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Research article

Music to relieve pain and anxiety in cardiac catheterization: A systematic review and meta-analysis

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ABSTRACT

Objectiveto evaluate the effectiveness of using music to relieve pain, anxiety, and change in vital signs in adult and older adult patients undergoing cardiac catheterization.

Methodsthis is a systematic review with meta-analysis carried out in October 2022, using 12 data sources, without time or language restrictions. The study followed the recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses. The "Risk-of-bias tool" was used to assess the risk of bias, the "R CORE Team program: A language and environment for statistical computing" was used to perform the meta-analysis, and the "Grading of Recommendations Assessment, Development and Evaluation" was used to assess the quality of evidence in the studies.

Results: a total of nine studies were included, totaling 1456 participants. The most used tools for measuring anxiety were the State-Trait Anxiety Inventory and Numerical Rating Scale. This was also used to measure pain, in addition to the Visual Analogue Scale. The use of instrumental, classical and relaxing music prevailed, applied using headphones during the painful procedure, at a frequency of 60 to 100bpm and sound intensity of 60–70 dB. There was statistical significance in the use of music in reducing pain, anxiety and systolic blood pressure.

Conclusion: music interventions are effective in relieving pain, reducing systolic pressure and anxiety, but indifferent in terms of heart rate, respiratory rate and diastolic pressure. They provide humanization of care, can reduce hospital costs and length of hospital stay.

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1. Introduction

Cardiovascular Diseases (CVD) are responsible for 49 % of deaths in Europe and annual costs of 192 million euros for the European Union, therefore being considered public health problems, and there is a forecast of 23.6 million annual deaths from these causes by 2030 [1].

In this sense, diagnostic exams such as cardiac catheterization are performed to verify the structure and functioning of the coronary arteries and cardiac muscle [2], and can generate anxiety in clients due to fear of pain, the nature of the invasive procedure and possible negative prognosis [3].

After the procedure, the individual rests with a compressive dressing at the puncture site to avoid complications such as: formation of hematomas, pseudoaneurysms, arteriovenous fistulas, bleeding and thrombi, although this leads to other complications such as pain [4]. A pain report needs to be considered by the multidisciplinary team, and they are responsible for measuring its intensity through uni or multidimensional instruments [5]. Pain management can be through pharmacological or non-pharmacological strategies. However, pharmacological strategies are associated with several side effects, while non-pharmacological strategies are associated with fewer side effects, in addition to composing a multimodal and interprofessional approach to pain control [6].

Music interventions have been adopted as a strategy to manage anxiety, as it is a low-cost technology, easy to apply and highly acceptable [7]. This strategy acts by releasing endogenous opioids, modulating hormones, reducing catecholamine secretion, heart rate (HR), respiratory rate (RR), blood pressure and anxiety. Therefore, it is considered a complementary intervention with anxiolytic action [8].

Music can reduce the need for painkillers or sedatives. Slow music reduces blood pressure, HR, RR and oxygen saturation, while upbeat music increases the aforementioned physiological parameters through the resonance mechanism between musical and body rhythms, although individual music preferences must be considered [9].

It is worth highlighting that aspects such as musical structure and tonality, that is, songs with a well-defined harmonic structure or acoustic dissonances are capable of influencing individual feelings, regardless of their emotional characteristics. Furthermore, the literature also suggests that the emotions induced by musical listening possibly share the same psychophysiological and neurophysiological mechanisms. As an example, feelings such as: well-being and pleasure can be cited; sadness and pain; fear, tension and anxiety [10].

The first group is related to a cholinergic autonomic response, activation of the dopaminergic reward circuit, as well as activation of the striate cortex, orbitofrontal cortex and ventral tegmental area. The second is more related to the increase in prolactin concentration, with the activation of the hippocampus, ventromedial prefrontal cortex and cingulate. The third, in turn, is more associated with the activation of the cerebellum, amygdala and motor cortex, in addition to being related to a sympathetic adrenergic autonomic response. However, it is also necessary to consider that parasympathetic reactions, such as bradycardia developed in response to fear, can be developed when it comes to atonic music, for example [10].

Although systematic reviews and meta-analyses have recently presented significant statistical results regarding the use of music to relieve anxiety and changes in physiological parameters during cardiac catheterization, the need for further studies that could strengthen or discuss the findings was described [11–13].

Therefore, this study is justified by providing a more up-to-date quantitative and qualitative synthesis, with a high level of evidence. It innovates by proposing to carry out a meta-analysis of all physiological parameters, including a greater number of data sources in the searches, without restricting the language of the evaluated studies, in addition to restricting the coronary procedure and using different tools from those already used in the evaluation of the risk of bias, meta-analysis and quality of evidence.

In view of the above, this study aims to evaluate the effectiveness of using music to relieve pain, anxiety, and change in vital signs in adult and older adult patients undergoing cardiac catheterization.

2. Methods

This is a systematic review and meta-analysis performed according to the recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [14,15], following the guidelines and steps of the Cochrane Manual for Systematic Reviews of Intervention [16]. This study was registered on the International Prospective Register of Systematic Reviews (PROSPERO) platform under protocol number CRD42022362448.

2.1. Elaboration of the research question

The Population, Intervention, Control, Outcome and Study design (PICOS) strategy was adopted to construct the research question. The mnemonic was outlined as follows: Population: adults and older adults undergoing cardiac catheterization; Intervention: music; Control: no music; Outcomes: pain and anxiety relief; Study design: Randomized Clinical Trials (RCT). In this context, the research question elaborated was: Is the use of music effective in relieving pain and anxiety in adult and older adult patients undergoing cardiac catheterization?

2.2. Study location

This review was conducted in October 2022, using the following 12 data sources: CINAHL, ClinicalTrials.gov, Cochrane Library, EMBASE, *Literatura Latino-americana e do Caribe em Ciências da Saúde* (*LILACS*), MEDLINE/PubMed, PsycINFO, Science Direct,

Scientific Electronic Library Online (SciELO), SCOPUS and Web of Science. Gray literature was searched through the website www.opengrey.eu.

