

Music therapy and music-based interventions in the treatment of pain: state of the art

Musicoterapia e intervenções baseadas em música no tratamento da dor: estado da arte

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ABSTRACT

BACKGROUND AND OBJECTIVES: Music therapy promotes positive effects on cognition, psychosocial aspects, control of somatic symptoms and quality of life. The influence on pain is still a controversial topic. The objective of this study was to investigate the state of the art of musical interventions and music therapy in the treatment of acute or chronic pain, as well as developing criteria to facilitate the creation of strategies for applying music in clinical research.

CONTENTS: This research was based on papers published between August 2010 and March 2023 in the Pubmed database. Of these, open access literature review articles were selected. A total of 44 studies whose results and conclusions showed that there is evidence of pain relief in many clinical and environmental conditions were selected, although there is great heterogeneity in methods and controversy in the literature regarding positive and adverse or side effects. The music chosen by a professional or patient alleviates significantly the painful experience by many mechanisms, although statistical data is limited or controversial.

CONCLUSION: Music appears to have a positive impact on various environmental situations or biological conditions that result in painful experience and, therefore, can significantly alleviate pain, which is supported by evidence of complex neural mechanisms involving the descending pain inhibitory system. The benefits justify the use of music as a low-cost and low-risk therapeutic strategy, and the methodological challenges justify a more careful design in future research, including details of the type of musical intervention performed.

Keywords: Anxiety, Pain, Orofacial pain, Music, Music therapy, Quality of life.

RESUMO

JUSTIFICATIVA E OBJETIVOS: A musicoterapia promove efeitos positivos sobre a cognição, os aspectos psicossociais, o controle de sintomas somáticos e a qualidade de vida. A influência na dor ainda é controversa. O objetivo deste estudo foi investigar o estado da arte das intervenções musicais e da musicoterapia no tratamento da dor aguda ou crônica e elaborar critérios para facilitar estratégias de aplicação da música em pesquisas clínicas.

CONTEÚDO: Esta pesquisa foi realizada a partir de trabalhos publicados entre agosto de 2010 e março de 2023 na base de dados Pubmed, sendo selecionados artigos de revisão da literatura de acesso livre. Foram selecionados 44 trabalhos cujos resultados e conclusões mostraram que há evidências de alívio da dor em diversas condições clínicas e ambientais, muito embora haja grande heterogeneidade nos métodos e controvérsia na literatura sobre efeitos positivos e adversos. A música escolhida por um profissional ou paciente alivia a experiência dolorosa, em muitos aspectos, de forma significativa, apesar dos dados estatísticos serem limitados ou controversos.

CONCLUSÃO: A música parece apresentar impacto positivo em diversas situações ambientais ou condições biológicas que resultam na experiência dolorosa e, portanto, pode aliviar a dor de forma significativa, o que é suportado por evidências em mecanismos neurais complexos que envolvem o sistema inibitório descendente de dor. Os benefícios justificam o emprego da música como estratégia terapêutica de baixo custo e baixo risco, e os desafios metodológicos justificam um delineamento mais cuidadoso em pesquisas futuras, incluindo detalhes do tipo de intervenção musical utilizado.

Descritores: Ansiedade, Dor, Dor orofacial, Música, Musicoterapia, Qualidade de vida.

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HIGHLIGHTS

- Music activates various brain structures and interferes with neuronal processing, causing changes in the perception of pain and in cognitive, affective and evaluative processes.
- The implementation of non-pharmacological therapies, including music therapy, although not the essential management of pain, can be considered an adjunct to patient care.
- Individual musical preference should be considered in the music therapy plan, as music has a greater analgesic effect if it is chosen by the patient themselves.

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INTRODUCTION

Music can play an important role in psychosocial aspects and improve the quality of life of individuals by reviving memories, evoking feelings, improving non-verbal communication, providing a healthy environment and strengthening interpersonal relationships¹. In terms of its use in healthcare, music can improve behavior and psychological symptoms, such as depression², anxiety, apathy and agitation, as well as modulating pain for patients³, but also for their families when coping with illness or mourning⁴.

Music can positively affect vital signs and the perception of pain in hospitalized patients, reducing pain and lowering blood pressure and respiratory rate. It is a low-cost, effective, pleasant therapy that is accessible to everyone, including staff and companions⁵.

According to the International Association for the Study of Pain (IASP), the current definition of pain is: “an unpleasant sensory and emotional experience associated with, or resembling that associated with, actual or potential tissue damage”⁶. Therefore, the implementation of non-pharmacological therapies, including music therapy, although not the essential management of pain, can be considered an adjunct to patient care. It is suggested that educational strategies on music therapy be implemented with health professionals in order to increase its application in health services⁷.

Likewise, it is important to establish interdisciplinary groups that generate intervention proposals for the management of painful conditions, based on evidence and that promote the implementation of non-pharmacological strategies that contribute to the patient's well-being⁷. Despite the extreme importance identified in the use of complementary therapies, these therapeutic modalities are still rarely included in health care⁸.

