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The Assessment of the Effect of Music Therapy on Stress Levels of Individuals

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Abstract

In the modern world, stress has been increasingly affecting individuals' psychological and physical well-being. The most common treatment methods are antidepressants, yoga, and meditation. However, despite the existence of these methods, individuals negatively influenced by stress have been continuously augmenting. Hence, this review aimed to assess the effect of music therapy on the stress levels of individuals. Stress levels were analysed and evaluated using the most common biomarkers in the scientific literature. Data and conclusions collected from different studies, including randomised clinical trials and pilot studies, were utilised for presenting a wider range of scientific literature as well as to reach a more overarching conclusion. It was concluded that additional research for different types of music therapy, music genres, tempos, and time of exposure was required. It was also demonstrated that the scientific evidence for this topic was too limited due to the small sample size and limited contexts of stressors. Therefore, investigation of different settings, instead of only medical and educational environments, or the same research question with different sample groups were shown to be potential for future research.

Keywords: blood pressure, heart rate, hormone, music therapy, stress.

INTRODUCTION

Stress can be described as a state of mental, emotional, or physical tension (*Stress and Your Health: MedlinePlus Medical Encyclopedia*, n.d.). There are three main types of stress: acute, chronic, and traumatic stress. Acute stress, which is usually experienced as a response to perilous or thrilling situations, is ephemeral. Meanwhile, chronic stress, as its name suggests, lasts

for an extended time period. Traumatic stress, unlike others, is triggered by a life-threatening experience that exposes a person to the feeling of fear or helplessness, which might maintain its detrimental effects as PTSD, post-traumatic stress disorder (Professional, n.d.). Among many symptoms of this tension are headaches, muscle tension, weight loss, sleep troubles, and fatigue.

Today, numerous people suffer from stress and its symptoms regardless of its type, which makes stress a vital health topic to be addressed. In fact, according to the American Institute of Stress, in 2022, 77% of people claimed their physical health is influenced by stress while 73% stated that their mental well-being is impacted by it (*Stress: What You Need to Know | McLean Hospital, 2023*).

There are several treatment methods that can be utilized to reduce the stress experienced by people. However, the main applied ones are medication and alternative therapies (*Treatment for Stress, n.d.*). The most common medicaments administered to cope with stress are beta-blockers, selective serotonin reuptake inhibitors (SSRIs), and tranquillizers (Lillis, 2023). Even though these drugs may be impactful in declining stress, they might display some severe effects on health. In the short term, they may impede brain function, and cause drowsiness, dizziness, diarrhoea, constipation, nausea, or rashes (*Beta-blockers for Anxiety: What to Know, 2023; Short and Long Term Effects | Teens | Survive - Stop Yourself. Stop a Friend., n.d.; SSRIs - Tests & Treatments | NHS Inform, 2023*). In the long range, however, the continuous usage of the medicaments may result in addiction and cause seizures or even death. They might also complicate concentrating and cause sleep disturbance, sexual dysfunctionality, and emotional lability.

Alternative therapies, on the other hand, comprise acupuncture, Tai Chi, aromatherapy, hypnotherapy, yoga, and meditation. Although there are instances, in which alternative therapies have been beneficial, there is not a sufficient amount of scientific evidence to support their effectiveness. Moreover, each of the aforementioned alternative therapies possesses downsides. For instance, acupuncture may cause soreness, bleeding, and soreness; rigorous forms of Tai Chi have an increased risk for joints; aromatic plant oils used in aromatherapy may severely endanger skin if applied undiluted; hypnotherapy may result in sleep problems; yoga and meditation, if not performed with a correct technique, may result in injury (specifically for yoga), panic attacks, depression, negative thinking, and even re-enactment of traumatic childhood memories (*Acupuncture - Mayo Clinic, 2023; Sauer, 2018; Aromatherapy, n.d.; Hypnosis - Mayo Clinic, 2022; Johnson, 2022*).

MUSIC THERAPY

Considering the drawbacks of the available treatments, a new alternative and its potential have been of central interest to certain research papers, especially in the last century: music therapy. Music therapy is the therapeutic utilization of music or its elements, such as sound, harmony, melody, and rhythm, to address the emotional and physical needs of individuals or groups (Professional, n.d.; Ramalingam et al., 2022; *What Is Music Therapy? | Taking Charge of Your Health & Wellbeing, n.d.*). Although scientific evidence has been gathered predominantly after the 1800s, it has been one of the most accustomed approaches to treating diseases in various cultures since ancient times (*History of Music Therapy | American Music Therapy Association (AMTA), n.d.*).