Descriptors were adopted in English in accordance with the Medical Subject Headings (MeSH) to elaborate the search syntax. The search syntax was adapted for each data source and is described below: (Angiography OR Angiogram OR "Cardiac Angiography" OR "Cardiac Catheterization" OR "Peripheral Angiography" OR "Coronary Angiography" OR "Cardiac Catheterization" OR "Cardiac Catheterizations" OR "Heart Catheterizations" OR "Heart Catheterization") AND ("Musical Intervention" OR Music OR Songs OR Song OR "Music Therapy" OR "Therapy, Music") AND (Pain OR Ache OR "Acute Pain" OR "Pain, Acute" OR "Pain Management" OR Anxiety OR Angst OR "Anxiety Disorders" OR "Anxiety Disorder"). The Boolean operators "AND" and "OR" were used to cross the descriptors.

2.3. Eligibility criteria

RCTs that evaluate the effectiveness of using music to relieve pain, anxiety, and change in vital signs in adult and older adult patients undergoing cardiac catheterization were included, without time or language restrictions. Studies that did not answer the research question or were duplicated in the data sources were excluded.

2.4. Study search and selection process

Two researchers independently conducted the search and selection of articles at all stages. Both received the same training to reduce the chance of errors and/or discrepancies in conducting the steps and in the results found.

An initial screening was performed by reading the titles and abstracts using the Rayyan software program, which was also used to remove duplicates. The selected material was read in full and assessed for its adequacy to the eligibility criteria. When appropriate, the articles were included in the sample to compose the quantitative and qualitative data analysis.

Disagreements were resolved by consensus among the researchers, and a third reviewer was consulted to establish the final decision when necessary. Duplicates were only considered once. It should be noted that the reverse search was carried out by the two researchers who decided on the inclusion of the most appropriate references in the results.

2.5. Data extraction

A shared folder was created on Google Drive with a spreadsheet prepared in Microsoft Excel so that the authors involved in the study search process, selection and extraction of results could fill it in according to the previously selected variables: authors, country, year, objective, sample, mean age, pain/anxiety assessment tools, assessment of physiological parameters, music intervention, and outcomes.

2.6. Presentation of results

Data were grouped, synthesized and presented using charts, figures and flowcharts. Primary outcomes were pain and anxiety, while the secondary outcomes were: systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate (HR) and respiratory rate (RR). The STAI scale was considered to assess anxiety and the VAS was considered to assess pain intensity in the statistical analysis. Data analysis was descriptive and inferential. The "Risk-of-bias tool" (RoB 2.0) [17] was used to assess the risk of bias in the included RCTs.

Data were entered into Review Manager program (RevMan 5.2.3). The OR and 95%CI were calculated for continuous outcomes for each study. According to the Cochrane Handbook [16] in the case of heterogeneity (I^2>75 %), the random effects model was used to combine the studies to calculate the OR and 95%CI using the DerSimonian–Laird algorithm in the meta package, which provides functions to conduct meta-analyses in R. The fixed effects model was used in case of heterogeneity (I^2<75 %) [16]. The "R CORE Team R: A language and environment for statistical computing" version 4.0.3 program was used to perform the meta-analysis.

The "Grading of Recommendations Assessment, Development and Evaluation" (GRADE) tool was applied to assess the quality of evidence of studies included in the meta-analysis [18].

2.7. Risk of bias analysis

The RoB 2.0 tool was used to assess the risk of bias, consisting of five domains: bias in the randomization process (D1), deviations from the intended intervention (D2), bias due to missing data (D3), bias in the measurement of outcomes (D4) and bias in the reporting of outcomes (D5). Each domain is classified as "low risk", "some concern" or "high risk". The summation of the assessment results in an overall methodological quality outcome was equally classified as "low risk", "some concern" or "high risk" [19].

2.8. Quality of evidence assessment

The GRADE tool was used to assess the quality of evidence from the studies included in the meta-analysis. This tool generates a result of the quality of evidence classified as "very low", "low", "moderate" or "high" [18].

3. Results

Fig. 1 describes the study search and selection process in the data sources. A total of nine studies were included in the sample at the end of the process. It should be noted that a reverse search was also performed.

3.1. Characterization of the studies

Table 1 presents the characterization of the studies based on the following bibliographic variables: authors, research development country, year of publication, objective, sample and mean age of participants.

A total of 1456 participants were included, with a mean age greater than 60 years in 55.55 % of the studies [20,22,25,27,28], greater than 50 years (22.22 %) [21,24], 48 years (11.11 %) [26] and one study (11.11 %) [23] did not mention the mean age of participants. Three (33.33 %) [21–23] studies were performed in Turkey, two (22.22 %) [20,25] in Germany, two (22.22 %) [24,26] in Iran and one (11.11 % for each study) in The United States [28] and The Netherlands [27]. The studies were published in the years 2005–2022.

3.2. Descriptive summary of studies

Table 2 describes the summary of studies based on the following descriptive variables: tools for pain and/or anxiety assessment, assessment of physiological parameters, music intervention performed and outcomes presented.

The physiological parameters evaluated in the studies were: anxiety in 100 % of the included studies [20–28]; pain in 33.33 % of the total [21,22,27]; and vital signs: SBP (55.56 %) [20–22,24,25], DBP (55.56 %) [20–22,24,25], HR (55.56 %) [20–22,24,25] and RR (33.33 %) [21,22,24]. The values of these parameters were compared between two groups: control: patients without music intervention undergoing routine care, and experimental: patients undergoing music intervention. In this comparison, 66.67 % of the studies describe lower values in all these parameters mentioned above in the experimental groups [21–26].

The most used tools for assessing anxiety were STAI (88.89 %) [20–26], NRS (22.22 %) [27,28] and HADS (11.11 %) [20]. Three studies assessed pain intensity and mentioned the following analysis tools: VAS (22.22 %) [21,22] and NRS (11.11 %) [27].