The scientific evidence on pain relief with music therapy or music interventions is weak, and there is controversy about the other positive and negative effects of the technique applied, for which there are no well-defined protocols in pain studies⁹.

The research question of this study was: “can music therapy or music intervention in health care reduce pain, acute or chronic, or influence the pain experience?”.

The main objective of this study was to carry out a literature review to investigate the state of the art of music interventions and music therapy in the treatment of acute or chronic pain in different clinical contexts. The secondary objectives were to gather information on the effects, advantages, disadvantages and limitations observed in studies on music interventions and music therapy in the treatment of acute or chronic pain, as well as to develop criteria to facilitate the creation of strategies for applying music in clinical research.

CONTENTS

This integrative literature review study used a bibliographic survey of the Pubmed database between August 2010 and March 2023, using the MeSH descriptors “music therapy” and “pain”. The inclusion criteria were review articles, published in Portu-

guese, Spanish and English, with a full version, free online access and those still in the process of being published, published no more than 10 years after the start of this research, i.e. from August 2010. During the screening, articles that were not related to the aim of this study and its keywords were excluded after reading the titles and abstracts.

After reading the screened papers, those that did not present clear results on the influence of music therapy or music intervention in the treatment of pain were also excluded in the eligibility phase, according to the recommendations of the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA¹⁰ - figure 1). The studies selected in the PRISMA inclusion phase were read in full and information was collected on 1) the objective of the study; 2) the main results, which exclusively presented the influence of music therapy or music intervention on the characteristics of pain in the research subjects.

RESULTS

The database search returned 920 papers and, after applying the inclusion and exclusion criteria, 113 papers were screened. After reading the title and abstract, 27 papers were excluded due to non-relevance or duplication, leaving 72 papers eligible for full reading. Of these, 28 papers were excluded because they did not present clear results on the influence of music therapy/music in the treatment of pain. The final selection therefore resulted in 44 studies being included in this study (figure 1).

Considering the papers included (n=44), figure 2 shows a clear increase in the number of publications per year from 2020 onward. The main results of the studies are shown in table 1. Of these, 40 studies showed evidence of a reduction in pain levels in

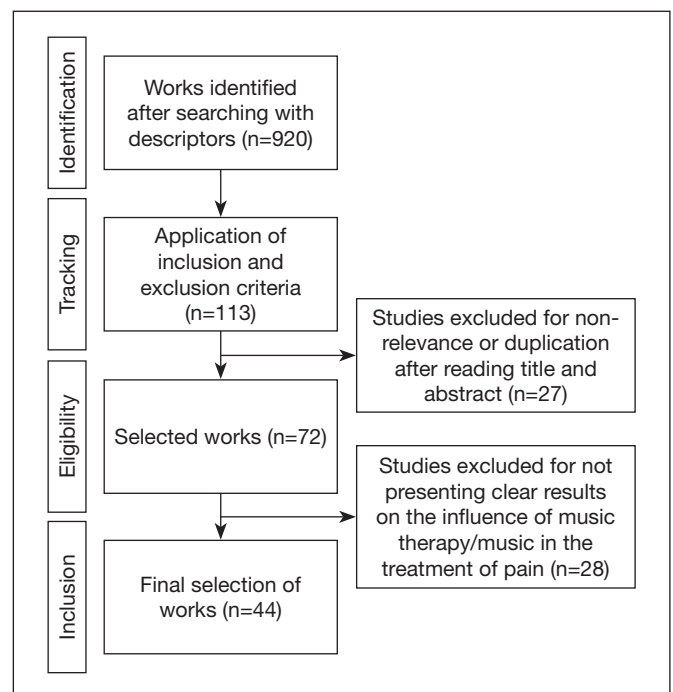


Figure 1. Search flow in Pubmed database according to PRISMA Statement¹⁰

different clinical conditions, while 4 showed no improvement. Among the papers included in this research, figure 1 shows that the number of scientific papers has been increasing in recent years. The main results and/or conclusions of the studies included are shown in table 1.

DISCUSSION

Music therapy is an intervention in which the therapist works with the client to promote health, using musical resources with objectives and strategies established in the professional-client re-