Two main forms of music therapy are receptive and active music therapy (Ramalingam et al., 2022). In the first type (receptive), people are not involved in the creation of music themselves. They listen to music and respond to it silently, verbally, or physically (i.e. dancing) for a pre-determined period of time. The latter form (active), however, requires people to be engaged in music production. Individuals could improvise arbitrary sounds and lyrics, create music with the assistance of their therapist, or mimic

the music their therapist created, either by singing the lyrics or playing the instrumentals (*What Are the Four Methods of Music Therapy?, 2022*). This type of therapy does not require any musical talent, which makes it possible for people to receive music therapy regardless of their age and gender.

The primary focus of music therapy is to uplift the mood of the patients, explore their emotions, reduce their depression, and ease their anxiety or stress levels. Nonetheless, the potential advantages of music therapy further include building social skills and improving communicative skills, strengthening self-confidence, and developing cognitive skills (i.e. problem-solving, and language skills). Hence, the music genre might differ depending on the need for their treatment and the preferences of the clients. Some of the most frequently applied music genres are classical, jazz, rock, and country music.

Previously, scientific research demonstrated that music therapy, as a complementary therapy, might be beneficial for people with dementia, traumatic brain injuries, stroke, cancer, Parkinson's disease, autism spectrum disorder, and mood disorders (Professional, n.d.). However, the application of music therapy specifically for stress has been a new topic of interest. Although there are some research papers, regarding the impact of music therapy on stress, they are identifying the influence unilaterally, meaning that they evaluate the effect based on one of the indicators of stress (i.e. cortisol levels, blood pressure, or heartbeat rates). This research, therefore, aimed to provide an overarching conclusion regarding the impact of music therapy on stress by comparing evidence suggested for different indicators of stress as well as to evaluate the sufficiency of the scientific evidence provided by the scientific community.

In scientific literature, several stress indicators were utilised to measure stress levels in the body. Cortisol, norepinephrine and epinephrine hormones, diastolic and systolic blood pressures, and heart rates are the most common biomarkers. In this review, the effect of all of these indicators was synthesized to arrive at a conclusion.

CORTISOL

The indicator most frequently evaluated in the literature was cortisol levels (Professional, n.d.). Cortisol, predominantly known as "stress hormone," is a steroid hormone, as can be seen in **Figure 1**, that is secreted from the adrenal glands, located at the top of the two kidneys in the human body. Pituitary glands, placed at the base of the brain, are responsible for the regulation of cortisol production (*The Role of Cortisol in the Body, n.d.*). As a "fight-or-flight hormone" and a neurotransmitter, cortisol has a vital function in the regulation of the body's stress response. Additionally, the cortisol hormone plays a crucial role in regulating blood pressure and blood sugar, repressing inflammation, and controlling metabolism (the use of fats, proteins, and carbohydrates) (Professional, n.d.). Cortisol amount increases when a person feels stressed, whereas, cortisol levels decline as stress dissipates in the body.

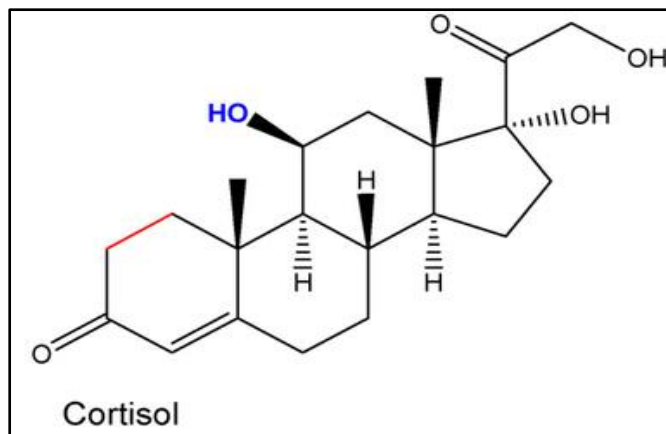


Figure 1 (Fig. 1. Molecular Structure of Cortisone (C₂₁H₂₈O₅, MW = 360.44),. . ., n.d.): The Chemical Structure of Cortisol Hormone