The music intervention applied in the experimental groups in all of the studies was implemented through recorded music [20–28]. Most of the songs were instrumental (55.56 %) [21–23,25,26], classical genres (22.22 %) [24,25], modern and jazz (11.11 %) [25], through headphones (44.44 %) [20,22,24,26] or speakers (33.33 %) [25,27,28]. Its application was during the entire painful

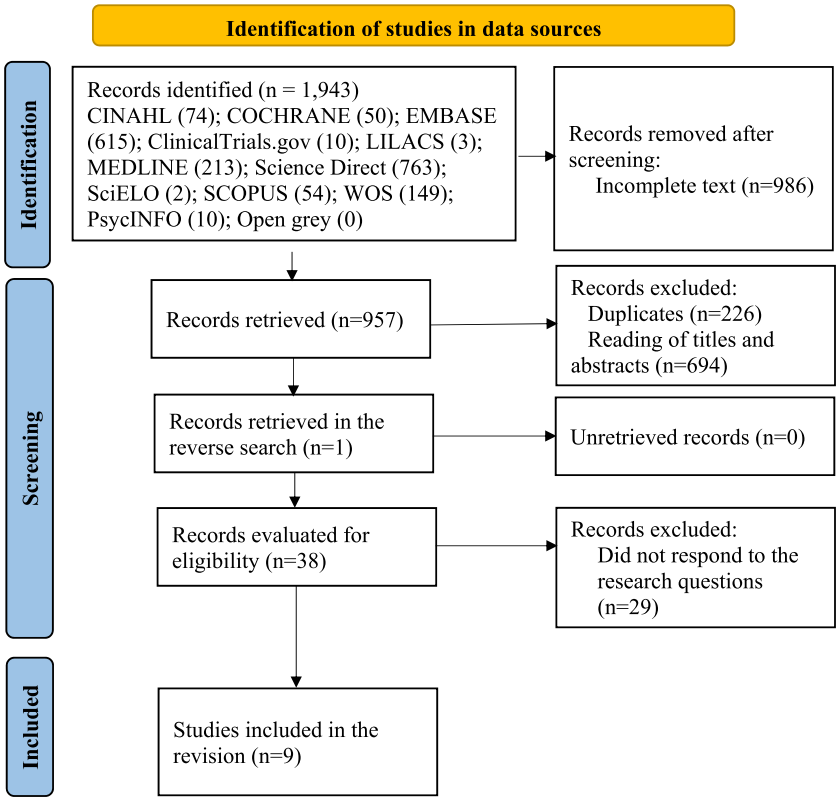

Fig. 1. Study flowchart adapted from PRISMA 2020.

Table 1
– Characterization of the studies.

Authors/Country/Language/Year	Objective	Sample/mean age
Argstatter; Haberbosch; Bolay/ Germany/German/2006 [20]	To examine whether the preventive or adjuvant use of music therapy results in a reduction in subjective and objective anxiety and therefore leads to a reduction in sedative medication.	83 patients/66 years
Çelik; Güzelçiçek; Çelik/Turkey/ Turkish/2022 [21]	To investigate the effects of music therapy on patients undergoing coronary angiography before the invasive procedure on pain, anxiety and vital signs to reduce the administration of sedatives and ask patients' opinions about the music they listened to.	62 patients/Not applicable (NA)
Çetinkaya et al./Turkey/Turkish/2018 [22]	Evaluate the effect of listening to music during coronary angiography on the anxiety level and physiological parameters.	171 patients/66.8 years
Doğan; Şenturan/Turkey/Turkish/ 2012 [23]	To examine the effects of music on the anxiety level in patients undergoing coronary angiography.	200 patients/NA
Esfandiari et al./Iran/Persian/2022 [24]	Examine the comparative effects of eye masks and music on anxiety levels and hemodynamic indices of patients undergoing coronary angiography.	300 patients/58.83 years
Goertz et al./Germany/German/2011 [25]	To evaluate the anxiolytic effects of different music styles and no music in 200 patients undergoing cardiac catheterization and to assess if there is a difference if patients select one of these therapies or are randomized to one of them	197 patients/65 years
Mozaffari; Tavangar; Pourmovahed/ Iran/Persian/2020 [26]	Evaluate the effects of muscle relaxation and music therapy on the anxiety of candidates for coronary angiography.	105 patients/48 years
Nilsson et al./The Netherlands/Dutch/ 2009 [27]	To investigate the effects of music on anxiety, angina, pain, relaxation and comfort in patients during angiographic procedures and to assess gender differences.	240 patients/NA
Weeks; Nilsson/USA/English/2011 [28]	To test the effects of three different sound environments, two of which involved adjunctive music intervention on patient experiences of anxiety and well-being during coronary angiographic procedures.	98 patients/NA

NA: the studies do not mention the overall average age of the participants. Only the average age of each group or the age range of each group is mentioned.

procedure (33.33 %) [20,24,27], for 15–45 min (22.22 %) [21,22], or 20 min before the invasive procedure (11.11 %) [26], at a frequency of 60 to 100bpm (55.56 %) [21,22,25,27,28], with a sound intensity of 60–70 dB (22.22 %) [27,28].

The studies describe a reduction in anxiety levels (77.78 %) [20,21,23–26,28], hemodynamic parameters (33.33 %) [22,24,25], pain (22.22 %) [21,22], use of analgesics and sedatives (11.11 %) [21], and increased well-being (11.11 %) [28]. Two studies (22.22 %) [22,27] reported that there were no differences in anxiety levels (11.11 %) [22], and that the intervention is feasible but not effective (11.11 %) [27].

3.3. Risk of bias analysis

Fig. 2 presents the risk of bias analysis of the nine studies included using the RoB 2.0 tool [19].

Most studies (77.78 %) were classified as having an overall "low risk" of bias. Only one (11.11 %) was classified as "some concern" and another (11.11 %) as "high risk". The domains with the worst evaluation were D2, which presented 66.67 % of the studies with "high risk" of bias, and D4, which only presented three RCTs with "low risk of bias" in this regard. This can be justified by the nature of the intervention, which makes it impossible to blind the patients and sometimes the data collection team and/or the outcome evaluator.

3.4. Meta-analysis

A meta-analysis was used to analyze the combination of results from different studies regarding the effects of music intervention. Anxiety, pain, SBP, DBP, HR and RR outcomes were analyzed independently. Thus, a total of seven studies were analyzed, although the number of studies analyzed by outcome varied.

The fixed effects model was considered for $I^2 < 75$ %, and the random effect model was considered for $I^2 > 75$ % [16]. The analyzes presented were carried out using the R language [29].