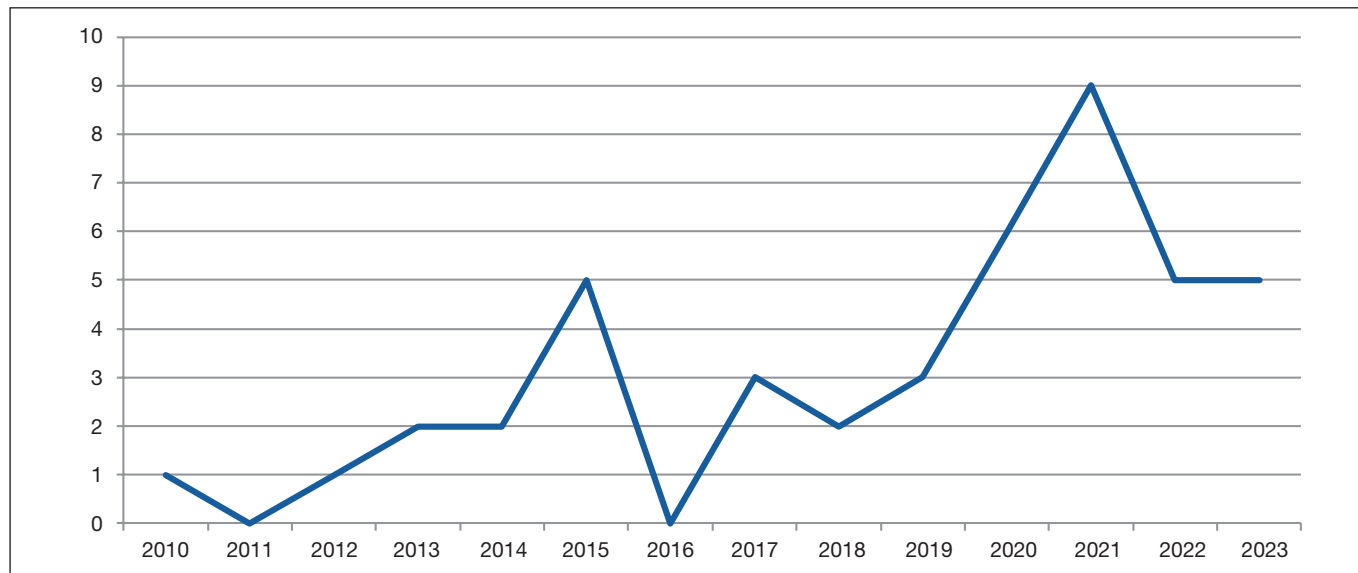


Figure 2. Number of scientific papers included by year of publication

Table 1. Distribution of literature review articles included, objectives, main results and/or conclusions, in ascending order of year of publication

Authors	Year of publication	Objectives	Results and/or conclusions
Bradt and Dileo ¹¹	2010	To investigate the effectiveness of music therapy in end-of-life care.	No evidence of a beneficial effect on pain.
Santos and Carvalho ¹²	2012	Analyzing nursing care for people with arthritis.	Only one study showed a reduction in pain in elderly people with arthritis, and recommended a 20-minute daily session of listening to music that has between 60 and 80 beats per minute, especially music that promotes relaxation, such as classical music.
Archie et al. ¹³	2013	To evaluate musical interventions in palliative cancer care.	Music reduces acute pain and the use of painkillers.
Thrane ¹⁴	2013	To clarify which integrative modalities are most effective in reducing pain and anxiety in children and adolescents with cancer.	Music therapy is a modality with good evidence of a positive effect on pain reduction.
Greenlee et al. ¹⁵	2014	A clinical guide to inform doctors, patients and researchers about the state of the science regarding the evidence-based use of complementary and integrative therapies for patients undergoing breast cancer treatment.	Music therapy can be considered to relieve the pain associated with surgery (level of evidence: C).
Pauwels et al. ¹⁶	2014	To present relevant neurobiological effects of listening to music in adults, the Mozart effect and the benefits of music for diseases.	There is a moderate effect on pain reduction, which is greater if the music is familiar, chosen by the research subject.
Boerner et al. ¹⁷	2015	To examine the effects of psychological interventions on pain.	There is no evidence of pain reduction from listening to music during vaccine injection.
Hole et al. ¹⁸	2015	To assess whether music improves recovery after surgical procedures.	Music reduces post-operative pain; the choice of music and the time of application made little difference to the results. Music was effective even when patients were under general anesthesia.

Continue...

Table 1. Distribution of literature review articles included, objectives, main results and/or conclusions, in ascending order of year of publication – continuation