The coping mechanism behind this primary stress hormone is directly related to blood glucose levels (*Cortisol | You and Your Hormones From the Society for Endocrinology*, n.d.). When a person is exposed to stress, certain cells in the hypothalamus release corticotrophin-releasing hormone. This hormone stimulates pituitary glands to secrete adrenocorticotropic hormone into the bloodstream. When adrenocorticotropic hormone is detected in high amounts in the bloodstream, cortisol production is stimulated in the adrenal glands. This raises the cortisol levels in the blood. When one is under stress for a prolonged time, it means their adrenal gland is frequently stimulated by these hormones. Hence, long-term exposure to extreme stress may result in the surplus production of cortisol hormone, which could potentially exhaust adrenal glands. This may cause the adrenal glands to no longer produce sufficient amounts of cortisol hormone when required.

NOREPINEPHRINE AND EPINEPHRINE

The second and third types of indicators most commonly researched in the scientific literature were epinephrine and norepinephrine, whose chemical structures can be viewed in **Figure 2**. Similar to the cortisol hormone, norepinephrine and epinephrine are also neurotransmitters and “fight-or-flight” hormones that are located at the top of the two kidneys. When faced with a stressful situation, the release of these two hormones increases blood pressure, heart rate, and blood glucose levels (Lillis, 2023). Nonetheless, epinephrine has slightly more of an impact on the heart whereas norepinephrine has slightly more influence on blood vessels (Crna, 2023). More specifically, epinephrine, widely known as adrenaline, contributes to metabolism, concentration, attention, and excitement while also causing panic (Professional, n.d.). However, abnormal epinephrine levels might lead to anxiety, hypertension, sleep disorders, and weak immunity. On the other hand, norepinephrine, also called noradrenaline, augments alertness, attention, and arousal; constricts blood vessels to maintain blood pressure in response to stress; and might be involved in mood, memory, and circadian cycle (Professional, n.d.).

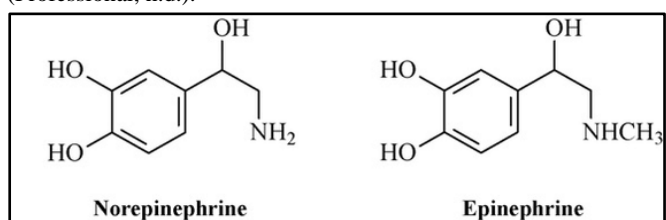


Figure 2 (Fig.4.Structural Formulas of Dopamine, Norepinephrine And . . ., n.d.): The Chemical Structures of Norepinephrine and Epinephrine Hormones

Although epinephrine and norepinephrine are both secreted from the adrenal glands, their secretion involves other mechanisms as well (Honour, 2023). When the hypothalamus receives stress signals from the amygdala, a centre in the brain for processing emotions, it sends signals to the adrenal medulla through the autonomic nervous system. As a result, the adrenal medulla releases norepinephrine and epinephrine hormones into the bloodstream. Long exposures to abnormal levels of epinephrine may increase the potential risk of heart attack or stroke and may lead to heart palpitations, high blood pressure, weight loss, or anxiety (*Adrenaline*, 2023).

BLOOD PRESSURE

Blood pressure and heart rate were two biomarkers utilised in the scientific literature following cortisol, epinephrine, and norepinephrine. Blood pressure is a measure of the force (pressure) of blood against the walls of arteries after it is pumped from the heart (Website, 2023). Blood pressure is measured in two figures: systolic and diastolic blood pressure. Systolic blood pressure is the pressure in the arteries measured when blood is pumped out of the heart. Diastolic pressure is the pressure in the arteries between the heart is at rest between beats. Since blood pressure in the arteries declines when the heart relaxes, systolic pressure is always higher than the diastolic value (*Understanding-Blood-Pressure-Readings*, n.d.). According to the American Heart Association, normal systolic blood pressure is less than 120 mmHg and normal diastolic blood pressure value is less than 80 mmHg for people 18 years or older (*High Blood Pressure Symptoms, Causes, and Problems | cdc.gov*, 2023). If the systolic pressure is between 120 mmHg and 139 mmHg while the diastolic pressure is in a range of 80 to 89 mmHg, it means the individual has elevated blood pressure, which is categorized as “prehypertension.” In extreme cases where the systolic value is 140 mmHg or higher and diastolic pressure is 90 mmHg or higher, the individual is diagnosed with hypertension, in other words, high blood pressure. This information is summarized in **Table 1**.