3.4.1. Anxiety

Five studies described the effectiveness of music interventions in relieving anxiety, and one study did not show statistical significance between groups. The meta-analysis describes statistical significance for this outcome and shows the effectiveness of using music to relieve anxiety (SMD = −1.43; 95%CI = −2.42; −0.44), as shown in Fig. 3. The random effect model was considered when $I^2 = 97$ %.

3.4.2. Pain

Two studies describe that the music intervention proved to be effective. The meta-analysis describes statistical significance for this outcome and shows the effectiveness of music in pain relief (SMD = −1.03; 95%CI = −1.31; −0.76), as can be seen in Fig. 4. The fixed effects model was considered for $I^2 = 0$ %.

Table 2
– Summary of the studies.

Authors	Pain/anxiety assessment tools	Assessment of physiological parameters	Music intervention	Outcome
Argstatter; Haberbosch; Bolay [20]	Anxiety: STAI and HADS	Anxiety: reduction of 7.3 points on the STAI scale; SBP: 153 mmHg in the experimental and 152 mmHg in the control; DBP: 81 mmHg in the experimental and 78 mmHg in the control; HR: 74bpm in the experimental group and 72bpm in the control	Application of music through headphones, throughout the cardiac procedure - Music selection: "Relaxation" by Martin Rummel	Reduction of anxiety
Çelik; Güzelçiçek; Çelik [21]	Anxiety: STAI Pain: VAS	Post anxiety: 48.36 in the experimental and 49.27 in the control ($p = 0.000$); Post pain: 0.5 in the experimental and 1.48 in the control ($p = 0.001$); SBP: 126 mmHg in the experimental and 132 mmHg in the control ($p = 0.082$); DBP: 74 mmHg experimental and 80 mmHg control ($p = 0.002$); HR: 71 bpm experimental and 78 bpm control ($p = 0.002$); Respiratory Rate (RR): 17irpm experimental and control ($p = 0.836$)	Application of instrumental music on the television in the waiting room, prepared by a music therapist, heard repeatedly and continuously, with 60–100 bpm, at volume 20, for 45 min - Music selection: instrumental music, in the taqsim, saz semai and peshrev type, in the Nihavend mode	Reduction of anxiety, pain, use of analgesics and sedatives
Çetinkaya et al. [22]	Anxiety: STAI Pain: VAS	Anxiety: 40.4 in the control group and 39.09 in the experimental group; Pain: 2.83 in the control and 0.77 in the experimental; SBP: 134 mmHg in the control and 127 mmHg in the experimental; DBP: 78 mmHg in control and experimental; HR: 78bpm in the control and 77 in the experimental; FR: 23irpm in control and 20 in experimental	Application of instrumental music on headphones associated with an MP3 Player, with 60 to 80bpm, during coronary angiography for 15–20 min - Music selection: sufi music, with Hüseyni melody, played through a Turkish reed flute called "Ney"	There was no significant difference in anxiety levels, but SBP and pain intensity were reduced
Doğan; Şenturan [23]	Anxiety: STAI	Anxiety: ranges from 37.61 to 35.60 in the control group and ranges from 35.11 to 31.07 in the experimental group	Application of instrumental music in Hüseyni mode in the procedure room, before the patient's arrival until the end of the procedure, when the individual leaves - Music selection: instrumental music in Hüseyni mode, using instruments such as Ney, Rebab, Çeng, Ud, Dombra and Rübab to improvise the rhythm and water sounds	Reduced anxiety
Esfandiari et al. [24]	Anxiety: STAI	Anxiety: 45.4 in the control group and 34.71 in the experimental group; SBP: 140 mmHg experimental and 160 mmHg control; DBP: 97 mmHg in the control group and 87 mmHg in the experimental group; HR: 82bpm in the control group and 73bpm in the experimental group; FR: 18irpm in the control group and 17irpm in the experimental group	Application of classical, relaxing and non-verbal music in wireless headphones during the entire performance of the coronary angiography - Music selection: 10 classical songs by Johann Sebastian Bach, non-verbal, from the album "The Most Relaxing Bach Album in the World. Ever!"	Decreased anxiety and hemodynamic indices
Goertz et al. [25]	Anxiety: STAI	Anxiety: 38.1 in the control group and 31.4 in the experimental group; SBP: 141 mmHg in the control group 140 mmHg in the experimental group; DBP: 73 mmHg in both groups; HR: 74bpm in the control group and 73bpm in the experimental group	Application of instrumental music, through CDs on loudspeakers, with 60 to 80bpm, without rhythmic irregularities and low contrast amplitude. Classical, modern and jazz music were Applied - Music selection: 16 classical songs composed by George Frederic Händel, Johann Sebastian Bach, and Wolfgang Amadeus Mozart; 10 modern songs by Erik Satie, Christopher Franke, and Arvo Pärt; and 13 smooth jazz songs composed by Keith Jarrett and Till Brönner	Significant reduction of anxiety, in addition to the trend towards lower values of SBP, DBP and HR
Mozaffari; Tavangar; Pourmovahed [26]	Anxiety: STAI	Anxiety: went from 49.02 to 44.28 ($p < 0.004$) in the experimental; and went from 48.25 to 48.45 in control	Application of instrumental and slow music, on headphones and MP3 Player for 20 min before cardiac catheterization - Music selection: not specified	Reduced anxiety
Nilsson et al. [27]	Anxiety: STAI and NRS Pain: NRS	Anxiety: ranges from 13 to 15 in the control group and from 14 to 15 in the experimental group; Pain associated with puncture: ranges from 2 to 5 in the	Application of soft music with 60 to 80bpm on a loudspeaker throughout the coronary procedure at a sound intensity of 60–70 dB	Music intervention is feasible, but not effective

(*continued on next page*)

Table 2 (*continued*)

Authors	Pain/anxiety assessment tools	Assessment of physiological parameters	Music intervention	Outcome
		control group and from 1 to 5 in the experimental group	- Music selection: MusiCure composed by Niels Eje	
Weeks; Nilsson [28]	Anxiety: NRS	Anxiety: ranges from 1 to 10 in the control group; 1 to 9 in the music on loudspeakers group and 1 to 8 in the patient-focused music on pillows group	Application of MusiCure® music on speakers or on an audio pillow with 60 to 80bpm, at a volume two levels below the maximum, with the possibility of increasing or decreasing it. Loudspeaker music fixed at 60 dB - Music selection: MusiCure composed with classical technique by Niels Eje, considered a genreless sound area	Reduced anxiety and increased well-being

HADS: Hospital Anxiety and Depression Scale.
NRS: Numerical Rating Scale.
STAI: State-Trait Anxiety Inventory.
VAS: Visual Analogue Scale.