Authors	Year of publication	Objectives	Results and/or conclusions
Koelsch and Jäncke ¹⁹	2015	To Evaluate the effects of music on the heart and the beneficial effects of music in clinical settings.	There is a small to moderate reduction in pain in patients with coronary disease.
van der Heijden et al. ²⁰	2015	To analyze musical interventions on pain, anxiety and distress in children undergoing surgery.	There is a potential reduction in pain in children undergoing surgery.
Vetter et al. ²¹	2015	To evaluate the effect of art, including environmental features such as music, interior design including visual art and architectural features on health outcomes in surgical patients.	Music reduces pain, especially if it is self-selected.
Chai et al. ²²	2017	To describe the neurological mechanisms in which music acts to control pain.	Digital music can modulate pain and reduce the use of opioid painkillers.
Garza-Villarreal et al. ²³	2017	To determine the effect of music as an adjuvant for chronic pain and to identify characteristics of musical interventions associated with positive clinical outcomes.	Music reduces the symptoms of chronic pain. Music chosen by the individual has a greater analgesic effect than music chosen by the researcher.
Li et al. ²⁴	2017	To analyze studies on burn patients to determine the effect of music during treatments.	There is evidence of pain reduction during treatment procedures, although there is heterogeneity and controversy between the results of the studies.
Kühlmann et al. ²⁵	2018	To evaluate anxiety and pain after perioperative musical interventions compared to control conditions in adult patients.	There is a moderate and statistically significant reduction in pain. Individual musical preference should be considered in the music therapy plan.
Schmid et al. ²⁶	2018	To provide data on music therapy in palliative care.	There is controversy over the results in terms of pain reduction.
Deng ²⁷	2019	To evaluate integrative medicine therapies for pain control in cancer patients.	Music therapy is effective in reducing pain and should be applied in multidisciplinary treatment. Level of evidence: C.
Honzel et al. ²⁸	2019	To analyze studies that have evaluated the relationship between music or virtual reality and pain in healthy and pain-affected populations using objective and subjective measures of pain as the primary outcome.	Music activates the auditory cortex, the descending pain inhibitory system, the brain's reward system and causes changes in the perception of pain and in cognitive, affective and evaluative processes.
Stegemann et al. ²⁹	2019	To examine the evidence on the effectiveness of music therapy and other music-based interventions applied in pediatric health care.	Pain can be reduced in medical procedures, cancer care, palliative care and neonatal care.
Ciobica et al. ³⁰	2020	To discuss the relationship between neuropsychiatry and oral diseases, as well as professional practices for treatment.	Music increases the pain threshold of the oral mucosa, decreases the activation of the cingulate cortex to painful stimuli and decreases muscle activity due to teeth clenching related to temporomandibular dysfunction.
Fan and Chen ³¹	2020	To evaluate the effectiveness of non-pharmacological interventions for pain relief after orthopedic surgery.	Music may have a potential role in controlling orthopedic postoperative pain.
Fu et al. ³²	2020	To evaluate the effects of perioperative music on the need for drugs, length of stay and costs.	Perioperative music can reduce the need for sedative and opioid drugs in the postoperative period, medical costs and minimize the risk of adverse events, although there is no reduction in the length of hospital stay. No adverse effects were observed for the musical intervention.
Köhler et al. ³³	2020	To analyze the evidence for music therapy in the different phases of cancer treatment.	There is controversy about pain reduction, although there is evidence to support the promising use of music therapy.
Santiváñez-Acosta ³⁴	2020	To evaluate the effectiveness of music therapy on pain during labor.	There is a significant reduction in pain during and after labor, although the data from the studies on labor and musical intervention is not detailed.
Yu et al. ³⁵	2020	To evaluate the effect of musical interventions on short-term pain after total knee replacement.	There was no improvement in pain. Studies are heterogeneous and make it difficult to explore the data further.
Cheng et al. ³⁶	2021	To review the effect of music therapy and interventions on hemodialysis patients suffering from pain.	Music therapy and music-based interventions can increase the satisfaction of patients suffering from pain during hemodialysis by minimizing the painful experience.
Wen et al. ³⁷	2021	To evaluate the effectiveness of interventions for patients with non-chronic kidney disease.	Two or three interventions a week for 4 to 6 weeks reduces pain in 41% to 61% of cases.

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Table 1. Distribution of literature review articles included, objectives, main results and/or conclusions, in ascending order of year of publication – continuation