Table 1 (*High Blood Pressure Symptoms, Causes, and Problems | cdc.gov*, 2023): The Summary of Normal, Elevated, and High Blood Pressure Values for Systolic and Diastolic Blood Pressure

The American College of Cardiology/American Heart Association Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults (2017 Guideline) ¹	
Normal	systolic: less than 120 mm Hg diastolic: less than 80 mm Hg
Elevated	systolic: 120-129 mm Hg diastolic: less than 80 mm Hg
High blood pressure (hypertension)	systolic: 130 mm Hg or higher diastolic: 80 mm Hg or higher

Given data by the World Heart Federation estimates that 1.3 billion adults, whose ages range between 30 and 79, are hypertensive (*Hypertension | What We Do | World Heart Federation, 2023*). Although there is not sufficient scientific evidence to claim that stress by itself is a direct cause of hypertension, stress can repeatedly elevate blood pressure, which increases the risk of hypertension. When left untreated, hypertension may lead to stroke, vision and memory loss, kidney damage, atherosclerosis, angina, or heart attack. Even though professionals recommend having a healthy diet with less salt, regular physical exercise, limiting alcohol consumption, prohibiting cigarettes, and sleeping 7 to 9 hours, there is still no permanent cure for hypertension, which emphasises the importance of not having hypertension (*Low Blood Pressure (Hypotension) - Symptoms and Causes - Mayo Clinic, 2022*).

HEART RATE

Heart rate, also called pulse rate, is the number of the heartbeat or contractions of the heart in one minute (Professional, n.d.). The resting pulse rate for an adolescent (13 - 18 years old) and an adult (18 years or older) is 60 to 100 beats per minute (bpm) (Professional, n.d.). This range varies for different age ranges: for newborns the estimated values are 100 - 250 bpm; for infants it is 100 - 180 bpm; for toddlers, it is 98 - 140 bpm; for children between 3 and 5 years old it is 80 - 120 bpm; for individuals from age 5 to 12 it is 75 - 118 bpm. A person's pulse rate may exceed 100 bpm, which is caused by the release of adrenaline and noradrenaline when they feel stressed (Geng, 2023). In this case, the heart rate is considered a fast pulse rate, also named tachycardia. Unless one is exercising or fighting off an infection, tachycardia may lead to heart failure, stroke, or abrupt cardiac death (*Tachycardia - Symptoms and Causes - Mayo Clinic, 2023*).

DISCUSSION

INFLUENCE OF MUSIC THERAPY ON CORTISOL LEVEL

In scientific literature, the impact of music therapy on stress was usually measured either preoperatively or postoperatively when the cortisol hormone was utilised as the stress biomarker. In these studies, the cause of stress was determined as the surgical operation or perioperative procedures that the patients were supposed to undergo. In a study, specifically focusing on the impact of IV-line insertion on the cortisol levels of children diagnosed with leukaemia, researchers found that music therapy declined the cortisol levels in the body by 0.67 ng/mL on average. However, a 2018 study performed with the participation of 107 healthy individuals aged between 19 and 23 revealed that cortisol levels could rise ninefold when participants were under extreme stress (Çay et al., 2017). Similarly, in another research examining stress levels before and during exam periods on medical students, it was concluded that during relaxation before the examinations the cortisol level in females was 2.92 ng/mL and 2.48 ng/mL in males (*Effect of Examination Stress on Mood, Performance and Cortisol Levels in Medical Students, 2012*). In the course of the exam period, however, the hormone level rose to 5.19 ng/mL in female students and to 5.02 in male students, indicating an increase of 2.27 ng/mL in females and 2.54 ng/mL in males. The results of these two studies provide evidence that in the study conducted on children with leukaemia, an average augmentation of 0.67 ng/mL was statistically insignificant, meaning that music therapy was not necessarily impactful in decreasing cortisol levels, one of the most crucial stress hormones and biomarkers (Mulatsih et al., 2020).