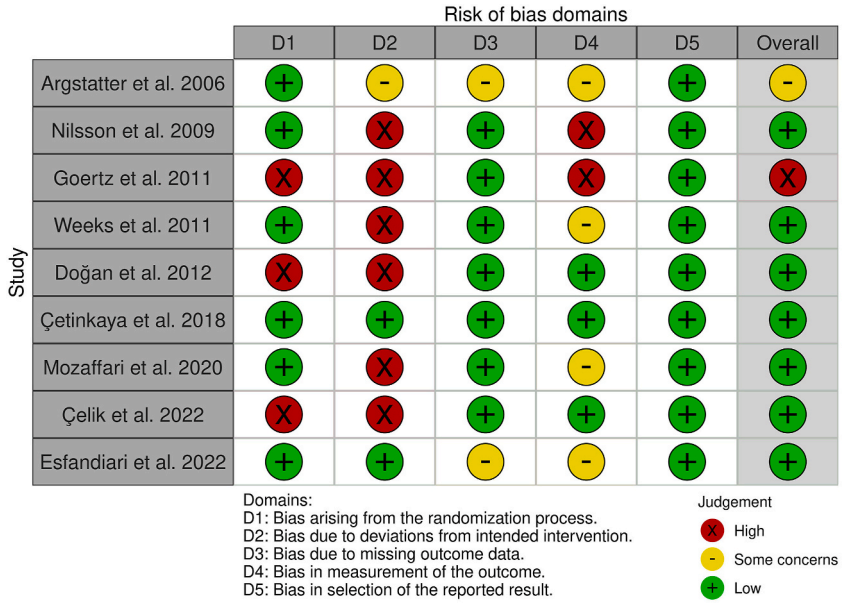

Fig. 2. Risk of bias analysis of included studies.

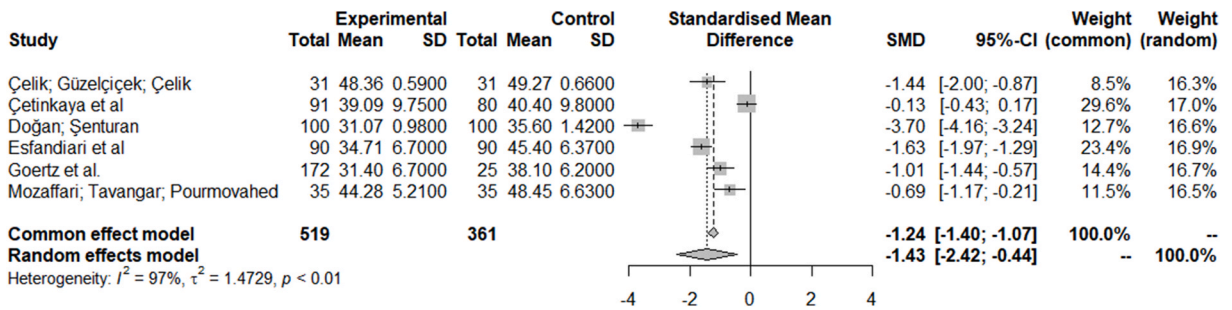

Fig. 3. Forest plot for anxiety.

3.4.3. Systolic blood pressure

There was statistical significance favoring the experimental group and SBP reduction in only one study. Through the meta-analysis, the fixed effects model was considered for $I^2 = 15$ %, with the description of statistical significance for this outcome and evidenced the

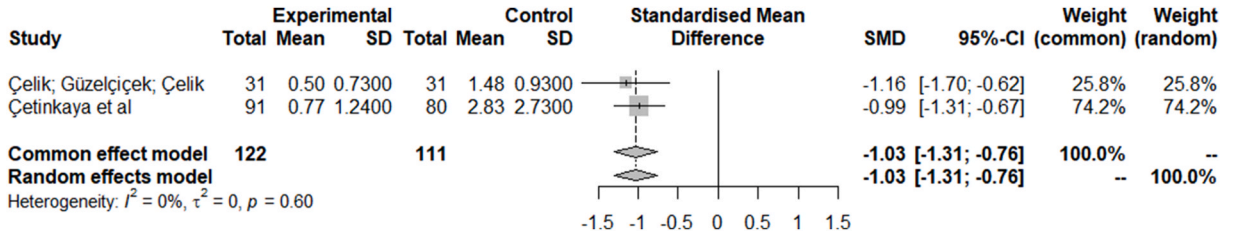

Fig. 4. Forest plot for pain.

effectiveness of using music in reducing SBP (SMD = −0.32; 95%CI = −0.55;-0.09), as shown in Fig. 5.

3.4.4. Diastolic blood pressure

Only one study showed statistical significance favoring the experimental group. The meta-analysis shows a tendency to favor the experimental group with music intervention to reduce DBP, but there was no statistical significance between the groups (SMD = −0.18; 95%CI = −0.84; 0.49), as shown in Fig. 6. The random effects model was considered for I^2 = 82 %.

3.4.5. Heart rate

Only one study showed statistical significance favoring the experimental group. The fixed effects model was considered for I^2 = 72 %. Although the meta-analysis shows a tendency to favor the experimental group with music intervention to reduce HR, there was no statistical significance between groups (SMD = −0.19; 95%CI = −0.42; 0.05), as shown in Fig. 7.

3.4.6. Respiratory rate

No study showed statistical significance between groups. The fixed effects model was considered for I^2 = 0 %. Although the meta-analysis in Fig. 8 reveals a tendency to favor the experimental group with the music intervention to reduce the RR, there was no statistical significance between the groups (SMD = −0.17; 95%CI = −0.43; 0.09).