Authors	Year of publication	Objectives	Results and/or conclusions
Gaubá et al. ³⁸	2021	To assess whether music reduces the use of analgesics and anxiolytics during flexible cystoscopy.	Classical music was used in most of the studies and there was a reduction in pain during flexible cystoscopy, which can increase satisfaction with the procedure. The musical intervention is simple, low-cost and easily accessible.
González-Martín-Moreno et al. ³⁹	2021	To analyze the effects of music on pediatric and adolescent cancer patients.	Only two studies analyzed the interventions and observed that music can distract the person and listening to familiar music brings back pleasant memories, which reduces the perceived pain.
Hakimi et al. ⁴⁰	2021	To evaluate the effects of postpartum music therapy.	Despite the methodological heterogeneity and low quality of clinical studies, music therapy and music interventions are capable of reducing postpartum pain.
Kakar et al. ⁴¹	2021	Evaluating musical interventions in cardiac surgery.	Music selection by the patient or the researcher reduced pain by 1.3 points on the Visual Analogue Scale. The average duration of the interventions was 30 minutes.
Patiyal et al. ⁴²	2021	To evaluate the effects of music therapy in orthopedic surgery.	There is a significant reduction in pain.
Santa et al. ⁴³	2021	To identify the effects of musical interventions in pediatric oncology.	Music is effective in reducing pain and increasing the quality of life of children and adolescents undergoing cancer treatment. Music can be adopted as a mono or multimodal therapy. The musical interventions were classified as passive or active.
Wu et al. ⁴⁴	2021	To analyze the influence of music-based interventions on the physical and psychological outcomes of patients with chronic kidney disease on hemodialysis.	There is a mild to moderate effect on pain reduction.
Abushukur et al. ⁴⁵	2022	To review adjuvant therapies in order to improve postoperative recovery in patients undergoing breast surgery.	The genre, dynamics and duration of the music depend on the patient, as does its use in an appropriate clinical setting. Music can reduce the perception of pain.
Chiang et al. ⁴⁶	2022	To evaluate the applicability of music-based interventions in orthopedic surgery.	The applications are varied (by the patient himself, ambient sound or by a music therapist); the musical genre is varied; applied in various orthopedic, clinical or surgical procedures, before, during and after procedures. The benefits, such as pain reduction, are applicable to both children and adults.
Ormston et al. ⁴⁷	2022	To evaluate the effects of music therapy on newborns with perinatal brain damage compared to standard neonatal intensive care.	There is an improvement in physiological parameters, particularly in pain management and feeding capacity.
Rennie et al. ⁴⁸	2022	To understand the use of music therapy as a complementary treatment to conventional cancer therapy for pain control.	There is almost unanimity among the articles selected as to whether it is a reliable recommendation with good applicability for modulating pain in cancer patients. It is a non-pharmacological modality with substantial psychosocial and physiological benefits with minimal or no harm to the patient.
Ting et al. ⁴⁹	2022	To analyze the effects of musical interventions on pain in newborns and children.	There is a significant decrease in pain levels, from both a psychological and physiological point of view, in both newborns and babies/children. Pain reduction was observed in situations such as needle sticks, chronic pain and in health procedures, as well as in post-operative pain. Classical music, children's music and pop music had significant analgesic effects, while world music, "pain-specific" musical composition and multiple combinations of music had no analgesic effects.
Gerogianni ⁵⁰	2023	To evaluate the factors that affect pain in hemodialysis and its non-pharmacological management.	Pain reduction possibly occurs by influencing the autonomic nervous system and improving emotional aspects, increasing positive emotions and reducing negative emotions. It is a safe and inexpensive method, without the side effects of pharmacological therapy, and can be easily applied.

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Table 1. Distribution of literature review articles included, objectives, main results and/or conclusions, in ascending order of year of publication – continuation

Authors	Year of publication	Objectives	Results and/or conclusions
He et al. ⁵¹	2023	To summarize the music therapy strategies applied and their effect on reducing pain, anxiety and physiological changes in patients undergoing prostate biopsy.	Pain was assessed using the Visual Analogue Scale, considering 7 clinical studies with 662 patients, showing that music therapy during prostate biopsy can reduce pain. However, the analysis resulted in a low quality of scientific evidence, especially when considering factors such as imprecision, inconsistency, indirectness, risk of evaluation bias and publication bias.
Huang and Huang ⁵²	2023	To identify the effectiveness of music therapy in adult patients with colorectal cancer.	57% of the articles selected showed that music therapy reduced pain. Most used a numerical scale for evaluation and the protocols were heterogeneous. The results were conflicting, which makes it difficult to draw a generalized conclusion for all cancer patients.
Maleki and Youseflu ⁵³	2023	To determine the effect of music-based interventions on short-term postpartum episiotomy pain.	Reduction of 1.6 in the visual analog scale of pain in primiparous or multiparous women. The greatest and least effect of music on pain reduction was at 2 and 48 hours after episiotomy repair, respectively. The effect of music on pain reduction was statistically significant from 1 to 24 hours after episiotomy repair.
Tan et al. ⁵⁴	2023	To evaluate the effectiveness of musical intervention in patients with dental anxiety during clinical procedures.	There was no significant difference in pain scores between the experimental and control groups preoperatively; postoperatively, music therapy significantly reduced pain scores in patients with dental anxiety; different study populations (children or adults), different oral procedures, different countries and different years did not significantly affect the results of this study.

lationship. On the other hand, other interventions that use music for health purposes, without a music therapist, can be called music medicine or music listening⁵⁵.

Music therapy is an approach that seems to have a positive impact on various symptoms and needs, improving individuals' quality of life^{13,26}. It is a non-invasive, safe and inexpensive intervention that can be carried out easily and successfully in a health service¹⁸, with varied applications, considering the environment, the musical style, the population, the clinical procedure and the time of application⁴⁶. However, one study¹¹ stated that there is limited evidence of the effectiveness of music therapy on quality of life in end-of-life care, and concluded that there is no evidence of beneficial effects on pain, although only two research evaluating this variable were presented.

On the other hand, there is evidence of the positive results of music in reducing pain²³ and the potential to reduce the need for analgesics and/or anxiolytics, even if only in small quantities, which may represent important beneficial clinical implications, although another study states that music therapy does not work like a drug to reduce a symptom²⁶.

While some pharmacological agents take weeks to months to take effect, interventions that provide more immediate benefits, even if modest, may warrant further investigation¹³. Considering the painful experience in different clinical conditions, as well as its various repercussions, music therapy and music-based interventions can increase the satisfaction of patients suffering from pain during health procedures, minimizing the

painful experience^{36,38}, although the effect on pain reduction can be mild to moderate⁴⁴.