Another particular situation, in which music therapy was noted as "ineffective" in lowering cortisol levels, was when people had a fever. As an immunosuppressive and anti-inflammatory hormone responsible for activating the immune response, cortisol increases when an individual has a fever. 80 - 90% of cortisol circulating in the body is released by Cortisol Binding Globulin (CBG) — a protein that is sensitive to alterations in temperature (Cizza & Rother, 2012; Ramalingam et al., 2022). It was also found that not only in a fever, but also in similar conditions that result in extreme levels of cortisol, such as infection severity, disability, children with cancer relapse, and repeatedly sticking, music therapy remained ineffective in reducing cortisol levels. One might argue that the studies presented so far are solely concentrated on either children or young people, which decreases the reliability of their results for different age groups. However, there is another study, performed among people aged between 32 and 62, that reinforces the ineffectuality of music therapy on the declination of cortisol hormone. According to the study, no significant differences were acquired when 30 females received music therapy postoperatively. Although the age range provides supportive evidence that even at older ages music therapy maintains its inadequacy on cortisol levels, one should not overlook the limitations of the sample group. Considering that the experiment was performed on 30 participants that consisted of solely females might indicate that the conclusion may not be the same for males at the same age interval. Additionally, it is understandable to suggest that the sample range was not sufficient enough to arrive at a general conclusion for everyone.

Despite compelling evidence against the ineffectiveness of music therapy in declining cortisol hormone levels, there is another experiment mentioned in the same research paper that supports the significant influence of music therapy on cortisol levels (Ramalingam et al., 2022). In that experiment, 20 participants aged 21 - 60 years received music therapy intraoperatively, including anaesthesia, and opted for the music of their own preference (*APA PsycNet, n.d.*). The findings demonstrated that participants who listened to music according to their personal stereo were under significantly less stress when compared with the control group that did not listen to music. The article specifically indicated that the operation was a minor surgery, which might point out that the results are deficient in validity and reliability for extreme stress cases. Nonetheless, the fact that globally, 67% of people do not have extreme stress reinforces moderate and lower stress is relatively more widespread than extreme stress, rendering more importance to the findings of the experiment (*67 Workplace Stress Statistics in 2023, n.d.*). Moreover, it might be assumed that the sample range was too small, similar to the previously mentioned research. Considering that the difference of both experiments' sample ranges was not as different, however, it can be suggested that their reliability is similar in this aspect. Similarly, in a randomized controlled trial, it was observed that patients who received postoperative music therapy had significantly lower levels of cortisol in comparison to the people in the control group. While patients in the control group had a 72 mmol/L decrease in the level of the hormone, patients who listened to music almost tripled the decline, 206 mmol/L (Nilsson et al., 2005).

All the data provided above showcase that while in certain studies music therapy was found significantly effective, in others its efficiency was insufficient. The fact that most of the studies that concluded music therapy had an insignificant impact on cortisol levels were performed with children and young people narrows

down the reliability of the studies to a limited age interval. Meanwhile, studies claiming the effectiveness of music therapy were conducted within a wider range of ages, increasing the validity of the data for more people. However, the common feature of all the studies was that they were either entirely focused on school exams or surgical operations as a source of stress without accounting for the impact of other sorts of stressors, such as financial difficulties and stress included in a working environment.

EFFECT OF MUSIC THERAPY ON EPINEPHRINE AND NOREPINEPHRINE

Similar to the cortisol hormone, stress levels have been researched using norepinephrine and epinephrine in scientific literature. One study conducted with the participation of male and female Japanese college students, for instance, concluded that high-uptlifting and low-uptlifting music types had different effects on neuroendocrine responses in the body (Hirokawa & Ohira, 2003). Moreover, in another pilot research performed on patients with mechanical ventilatory support, the researchers gathered evidence demonstrating that the concentration of both hormones varied between individuals listening to music and those who withheld it (*Influence of Music on the Stress Response in Patients Receiving Mechanical Ventilatory Support: A Pilot Study*, 2007). Although these studies second a correlation between stress and adrenaline and noradrenaline, the inadequacy of sample size and the limited variety in the sample groups, such as searching solely for the impact on Japanese college students and not students from other nations or other levels of school, render both experiments inconclusive.