Patients who received the music intervention showed better results in relation to anxiety, pain and SBP when compared to control groups.

3.4.7. Quality of evidence assessment

Table 3 presents the quality of evidence assessment of the studies included in the meta-analysis using the GRADE tool.

Outcomes classified as having “high quality” evidence were: pain, SBP and RR. HR was rated as a “moderate” quality, and anxiety and DBP were rated as “low quality” of evidence. Thus, it is confirmed that the music intervention is effective in reducing pain and SBP by showing statistical significance in the meta-analysis and high quality in GRADE; it is indifferent for HR and RR, as they did not show statistical significance in the meta-analysis, and a moderate and high quality of evidence in GRADE, respectively.

There is a tendency for music to be effective and promote anxiety relief, as it has statistical significance in the meta-analysis, but a low quality of evidence in GRADE. The same applies to DBP, as the meta-analysis did not show statistical significance, and it has a low quality of evidence in GRADE. In both cases, it is necessary to develop new studies with high methodological rigor and level of evidence to confirm or discard these findings.

4. Discussion

CVDs are more prevalent in individuals aged 65 years or older. Of these, it is estimated that around 50 % receive some cardiovascular procedure [30]. The population with a mean age greater than 60 years predominated in this review, which is corroborated by a methodological study carried out in the USA which presented a rate of 55 % of its participants aged 65 years or older when catheterization was performed [31].

An individual must have some risk criterion in order to perform this test, such as changes in cardiac troponin, electrocardiogram or Global Record of Acute Coronary Events with a score greater than 140, and must be performed within 24 h [32].

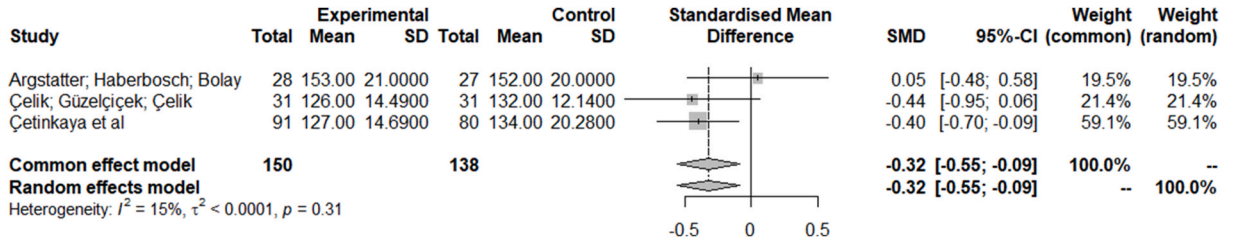

Fig. 5. Forest plot for systolic blood pressure.

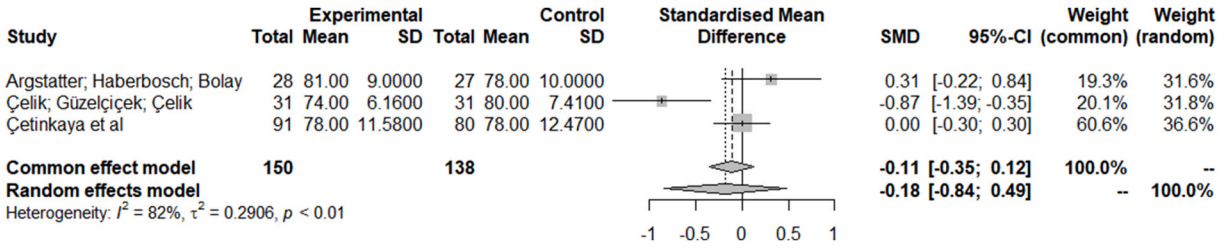

Fig. 6. Forest plot for diastolic blood pressure.

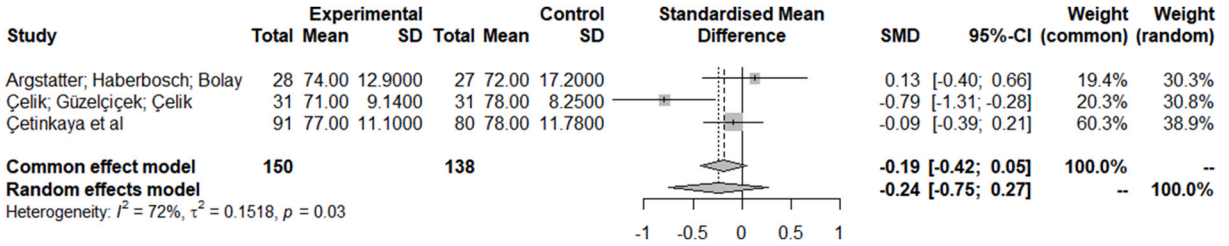

Fig. 7. Forest plot for heart rate.

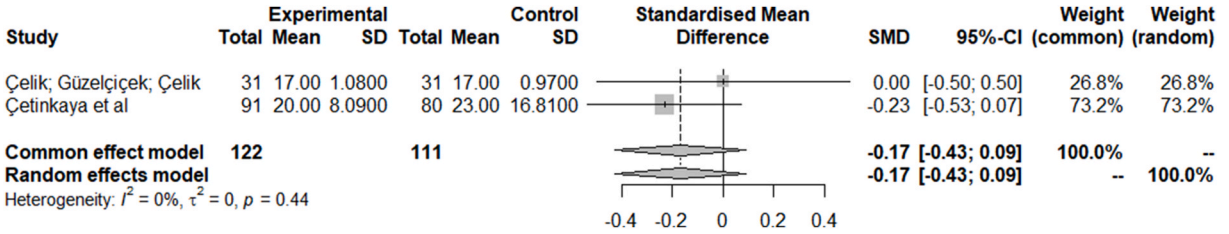

Fig. 8. Forest plot for respiratory rate.

This meta-analysis did not investigate the individuals' comorbidities or the clinical indication for performing the coronary procedure, but it is assumed that both factors influenced the geriatric public when considering the higher prevalence of CVD in older adults, and the need for one of the risk criteria mentioned above to perform the exam. It is also believed that there is a relationship between the risk criteria and the age of the population undergoing this test.

