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**EFFECTS OF LOW FREQUENCY SOUND VIBRATION TO HUMAN
PSYCHOLOGICAL AND PHYSIOLOGICAL PHENOMENON : A
LITERATURE REVIEW**

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Abstract

Low frequency sound (LFS) is used in Vibroacoustic Therapy (VAT) which categorized as one of Complementary and Alternative Medicine (CAM) fashion. VAT is a therapy fashion that uses audible sound (40 Hz - 120 Hz) to produce vibrations through the transducer which is applied directly to the body. The aim of this paper is to describe the effects of LFS to human psychological and physiological behaviour. The papers were peer-reviewed based on published papers that can be accessed freely online and the essences were combined to synthesize a new conclusion accompanied by the writer's ideas. It is showed that VAT can reduces the anxiety level, indicated by the decrease of average patients blood pressure up to 10.97 bpm. The significance reduction on patients Fibromyalgia Impact Questionnaire (88.8 to 16.8) indicated the capability of VAT to overcome Fibromyalgia's symptoms. The difference of neurite outgrowth frequency in NGF-treated PC12m3 cells between intervention of 40 Hz and 200 Hz vibrational sound condition is significance and potentially lead to the cure Alzheimer disease. LFS in VAT also decrease pain in patients with Juvenile Idiopathic Arthritis due to the reduction of Simplified Disease Activity Index up to 34. Results showed great effects of LFS on the health improvement and human psychology through VAT as a physics agent therapy. However, research about effects of VAT to human health and psychology is still needed due to the lack of information about physics phenomenon in the body with VAT treatment.

Keywords

Low frequency sound; Vibroacoustic Therapy; anxiety; Fibromyalgia; Alzheimer; Arthritis

1. Introduction

Complementary and alternative medicine (CAM) become popular because of its inexpensive cost and lack of side effects if it compared with conventional medicine. According to National Health Interview Survey (NHIS) in 2012, 17.7 % of Americans had used natural products, exclude vitamin and mineral, as a medicine. There are many of CAM types that peoples have usually taken such as herbal medicine, acupuncture, yoga,

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etc. Vibroacoustic therapy (VAT) is a non-invasive CAM types that transmit low frequency sound directly to the patient's body. VAT is believed have a positive effects to patient's psychology and health such as reduce pain, anxiety, decreasing blood pressure, and other psychological and physiological phenomenon. However, there is still lack of research which prove the evidence of VAT's capability to overcome diseases or its symptoms.

This literature review's objective is to describe an effects of low frequency sound vibration that is usually used as a physics agent therapy in VAT to human's psychological and physiological behaviour, especially on anxiety, fibromyalgia, Alzheimer, and juvenile idiopathic arthritis (JIA) case. A studies that are cited in this scientific written have a various fashions for executing VAT to the patients so the effects of VAT which describe in this paper are depend on how VAT was done to the patients. This article tells readers about the effects of vibrational sound that traced via questionnaire and psychological and physiological measurement instrument. In special case, the effects that occurred in individual cell are watched on cell at in vitro condition. This paper can aid further research in VAT with a deeper understanding about how low frequency sound acts to the human body.

2. Material and Methods

This paper is based on a literature study of some paper which contained primary data that has been published worldwide in several journals. Those papers are free to be accessed through the internet. Writers used these papers to analyze a connection between low frequency sound to the human body and relate a facts that explained by them each other to find some similarities, contradictories, and other relations that reveal other facts or only some writer's reviews. Authors also complemented the analysis with their own arguments and suggestions for further researches. At the end of the analysis, writers make a conclusion based on the examined data and facts that complemented in those papers and reviews from the writers. For gathering a suitable journals or papers that correlated with the effects of low frequency sound to the human body topic, the writers used a search engine and input the desired phrases that referred to the topic, such as "effects of low frequency sound to the human physiology research", "vibroacoustic therapy research", and other phrases that correlated with the topic. This research fashion resulted tens to hundreds of journals or papers that suitable with the topic

3. Results

3.1 Sound and VAT

Sound is a form of energy that need a medium for transmit through a space or reach some point from the origin point. The molecules of medium are oscillating during the sound transmit through it due to the energy that transferred from one molecule to the other molecule. The oscillated molecules make other molecules to oscillate and those molecules produce a sound as consequence of vibration.