Despite the augmentation of the evidence in favour of the positive correlation between stress and these two hormones, some of the results show the inconsistency of this correlation with different genres of music. A study conducted on the physiological and psychological influence of techno-music and classical music on individuals, for example, demonstrated that there was a dramatic increase in the level of norepinephrine due to the exposure to techno-music while no change was observed in epinephrine levels (Gerra et al., 1998). However, the results also noted classical music had no impact on the levels of both hormones. One might interpret this finding as the ineffectiveness of music therapy in reducing adrenaline and noradrenaline levels and thus stress. However, the same study used the Cloninger scale, a psychobiological model that identifies different dimensions of temperament and personality, to identify the influence of norepinephrine presence in the body (De Fruyt et al., 2000). It was concluded that norepinephrine was inclined towards novelty-seeking rather than harm avoidance on the scale (Zuckerman & Aluja, 2015). This signifies that individuals had a tendency to feel exhilaration and excitement rather than stress. In other words, the increase in the levels of norepinephrine was not necessarily associated with stress levels.

Comparatively, another research measuring the impact of listening to music before exercising reached the conclusion that slow rhythm music declined the plasma norepinephrine level; meanwhile, fast-tempo music increased the plasma epinephrine level. The first bit of the conclusion could be suggested as supporting evidence to the argument that music might reduce stress by lowering norepinephrine levels. However, the second half of the conclusion creates a contradiction with some other research. As opposed to the previous research that stated no relationship between epinephrine levels and techno-music, this study's findings claimed the opposite. Even though the tempo of the techno music was not particularly

stated in the previous research, the tempo of techno songs is between 120 bpm (beat per minute) and 140 bpm, which falls into the fast category (2023). Furthermore, the study only made a commentary on the effect of fast rhythm music on the epinephrine level and not on the norepinephrine level. Likewise, solely the impact of norepinephrine was considered in slow-tempo music. This leads to the conclusion that the research was not sufficiently overarching since both hormones are biomarkers of stress.

Taking into account all the findings of the studies, the need for additional research is apparent. This is because of the restricted nature of the measurements of the experiments and the controversial results recorded in different research papers. However, the most vital point not to overlook is that the reduction of stress cannot be solely based on the levels of norepinephrine and/ or epinephrine. As the research made on techno- and classical music showed, the increase or decrease in the levels of both hormones might be the indicator of another occurrence in the body rather than stress. This accentuates the necessity of performing additional psychobiological or psychological tests that measure the effect of hormones on the emotional state and mood of individuals.

considered to be in the normal range. One such study aimed to investigate the effect of classical music on mood, heart rate, and blood pressure. It was concluded that while fast rhythm music increases the rate of heart as well as systolic and diastolic blood pressure, music in slow tempo had a decreasing effect on the same factors. However, the research did not rely only on the decreasing effect of these three elements to arrive at this conclusion (Darki et al., 2022). Instead, they consolidated their findings through the results of mood surveys, which is similar to the research on the effect of techno-music and classical music on individuals' psychology and physiology that corroborated their results with the Cloninger scale for epinephrine and norepinephrine levels, as can be seen in **Figure 3**.

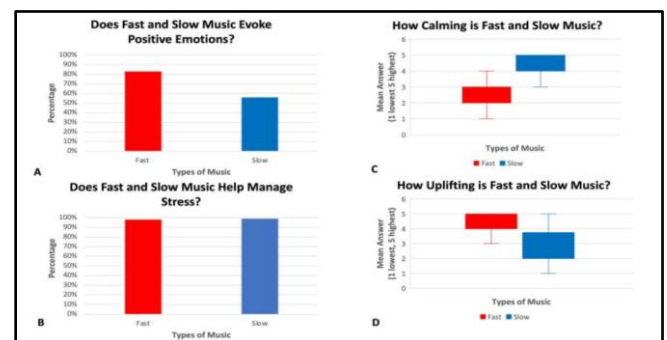


Figure 3 (Darki et al., 2022): The Graphical Representation of the Results of the Mood Survey