Familiarity with certain music drives emotional mechanisms to modulate pain, so that music has a greater analgesic effect if it is chosen by the patient themselves^{16,23}. When listening to unfamiliar music, the main analgesic mechanism may be cognitive rather than emotional¹⁶. Individual musical preference should be considered in the music therapy plan^{25,45}.

One study found that music selection by the patient or the researcher reduced pain by 1.3 on the visual analogue scale⁴¹. Another research used the term "music medicine" to describe studies involving listening to pre-recorded music without the presence of a therapist, although music therapy and "music medicine" have the same effect on reducing pain. According to the authors, for music to be an effective intervention, listeners must be involved in what they are experiencing, with the music therapist acting as a guide; in "music medicine", unguided intervention makes the results more difficult to control²⁸.

On the other hand, one study stated that evidence suggests that music genre is not important for analgesic effects²³. Another study found that the choice of music and the time of application made little difference to the beneficial results obtained in reducing post-operative pain. There are doubts as to how the music is chosen by the patient (self-selection or playlist), how it is applied in the clinical environment, the sound volume, and there are also issues to be investigated, such as about copyright¹⁸.

The reduction in post-operative pain with music therapy is moderate and significant, and can be applied before, during or af-

ter the surgical procedure²⁵. Perioperative music can reduce the need for sedative and opioid drugs in the postoperative period, reduce treatment costs and minimize the risk of adverse events, although there is no reduction in length of stay³².

In orthopedic surgeries, music can control post-operative pain³¹, with a significant reduction in pain⁴², but one study found no improvement in pain, although the heterogeneity of the researches made it difficult to explore the data³⁵. Good results have also been observed during and after labor^{34,40}.

Music intervention applied briefly after episiotomy has the greatest potential for reducing pain⁵³. Music therapy can be indicated to relieve pain associated with surgery (level of evidence C)²⁷ and is recommended to reduce anxiety and improve mood in patients with depression (level of evidence B). According to one survey, interventions classified with level of evidence C represent a dilemma for patients and health professionals when facing decisions about their recommendation. Level C interventions are supported by some evidence from controlled clinical trials, but do not have a large body of evidence to support their use. As such, grade C interventions represent areas of greater need for additional research. Level C interventions require shared decision-making between patients and professionals, based on discussions about the risk-benefit ratio for all available treatments¹⁵.

In chronic temporomandibular dysfunction (TMD), it has been shown that music modulates the activity of the masseter muscles and targets waking bruxism, so that highly dissonant and stressful music increases the motor effort of the masseter muscles during waking bruxism episodes, while relaxing music and the patient's preferred listening decreases this effort⁵⁶. However, the study did not provide details on which musical pieces were used with the research subjects. Another study stated that muscle activity due to bruxism related to TMD dysfunction decreases when individuals listen to music they prefer³⁰.

Music activates various brain structures and interferes with neuronal processing, causing changes in the perception of pain and in cognitive, affective and evaluative processes. Added to this is the stimulation of the descending inhibitory pain system, and all this may explain the reduction in pain. In a study

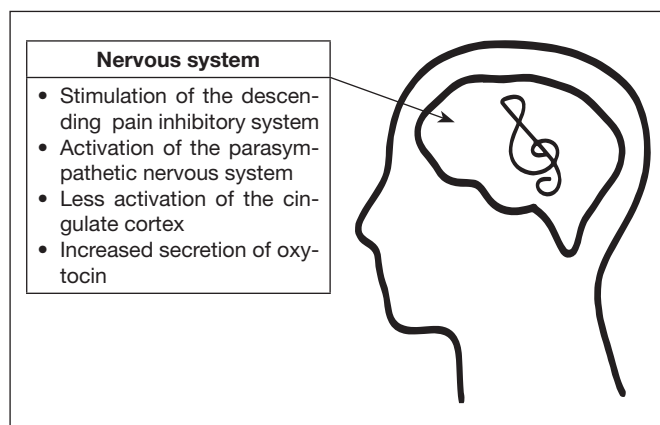


Figure 3. Possible neurophysiological mechanisms related to pain control through the application of musical interventions

using nuclear magnetic resonance imaging of the brain, changes in neural activity were observed, indicating a reduction in pain²⁸. The parasympathetic nervous system seems to have a greater influence on pain reduction, especially when listening to relaxing music. The cingulate cortex is less activated by painful stimuli when listening to music³⁰.

Positive results for pain control and maintaining vital signs at physiological levels are best observed with music selected by the patients themselves²¹. The magnitude of pain reduction is small to moderate, probably attributable to stimulation of the descending pain inhibitory system and increased oxytocin secretion¹⁹ (Figure 3). Music increases reward pathways in the brain, which could reduce chronic pain²². On the other hand, the psychological, emotional and spiritual aspects on which music can act should be considered in clinical care, in order to favor conventional treatment itself²⁶.