Human can sense the sound through the ear and its vibration through the skin as a periodic displacement. Human can only sense the sound in the certain range of frequency (20-20000 Hz) that called *audible sound*. The sound that can't be sensed by human ear are categorized to be two categories : frequency that fall below 20 Hz are categorized as infrasonic sound, and if fall above 20000 Hz are categorize as ultrasonic sound (Hooper, 2001). Although those kind of sound can't be sensed by human sensory system, they can still affect human body due to their physical characteristic and behaviour, such as they are vibrate in certain frequency, they can be reflected, etc. Sound vibration, the reason

why sound is occurred, can affect human body by making certain parts of the body vibrate with the same frequency, called *resonance*.

Vibroacoustic Therapy (VAT) is a new fashion of therapy that uses sound vibration from audible sound as a physical agent that intervene human body with non-invasive method. This therapy is pioneered by Olav Skille since 1982 that use 30-120 Hz rhythmic sinusoidal sound accompanied by music as therapy purpose (Punkanen et al., 2012). Skille attached six loud speaker as transducer of sound vibration at chair, two speaker were positioned to facing pair of leg, another two speaker at the seat area, and the lasts were at neck and back(Hooper, 2001). Skille believed that VAT is effective to reduce pain and another stress-related symptoms. Nowadays, VAT is a part of musical therapy, that has been used worldwide (Punkanen et al., 2012). VAT become alternative therapy because it were not used drugs to treating patient. VAT purely only use physical agent, vibration and music.

3.2 *VAT effect on anxiety*

Anxiety is a normal condition that every people has ever felt. Feeling anxious is normal unless it occurred in a long time and distract daily activity. That kind of anxiety can be categorized as anxiety disorders that differentiate to three more types of disorders: generalized anxiety, panic disorder, and social anxiety disorder. Anxiety can trigger fight or flight response that make body's sympathetic nervous system to release certain kind of hormones such as cortisol. Cortisol can affect human body that can be watched empirically such as fast heartbeat, shortness of breathing, rapid breath, etc. That indicate that anxiety can be watched via physiological phenomenon. The opposite, feeling of relax, means the contraindication of physiological behaviour that occurred due to anxiety.

Tanner has been conducted a research to seek how people with stress condition react after some period of VAT did to them. She make her respondents feeling stress for five minutes with some tests and then let them treated by VAT for five minutes and make them did the same tests once more. The physiological measurements has been conducted for each respondent during tests before and after VAT treatment was did. Those measurements are pulse rate and oxygen saturation level. A questionnaire for respondents was accompanied in that research for seek their personal assumptions about their feeling.

A results from that research are the decrement of pulse rate of 71.43% with average value 10.97 bpm, the increment of saturation of oxygen (SpO₂) in 35.71% respondents after VAT occurred, and the increment of performance during did the second tests. The questionnaire result showed that 78.57% respondents felt less of anxiety.

Tanner stated that her research has many limitation such as the respondents that already know about music therapy and want to support her research , so that potentially Hawthorne effect was occurred. The respondents also did the same tests after VAT treatment that can be categorized as a limitation too (Tanner, 2012).

3.3 *VAT effect on Fibromyalgia*

Fibromyalgia is a chronic syndrome involving generalized joint and muscle pain and fatigue. The etiology of this syndrome is still unknown but physical trauma, emotional trauma, and even human immunodeficiency virus (HIV) infection has been believed as a factors that lead to fibromyalgia. Patients who suffer fibromyalgia are more sensitive to feel a pain due to the mechanical and thermal pain thresholds that lower than healthy people (McCance et al., 2010).