Another research conducted on patients with dental anxiety took a similar approach. While the researchers measured the stress level of 34 patients using heart rate and blood pressure, they also substantiated the validity of their findings by measuring salivary cortisol and body temperature (Mejía-Rubalcava et al., 2015). This strengthens the idea that arriving at a conclusion about stress levels solely by measuring heart rate and blood pressure is not sufficiently and scientifically convincing. The fact that the study results demonstrated a significant difference in not only heart rate and blood pressure but also salivary cortisol concentration and body temperature dramatically increased the reliability of the results. These findings were authenticated by another research's results, which indeed specified the change with music. According

to that research, due to music therapy heart rates decreased by 18 bpm with a confidence interval of 95%, indicating the high accuracy of the data. The systolic blood pressure declined by 9.2 mmHg and diastolic blood pressure decreased by 7.9 mmHg, both with a confidence interval of 95%. Considering a drop of 20 mmHg might result in dizziness and fainting, these drops, slightly less than half of the critical value, in the blood pressure can be classified as significant (*High Blood Pressure (Hypertension) - Diagnosis & Treatment - Mayo Clinic, 2022*).

A meta-analytical study focusing particularly on the impacts of music on heart rate and blood pressure found similar results: a significant reduction was observed in systolic blood pressure, diastolic blood pressure, and heart rate as a result of music therapy. The findings of this study are indeed more valid compared to many other studies considering the research was performed for individuals in various clinical settings, including people who underwent ambulatory surgery, who were in the intensive care unit (ICU), who were in ICU and received mechanical ventilatory treatment, who were women before breast biopsy, and who were going to receive vascular angiography. Additionally, the sample size was relatively larger, involving the participation of 659 patients, when compared to other studies measuring the effects of music therapy on different factors. However, the researchers did not specify the music genre utilised in music therapy, which lessens the reliability of the results since the previously mentioned offered a differing insight regarding the type of music and its effect on heart rate and blood pressure.

Although most of the studies suggest evidence that reinforces a positive correlation between stress and heart rate and blood pressure, a few research offered different results. According to the research that aimed at music's effect on the stress response, to which 60 female volunteers participated and listened to relaxing music, the sound of rippling water, or no music, it was concluded that heart rate values did not vary between groups. Similar results were obtained in another study aimed to measure the impact of music tempo on the heart rate, in which 16 males and 16 females with ages ranging from 19 to 31 took part (Van Dyck et al., 2016). The same music was used either with an increased tempo or decreased by 45%, 30%, 15%, or maintained the same tempo. The study showed that listening to music resulted in a significant increase in heart rate when compared with silence. Moreover, a smaller reduction in heart rate was observed when the tempo of the music was decreased. However, no association between the increase in the tempo and heart rate was observed. Additionally, no particular effect of music type on heart rate was found. The study concluded that music created general arousal regardless of music genre, which does not support the view that music therapy decreases heart rate and thus stress. However, the sample size and the gathered data might have been too small to come to a conclusive outcome.

CONCLUSION AND FUTURE RESEARCH

After considering all the findings and conclusions gathered from various studies, it can be concluded that further research is certainly required to arrive at an overarching conclusion regarding the influence of music therapy on stress and biomarkers since the scientific literature was concentrated on a limited aspect of music therapy. All of the research mentioned in this paper, and most in scientific literature, were focused on receptive music therapy disregarding active music therapy and its potential effects on stress and its biomarkers. Together with the existing limitation on music

genre in the scientific literature only to uplifting, relaxing, slow, and fast music, overlooking the second type of music therapy points out a huge lack of evidence in scientific literature to arrive at a decisive conclusion on this topic. Furthermore, the small sample sizes in many of the research presented are not sufficient to validate their conclusions, which shows the need for additional evidence for the same type of research question. In other words, the reproducibility of the present studies and future studies is essential for a better understanding of the impact of music therapy on stress biomarkers. Another important point to take into account is that the effect of music therapy on stress should be evaluated and analyzed based on several factors, involving cortisol, epinephrine, norepinephrine levels, blood pressure, and heart rate. The analysis of these elements separately is not enough to make a solid claim since there are plenty of factors that could affect the levels of these hormones, blood pressure, and heart rate. However, the occurred of consolidating trends in each factor could aid in arriving at an overarching conclusion. Furthermore, the impact of these elements is observed and measured in a very specific setting, usually before, during, or after a surgical operation, or school conditions. However, these are not the sole reasons for stress. Hence, in the future, the influence of all these factors and additional factors accounting for stress, type of music, the tempo of the music, kind of music therapy, and time of exposure to music could be measured in a wider context of stressors, such as stress caused by the work environment, for an efficient understanding of the potential of music therapy as a treatment for stress.

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