of Mental Health. 2013. Annual report of department of mental health fiscal year 2009-2011.

Galbraith, N.D., and Brown, K.E. 2011. Assessing intervention effectiveness for reducing stress in student nurses: A qualitative systematic review. Journal of Advanced Nursing. 67(4): 709-721. https://doi.org/10.1111/j.1365-2648.2010.05549.x

Grasgreen A. 2011. College counseling directors' survey finds salary disparity students with anxiety other psychological problems [Internet]. [cited 2016 Jul 5]. Available from https://www.insidehighered.com/news/2016/07/05/survey-counseling-center-directors-finds-anxiety-and-depression-are-top-issues

Grasgreen A. 2012. Students rate mental health services [Internet]. [cited 2012 Oct 30]. Available from http://www.insidehighered.com/news/2012/10/30/colleges-dontalways-help-mental-health-issues-student-surveyshows

Isik, B.K., Esen, A., Buyukerkmen, B., Kilinc, A., and Menziletoglu, D. 2017. Effectiveness of binaural beats in reducing preoperative dental anxiety. The British Journal of Oral and Maxillofacial Surgery. 55(6): 571-574. https://doi.org/10.1016/j.bjoms.2017.02.014

Julian, L.J. 2011. Measures of anxiety: State-Trait Anxiety Inventory (STAI), Beck Anxiety Inventory (BAI), and Hospital Anxiety and Depression Scale-Anxiety (HADS-A). Arthritis Care & Research (Hoboken). 63 (Suppl. 11): S467-72 https://doi.org/10.1002/acr.20561

Kennedy, B.L., Schwab, J.J., Morris, R.L., and Beldia, G. 2001. Assessment of state and trait anxiety in subjects with anxiety and depressive disorders. Psychiatric Quarterly. 72: 263. https://doi.org/10.1023/A:1010305200087

Le Scouarnec, R.P., Poirier, R.M., Owens, J.E., Gauthier, J., Taylor, A.G., and Foresman, P.A. 2001. Use of binaural beat tapes for treatment of anxiety: a pilot study of tape preference and outcomes. Alternative Therapies in Health and Medicine. 7(1): 58-63.

McConnell, P.A., Froeliger, B., Garland, E.L., Ives, J.C., and Sforzo, G.A. 2014. Auditory driving of the autonomic nervous system: Listening to theta-frequency binaural beats post-exercise increases parasympathetic activation and sympathetic withdrawal. Frontiers in Psychology. 5: 1248. https://doi.org/10.3389/fpsyg.2014.01248

Oster G. 1973. Auditory beats in the brain. Scientific American. 229(4): 94-102.

Padmanabhan, R., Hildreth, A.J., and Lawa, D. 2005. A prospective, randomized, controlled study examining binaural beat audio and pre-operative anxiety in patients undergoing general anesthesia for day case surgery. Anaesthesia. 60(9): 874-877. https://doi.org/10.1111/j.1365-2044.2005.04287.x

Regehr, C., Glancy, D., and Pitts, A. 2013. Interventions to reduce stress in university students: A review and meta-analysis. Journal of Affective Disorders. 148(1):1-11. https://doi.org/10.1016/j.jad.2012.11.026

Rutschmann, J., and Rubinstein, L. 1965. Binaural beats and binaural amplitude-modulated tones: successive comparison of loudness fluctuations. Journal of the Acoustical Society of America. 38(5). https://doi.org/10.1121/1.1909802

Saipanich, R. 2003. Stress among medical students in a Thai medical school. Medical Teacher. 25(5): 502-506. https://doi.org/10.1080/0142159031000136716

Schwarz, D.W., and Taylor, P. 2005. Human auditory steady state responses to binaural and monaural beats. Journal of the international Federation of Clinical Neurophysiology. 116(3): 658-668. https://doi.org/10.1016/j.clinph.2004.09.014

Shamsuddin K., Fadzil, F., Ismail, S.W.W, Shah, S.A., Omar, K., Muhammad, N.A., Jaffar, A., Ismail, A., and Mahadevan, R. 2013. Correlate of depression, anxiety and stress among Malaysian University students. Asian Journal of Psychiatry. 6(4): 318-323. https://doi.org/10.1016/j.ajp.2013.01.014

Spielberger, C.D., Gorsuch, R.L., Lushene, R., Vagg, P.R., and Jacobs, G.A. 1983. Manual for the State-Trait Anxiety Inventory. Palo Alto, CA: Consulting Psychologists Press.

Spitzer, M.W., and Semple, M.N. 1998. Transformation of binaural response properties in the ascending auditory pathway: influence of time-varying interaural phase disparity. Journal of Neurophysiol. 80(6): 3062-76. https://doi.org/10.1152/jn.1998.80.6.3062

Tobias, J.V. 1963. Application of a "Relative" procedure to a problem in binaural beat perception: Report Civil Aeromedical Research Institute US. 26: 1-8.

Vaez, M., Ponce de Leon, A., and Laflamme, L. 2006. Health related determinants of perceived quality of life: a comparison between first year university student and third working peers. Work. 26: 167-177.

Wahbeh, H., Calabrese, C., Zwickey, H., and Zaidel, D. 2007. Binaural beat technology in humans: a pilot study to assess neuropsychologic, physiologic, and electroencephalographic effects. Journal of Alternative Complement Medical. 13(2): 199-206. https://doi.org/10.1089/act.2007.13401

Weiland, T.J., Jelinek, G.A., Macarow, K.E., Samartzis, P., Brown, D.M., Grierson, E.M., and Winter C. 2011. Original sound compositions reduce anxiety in emergency department patients: a randomized controlled trial. The Medical Journal of Australia. 19(11-12):195.

Wiwatwongwana, D., Vichitvejpaisal, P., Thaikruea, L., Klaphajone, J., Tantong, A., and Wiwatwongwana, A. 2016. The effects of music with and without binaural beat audio on operative anxiety in patients undergoing cataract surgery: a randomized controlled trial. Eye. 30(11): 1407-1414. https://doi.org/10.1038/eye.2016.160

Yusoff, M.S., Abdul Rahim, A.F., Baba, A.A., Ismail, S.B,, Mat Pa, M.N., and Esa, A.R. 2013. Prevalence and associated factors of stress, anxiety and depression among prospective medical students. Asian Journal of Psychiatry. 6(2): 128-133. https://doi.org/10.1016/j.ajp.2012.09.012

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