In turn, cardiac catheterization can generate anxiety due to lack of knowledge and its implications. It is influenced by fear of the disease, hospitalization process, anesthesia or some previous individual experience, leading to the development of tachycardia and arterial hypertension [7].

The most used tools in this review for assessing anxiety were STAI, NRS and HADS, while VAS and NRS were used for pain intensity. In this sense, it is necessary to use validated and reliable measures in pain management, such as the VAS, Verbal Rating Scale (VRS) and NRS scales, whose main domain evaluated is pain intensity [33]. However, there are two factors which make it difficult for nurses to perform this evaluation: the crowded hospital service and the professional's lack of experience. Pain can be underestimated in both cases, with inadequate management and treatment [34].

VAS is considered a good option when seeking to identify small changes in pain, although it is considered difficult to understand by the geriatric public. The NRS and VRS are easily applied, in addition to having a lower possibility of registering inappropriate responses [33].

Although most of the studies included in this review had a population aged over 60 years, the most used scale for measuring pain intensity was the VAS. It is believed that this is related to the search for a more accurate assessment and to be able to detect small changes in pain intensity measurements.

Given this context and, corroborating this systematic review, an RCT carried out in the USA with adults admitted to the emergency room for laceration repair also used the VAS and STAI scales to evaluate the effectiveness of using music in relieving pain and anxiety in these individuals. In this study, the musical intervention was applied through headphones, in which the patient had control over the musical selection, among 50 available genres and artists, in addition to control over the volume. Significant statistical results were presented for pain relief ($p < 0.05$), but without statistical significance in reducing anxiety using the STAI scale, nor in physiological parameters: HR, RR, SBP, and DBP [35].

It is highlighted that, when considering the most effective option to assess and relieve pain, it is important to consider a

Table 3
– Quality of evidence assessment.

Certainty assessment							No. of patients		Effect		Certainty	Importance
No. of studies	Study design	Risk of bias	Inconsistency	Indirect evidence	Imprecision	Other considerations	Music	No music	Relative (95%CI)	Absolute (95%CI)		
Anxiety (evaluated with: STAI scale)												
6	Randomized clinical trials	Not severe	Very severe[a]	Not severe	Not severe	none	519	361	–	**0** (2.42 lowest to 0.44 highest)	⨁⨁◯◯ Low	CRITICAL
Pain (evaluated with: VAS scale)												
2	Randomized clinical trials	Not severe	Not severe	Not severe	Not severe	none	122	111	–	**0** (1.31 lowest to 0.76 highest)	⨁⨁⨁⨁ High	CRITICAL
Systolic blood pressure												
3	Randomized clinical trials	Not severe	Not severe	Not severe	Not severe	none	150	138	–	**0** (0.55 lowest to 0.09 highest)	⨁⨁⨁⨁ High	IMPORTANT
Diastolic blood pressure												
3	Randomized clinical trials	Not severe	Very severe[a]	Not severe	Not severe	none	150	138	–	**0** (0.84 lowest to 0.49 highest)	⨁⨁◯◯ Low	IMPORTANT
Heart rate												
3	Randomized clinical trials	Not severe	severe[b]	Not severe	Not severe	none	150	138	–	**0** (0.42 lowest to 0.05 highest)	⨁⨁⨁◯ Moderate	IMPORTANT
Respitory rate												
2	Randomized clinical trials	Not severe	Not severe	Not severe	Not severe	none	122	111	–	**0** (0.43 lowest to 0.09 highest)	⨁⨁⨁⨁ High	NOT IMPORTANT

Legend: CI: Confidence interval; a: high heterogeneity; b: moderate heterogeneity.

multidimensional assessment in which the multidisciplinary team assesses physiological, psychological, spiritual, socio-emotional pain and its interference in the individual's daily life functions [36].

This meta-analysis showed the effectiveness of musical intervention in pain relief, in which instrumental music with a musical frequency of 60–100 bpm were the common aspects highlighted in the statistical evaluation. In this sense, it is believed that instrumental music exerts a positive influence on pain by modulating cortical and subcortical areas responsible for this action [37] by stimulating the PNS leading to muscle relaxation and bradycardia [9], in turn by being able to distract from environmental stimuli [38] and release endogenous brain opioids, which help control pain [39].

Music is also effective in other cardiovascular contexts, such as in the postoperative period of valve replacement. An RCT carried out in China applied a musical intervention through headphones for 15 min. Reductions in pain, anxiety, SBP and HR were described, agreeing with the findings of this review for pain, anxiety and SBP, but differing in the HR results [40].

However, another RCT carried out in Sweden with patients undergoing post-operative coronary artery bypass grafting or aortic valve replacement showed divergent results. In this case, a musical intervention was applied, using a pillow associated with an MP3 player, for 30 min, using relaxing music of the "new age" genre and sound intensity of 50–60 dB. There was a significant reduction in cortisol concentration ($p < 0.02$), although there was no statistical significance in the other parameters: HR, RR, mean arterial pressure, oxygen saturation, pain, and anxiety. It was also described that, possibly, more positive results could be presented if there were higher levels of anxiety reported, a longer duration of the intervention, and use of the musical selection established by the patients themselves, although more research on the subject is necessary [41].

Thus, it is identified that the therapeutic effect of music on the outcomes of the different variables studied may vary depending on the musical style used, the intervention time and the possibility of choosing the musical repertoire by the patient himself. Furthermore, music can be used as a complement to pain treatment, and therefore minimize the use of potent analgesics such as opioids. In addition, as members of the multidisciplinary team, nurses play an important role in managing this pain, as they are directly involved in the evaluation and decision-making process in providing care for these individuals [42].

In this sense, music is considered a safe, low-cost and non-invasive non-pharmacological strategy to be used by the nursing team in the management of chronic pain in elderly patients, especially when considering the pharmacokinetic and pharmacodynamic changes associated with the aging process. As a result, there is a low tolerance of these individuals for pharmacological therapy and greater risks associated with drug interactions due to the polypharmacy present in this population [43].