Studies of poor methodological quality can compromise the analysis of the effects of music on human health, as the results can be dubious or insufficient for assertive conclusions about the effects of music on the pain experience, allowing only the conclusion that the musical intervention is not beneficial¹⁷ or that the positive evidence is insufficient^{31,57}. Furthermore, the methodological heterogeneity of the studies makes it difficult to compare results^{24,33}, although there is promising evidence to support the use of music therapy³³ (Table 2). The literature is controversial on the results of pain reduction^{24,26} and the reduction of analgesic drugs^{22,28}.

The analyzed studies suggest that research involving music and pain should focus on expected results regarding changes in pain, psychosocial aspects and the sustainability of the musical intervention²². There is a lack of studies on chronic pain, especially with methods that detail the frequency, duration and type of musical interventions. There are doubts about results in specific populations, the most effective types of interventions and the parameters of measures to evaluate effectiveness. Further research is needed to determine whether certain subpopulations of patients are more likely to respond to music-based interventions than others, which interventions are most effective for such responsive patients and which measurement parameters best assess their effectiveness¹³. The application of two or three interventions a week for 4 to 6 weeks reduces pain in 41% to 61% of cases³⁷.

In the studies observed, variables such as the person responsible for choosing the music (patient or researcher), the duration of the musical intervention, the type of musical intervention and the type of control in the study, among others, may explain the heterogeneity of results in the literature. Combining studies with different "control" interventions may not be ideal for scientific analysis²³.

Despite an apparently growing interest in the subject over the last four years, as demonstrated by the increase in annual scientific publications shown in figure 2, the use of heterogeneous methods and the lack of details about the research protocols make it difficult to understand the results and the scientific discussion⁹. In oncology, the application of music therapy is capable of reducing pain, although the conflicting results in the

Table 2. Suggested paradigm for methodological design in studies on the effects of music therapy on pain control: parameters/topics of methodological interest for standardizing research and standardizing results

Parameters/Topics of Methodological Interest	
Music selection	<ul style="list-style-type: none"> • Selected by the patient • Selected by a music therapist • Selected by a trained health professional
Type of music intervention	<ul style="list-style-type: none"> • Music therapy • Music medicine
Type of music	<ul style="list-style-type: none"> • Musical genre • Copyright • Specific musical works
Health care environment/place	<ul style="list-style-type: none"> • Waiting room, doctor's office, operating room, intensive care unit, vaccination room, home, others
Music intervention status	<ul style="list-style-type: none"> • Isolated • Combined with a procedure (e.g. vaccination, surgery, electrotherapy, laser therapy, parturition, acupuncture, others)
Time of application in the service	<ul style="list-style-type: none"> • Before • During • After
Application methods	<ul style="list-style-type: none"> • Background sound, headphones, use of musical instruments • Frequency • Duration
Selection of the population sample	
Qualification of the executing professional/researcher	
Diagnosis of the patient/research subject	
Pain assessment parameters/instruments	

literature make it difficult to draw a generalized conclusion for all cancer patients⁵². Despite the evidence favorable to the use of music therapy in pain reduction, factors such as imprecision, inconsistency, risk of evaluation bias and publication bias can result in poor scientific quality of studies⁵¹.

There is controversy over whether there are any adverse effects or contraindications to music therapy or music interventions. One study⁴⁸ showed that music has minimal or no harm to the patient, with good pain modulation in cancer patients⁴⁸.

According to another study⁵⁸, music is a good resource in reducing preoperative anxiety with no adverse effects, and this practice should become routine in the search for a more humanized medicine. Another study⁵⁹ pointed out that music can have a calming effect and can mobilize the most intense human emotions⁵⁹.

According to a research⁵, musical intervention has no contraindications or adverse effects. The nature of music's effects seems to be beneficial for most people, as it provides a sense