Although there is lack of evidence on any medical treatment capability to cure fibromyalgia, low frequency sound stimulation showed its effectiveness in overcoming fibromyalgia symptoms. It is indicated through some instruments that traced patient's condition that linked with fibromyalgia or its symptoms. The instruments are:

Fibromyalgia Impact Questionnaire (FIQ), Jenkins Sleep Scale (JSS), Pain Disability Index (PDI), and Range of Motion (ROM). According to pain impact score on FIQ, there is a vast difference between before low frequency sound stimulation treatment with after treatment (81 %). It showed a significant decrement that mean patients suffer less pain impact after treatment than before treatment. The significant decrement also showed by JSS (90 %) score after treatment that means sleep disturbance that led by fibromyalgia is overcome through low frequency sound stimulation. The reduction of PDI till 49 % score lead to the conclusion that patients feel less pain after treatment was occurred. The effectiveness of low frequency sound stimulation is shown too through the increment of the ROM score after treatment (Naghdi et al., 2015).

3.4 *VAT effect on Alzheimer*

Alzheimer's disease (AD) is a cause of dementia syndrome that leads peoples to several of brain disabilities such as remember, learn, and even do the simplest tasks thanks to massive neurodegeneration of brain that continue to disconnects neurons communication and disrupts their metabolism and repair so neurons are dying and die. There are some risks factors that have been identified which lead to AD such as obesity, hypertension, down syndrome, and etc. Some researchers believe that genetic risk factors take a role in the pathophysiology of this disease. However, etiology of Alzheimer's disease is still unknown and there is need further study to reveal it. AD is currently cannot be cured, although medication such as donepezil, galantamine, and AChE inhibitors are referred for AD patients to slow down AD activity and reduce some symptoms for a length of time. Those medications are have a side effect for patients, such as dizziness, diarrhea, and headache. Therefore, a new therapy has to be discovered for overcoming AD's symptoms or even cure this disease. A study of behavior of drug-hypersensitive PC12 mutant cell (PC12m3 cell) while treated by vibrational sound shown a promising idea for a cure of AD. This cell could display neurite outgrowth and even differentiate to be a nerve cell due to the activity of nerve growth factor (NGF) and p38 mitogen-activated protein kinase (p38 MAPK). Beside of those chemical agents treatment, with the presence of NGF, PC12m3 cell was treated with vibrational sound at 40 Hz and shown a greater of neurites enhancement than without vibrational sound treatment. A 200 Hz vibrational sound was also used too but shown less neurite enhancement than at frequency 40 Hz. The 40 Hz frequency also shown it's capability to trigger p38 MAPK to be activated for neurite outgrowth in PC12m3 and 200 Hz frequency was not showing any neurite enhancement. Although that study shown good effects of vibrational sound on a single cell, the facts that complemented inside it are support the suggestion of capability of vibroacoustic therapy for healing AD. Low frequency vibrational sound that used in VAT could trigger the factors of neurite outgrowth in cell to be activated so there is possibility that VAT could regenerate the brain and replace died and dying neurons in brain with new neurons by send low frequency sound to the brain through a vibrotactiles (Koike et al., 2004).

3.5 *VAT effect on Juvenile Idiopathic Arthritis*

Juvenile Idiopathic Arthritis (JIA) is a term for arthritis diseases in children with age 16 or younger. The etiology of JIA, as it's name that complemented idiopathic term that means unknown origin, is not clearly known, but is believed that genetic and environmental factors are involved. Beside both of them, another factors that have possibility to influence the origin of JIA are immunologic and hormonal abnormalities, stress, trauma, and infectious triggers (Espinosa & Gottlieb, 2012). According to International League of Associations for Rheumatology, JIA is classified into seven categories : (1) Systemic Onset, (2) Oligoarthritis, (3) Polyarthritis, Rheumatoid Factor Negative, (4) Polyarthritis, Rheumatoid Factor Positive, (5) Psoriatic Arthritis, (6) Enthesis-related arthritis, (7) Undifferentiated Arthritis. Nowadays, treatments for JIA