Given this, a systematic review was carried out to identify the effects of music use on chronic pain in the elderly. In this case, live, recorded, or active music was used, for the most part, considering the patient's musical preference, resulting in high variability of genres: pop, classical, jazz, country, religious, or instrumental. The musical interventions were carried out by trained nurses, music therapists, or a choir director accompanied by a psychologist, over a period that varied from 10 min to 2 h. Several scales such as the VAS and NRS were used to assess pain intensity, identifying a significant reduction in chronic pain and anxiety, an increase in the feeling of well-being, and a tendency towards a reduction in the use of opioids [43].

The STAI scale was the most used to measure anxiety. It is assumed that this result is related to the need to use a reliable, validated, easy-to-administer, punctuation and interpretation scale which can more fully assess this parameter [44].

The meta-analysis describes the effectiveness of music in relieving anxiety. The studies included in the statistical evaluation commonly used instrumental music at 60 to 100bpm, applied through headphones or speakers for 15–20 min, or during the entire coronary intervention.

It is believed that these parameters may influence anxiety relief by stimulating the PNS and triggering muscle relaxation, bradypnea, low salivary cortisol, corticosteroid or catecholamine levels [9]. Its capacity for distraction [38] and synchronization of the musical rhythm with the body is also considered to generate relaxation [9]. Thus, the use of headphones to apply music is associated with the inhibition of environmental sounds to reduce the anxiety generated by external factors [45].

The presence of pain is capable of influencing several physiological parameters of an individual, such as cardiac output, RR, blood pressure, catecholamine level and oxygen consumption. During pregnancy, for example, the intensity of pain increases as uterine contractions increase and is also influenced by psychological factors. In these cases, music is also indicated to alleviate pain and anxiety during and postpartum. Corroborating the above, a systematic review, involving 17 RCTs, 2232 of which were primiparous, identified that music promotes pain and anxiety relief, reduces maternal SBP, in addition to influencing HR and intrauterine fetal reactivity [46].

Such results are associated with the ability of musical intervention to promote maternal distraction, stimulate the auditory center in the cerebral temporal lobe and restrict the pain center - located close to the auditory center in the same lobe - and increase the release of endorphins, promoting endogenous analgesia. Additionally, reducing maternal tension increases comfort and reduces labor pain [46].

Musical preference is something unique, being influenced by factors such as age, culture, and region. However, whenever possible, music with a frequency of 60 bpm, classical or piano, should be prioritized, as they stimulate the release of beta-endorphins, responsible for inhibiting pain signals through nerve cells. For this, headphones or small speakers can be used, with a sound intensity that is comfortable for the patient [46].

Music interventions can help nursing care when used as a complement to conventional treatment in the context of pain, anxiety and vital signs [47]. In this context, the nurse is the professional responsible for managing care, and reaffirms the use of a non-pharmacological strategy when applying music which contributes to managing symptoms and reducing hospital costs [47].

This strategy also has hemodynamic benefits such as: decrease in blood pressure, HR and RR [45]. The physiological parameters evaluated in this systematic review were: SBP, DBP, HR and RR. They were compared between the control and experimental groups, and the effectiveness of music in reducing SBP was described, although it is indifferent in the other parameters.

Similar to the results presented in this meta-analysis, Cochrane developed a systematic review involving 25 RCTs, 1532 neonates,

and 691 parents, to evaluate the effectiveness of using music or vocal interventions on the neurodevelopment of premature babies and their physiological parameters [48].

In general, relaxing and calm sound stimuli were used, with a lullaby style, applied live or through recordings made by parents, health professionals, or a music therapist, made at a frequency greater than three times and with a duration of at least 5 min. In this context, music is capable of reducing the HR of premature babies, especially after the intervention, but it does not increase oxygen saturation, nor does it reduce the RR of babies or the intensity of the parents' anxiety. It is noteworthy that no negative effects were found associated with the musical intervention [48].

Based on the above, it is also important to remember that some changes in physiological parameters, such as HR, SBP, and DBP, can be influenced by the musical style used in the intervention, and can be associated with a parasympathetic defensive reaction, which induces bradycardia and hypertension in due to fear [10].

This was exemplified in a study carried out in Italy, which compared the use of tonal instrumental classical music with atonal contemporary music, whose repertoire was selected by a group of 20 professional conductors. The intervention was applied using headphones associated with an MP3 player. A reduction in HR, an increase in SBP and DBP was identified when using atonal music. These results were associated with possible tension and agitation due to an activation of the parasympathetic response induced by the use of atonal music, its threatening properties, activation of the amygdala, increased excitability, and the sensation of anxiety [10].

4.1. Limitations

This review is limited by including few RCTs in the sample, the heterogeneity between studies in the assessment of some outcomes and the use of few scales to assess pain and anxiety. As this review addresses the adult and geriatric population, the findings cannot be generalized to the pediatric population.

5. Conclusion

Music is effective in relieving pain and reducing SBP, but it is indifferent in terms of HR and RR outcomes. It is able to reduce anxiety, although it does not change DBP, making it necessary to develop new studies to confirm or discard these findings. Music is a potentially effective, low-cost strategy for pain and anxiety management, and can be adopted as a nursing intervention, although the presence of a music therapist in the hospital service is also recommended to apply this strategy in a more targeted and specialized way. This provides humanization of care, can reduce hospital costs and length of hospital stay.

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Data availability statement

The data associated with this study has been deposited in a publicly available in the institutional repository of the Federal University of Rio Grande do Norte on this access link: https://repositorio.ufrn.br/handle/123456789/52072.

CRediT authorship contribution statement

Kauanny Vitoria Gurgel dos Santos: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Joyce Karolayne dos Santos Dantas:** Writing – review & editing, Writing – original draft, Investigation. **Thatiane Evelyn de Lima Fernandes:** Writing – original draft, Methodology, Investigation. **Kleyton Santos de Medeiros:** Visualization, Validation, Methodology, Formal analysis, Conceptualization. **Ayane Cristine Alves Sarmento:** Validation, Investigation, Formal analysis. **Kátia Regina Barros Ribeiro:** Writing – original draft, Validation, Methodology, Formal analysis. **Daniele Vieira Dantas:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Formal analysis, Data curation, Conceptualization. **Rodrigo Assis Neves Dantas:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Project administration, Methodology, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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