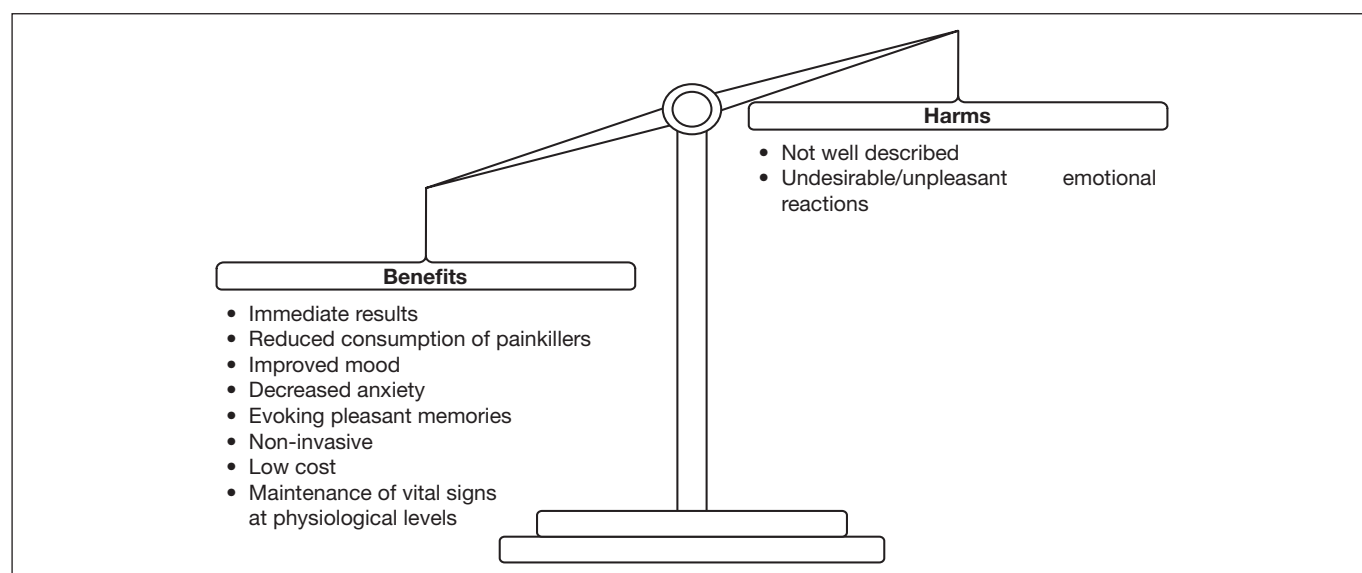


Figure 4. Possible pros and cons of musical interventions when used in pain management

of well-being, relaxation, distraction, pleasant memories and comfort (figure 4). However, particularly in senior individuals, some manifestations can interrupt the therapeutic process, such as tiredness, hunger or drowsiness¹. Music can bring back memories and experiences, evoke different feelings and encourage non-verbal communication. It provides a healthy environment for the client and favors the professional-client relationship¹. One study found no adverse effects of musical intervention³². Nevertheless, reports of adverse or negative effects with music are poor, perhaps because this parameter is not properly assessed²³.

Music is able to reduce anxiety in various populations^{13,16,21} and consequently reduces the intensity of pain¹⁶. During dental procedures, music therapy significantly reduced pain scores in patients with dental anxiety; different study populations (children or adults), different oral procedures, in different countries and in different years did not significantly affect the results⁵⁴.

In the pediatric population, music therapy and other music-based interventions have been shown to be beneficial in a wide variety of areas and appear to be effective, especially in combination with other forms of treatment and within a multimodal therapy approach, including pain relief^{29,43,47} and improved quality of life in cancer treatments⁴³. The evocation of pleasant memories while listening to familiar music seems to favor a reduction in perceived pain³⁹. During lumbar puncture, there is evidence that musical intervention (listening with headphones) during the procedure can reduce the child's self-reported pain and anxiety¹⁴.

Few randomized clinical trials have been carried out on the effects of music on pediatric patients undergoing surgery. Music as a non-pharmacological adjuvant intervention has the potential to reduce pain in children undergoing surgery. Its non-invasive nature is an advantage. This suggests that music therapy should be considered for clinical use²⁰. Music therapy is safe and relieves pain in the psychological and physiological domains in the pediatric population. There are musical styles capable of reducing the painful experience, while other styles have not shown this outcome in the pediatric population⁴⁹.

Ideally, music therapy should be tailored to individual preferences and pain levels. Three methods of curating or actively searching for musical content can be employed: personal, professional and automated selection (by apps/software), the latter of which does not seem to have been investigated to date²². With today's technological resources, patients can administer their own music via mobile devices. The effect of perioperative music can be maximized, it is independent of musical trends and, ultimately, its access can be free²¹.

CONCLUSION

The use of music, be it through music therapy or music-based interventions, has a positive impact on a variety of environmental situations and clinical conditions involving the experience of pain, and therefore significantly relieves pain. This relief seems to be related to influences on complex neural mechanisms involving the descending inhibitory pain system and other

neural circuits. The analgesic effect can result from music chosen by the professional or by the research subject (or patient), whose preferences should be considered in the therapeutic or musical intervention plan, although its results (positive or negative) should be evaluated by a professional to support shared decision-making between professional/team and patient.

On the other hand, there is little clinical evidence on the music applied techniques use to pain and the topic deserves better scientific research. To this end, from a methodological point of view, disclosing detailed information on the techniques used, the selection of the sample, the choice of the techniques used, the description of the procedure or intervention, the choice of musical works, the duration of the procedure, the environmental conditions, the evaluation time, the evaluation of beneficial and adverse effects and the qualification of the professional performing them is urgently needed in order to advance the scientific analysis of the results.

AUTHORS' CONTRIBUTIONS

Thiago Medina Brazoloto

Data Collection, Conceptualization, Project Management, Research, Methodology, Writing - Preparation of the original, Writing - Review and Editing

Fabio José Condino Fajarra

Writing - Review and Editing, Validation

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