patients are depending on drugs such as Nonsteroidal Antiinflammatory Drugs (NSAIDs) and Intraarticular Corticosteroids (Haines, 2007). But there is non-pharmacological therapy that shown effectiveness to treat JIA, vibroacoustic therapy. A study has shown that a group of patients that intervened with physical stimulus from vibrational sound beside conventional drugs, after 12 weeks of treatment, experienced more reduction of swollen joints and improvement of movement range than another group that only treated with conventional drugs. Comparing with group without VAT, The SDAI (Simplified Disease Activity Index) of group with VAT were decreased significantly after treatment. Beside these physiological improvements, VAT shown its contribution to decreasing less sleep and depression level (Ailioaie et al., 2011).

4. Discussion

Most of researches show that VAT affect human body positively, although some effects in certain condition are insignificant. The positive results to human health indicate that the physical phenomena of vibration in body, in a certain range of frequency, in this case at range audible sound, influence physiological behavior within the human body. But almost all of researches are showing an empiric evidences of benefit of VAT with neglecting the relation between mechanical activity of certain body parts with their physiological occurrence when the vibration occurring. Therefore, there is need a study that review how body work straightaway when vibration was occurred. There will be a review of microscopic scale of physiology, involving cells and their molecules, that providing the main reason of why that empiric physiology data are obtained.

Beside there is need to know how vibration intervene certain body parts straightaway when the vibration start, in certain diseases, there is need to know the pathophysiology and etiology of those diseases for therapy purposes. As an example, fibromyalgia is the diseases with unknown etiology. Naghdi et al, in their research, showed the advantage of low frequency sound stimulation to overcoming fibromyalgia's symptoms. The advantage represents the big potential of vibroacoustic therapy that used LFSS as a physical agent therapy for being alternative medicine for fibromyalgia case. Indeed, VAT is potential to be a cure of fibromyalgia if executed gradually to patient. However, there needs further research about fibromyalgia etiology before concluding what the best treatment for overcoming this syndrome.

Another research that conducted by Koike et al. confirmed the advantage of low frequency sound vibration on triggering brain mutant cell to regenerating neurite for overcoming Alzheimer diseases. However, that study is refer the effects of low frequency sound in a solitary cell and artificial environment so there is need a study of that effect in tissue or organ scale and with brain environment. That research fashion could leads to more discoveries of correlation of the brain and low frequency sound, especially in brain with AD, and to more possibilities of alternative medicine that used sound as physics agent therapy.

Ailioaie et al. also confirmed the benefit of VAT for medical purpose. They conducted research that showed the ability of VAT to reduce a symptoms of JIA patients. These phenomena conclude that VAT is a very potential therapy to treat and heal rheumatoid diseases in the human body without the intervention of drugs and other chemical agents. VAT can revolutionize the way of arthritis therapy and become a new fashion of alternative therapy for patients that suffer joint diseases.

The effect of vibrational sound to human psychology can be known by watching his/her physiology. For example, anxiety influence body to produce cortisol hormone that able to increase blood sugar level. Moreover, anxiety is causing heartbeat more fast, rapid breath, and etc. Therefore, beside questionnaire that filled by participants of research, psychology phenomenon that occurred due to vibrational sound can be learn through

physiological analysis. Research by Tanner confirmed the decrement of anxiety level on participants after VAT was conducted to them.

The effect of vibrational sound to the body may be blurred if research are involving music in the therapy. Music can interfere brain and make people who hear it enjoy. That will affect body physiology and make the effect of vibrational sound to the body blur.

There is need further researches to reveal the exact exposure of low frequency sound vibration to the body, especially on the physical aspect, cellular and microscopic scale within the body. Brain also interesting to study because psychological and physiological phenomenon are initiated from the brain. An instrument such as EEG and MRI could be involved for gather a physical data of brain while vibration is occurring.

For conclusion, low frequency sound vibration is beneficial in medicine according to its advantage to upgrading the physiological condition of the body that followed by increasing of psychological condition. There is still further research to know how exactly human body responds upon a vibrational stimulus.

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