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SPACE FOR MUSIC: ELEMENTS TO INCORPORATE INTO HEALTHCARE DESIGNS

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ABSTRACT

The hospital environment can, in many circumstances, act as a source of stress, negatively affecting the health of patients, staff, and families. Consequently, it necessitates innovative interventions to promote well-being. While the detrimental impact of noise in these settings has been widely studied, the potential positive effects of music remain an underexplored field, particularly within the realm of architecture. Several studies suggest that music may mitigate the adverse effects of noise by reducing stress and enhancing mood, among other benefits. However, the integration of music into hospital architectural projects is limited, with only isolated examples observed, such as pianos in waiting areas. This study aims to conduct a systematic review of the literature, analysing the impacts of music on the body and mind. Additionally, it examines the influence of specific musical variables, such as melody type, applied spaces, and methods of implementation—whether in person or electronic. This approach seeks to identify gaps in current knowledge and foster reflection on how architectural design could facilitate the inclusion of music to enhance the quality of the hospital environment. In doing so, it may be possible to propose more human-centred environments that prioritise holistic well-being.

Keywords: *acoustics, healthcare architecture, music-therapy, sounds, hospitals.*

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1. INTRODUCTION

Hospitals are complex environments that, due to their characteristics, can generate high levels of stress in patients, healthcare professionals, and visitors. In this context, architecture has the potential to transform this reality by integrating, among other things, therapeutic activities that can positively impact users. To achieve this, architectural practice should not be limited to merely adhering to pre-established functional plans and applying regulations, but should also expand knowledge from an alternative perspective.

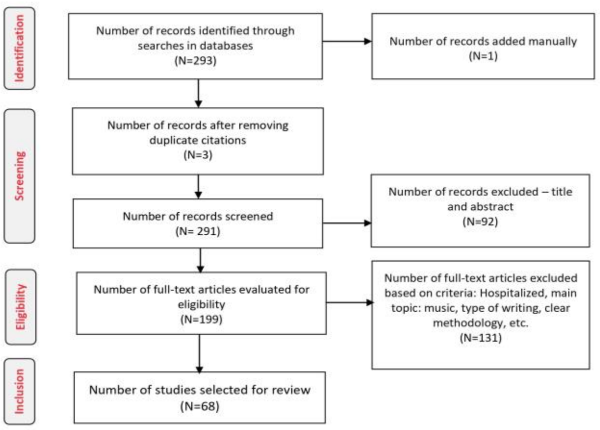
With this premise, the aim of this study is to explore the use of music therapy in hospital settings and to develop design guidelines that facilitate its implementation. Through a systematic review of the scientific literature, the study will analyse the effectiveness of Music Therapy (MT) in the hospital context, as well as the characteristics of its application and the spaces best suited for its integration. It is expected that the findings of this research will contribute to an interdisciplinary debate, promoting the development of more effective and human-centred architectural solutions that incorporate music therapy as a valuable therapeutic tool in hospital environments.

2. MATERIAL AND METHOD

A systematic review was conducted on the application of MT in hospitals during the last quarter of 2024. For the search of relevant articles, the electronic database PubMed was used, applying the following search strategy with keywords and Boolean operators: "((music therapy) AND (hospital)) NOT (review)".

Initially, articles related to music and sound in hospitals were evaluated for inclusion; however, it was concluded that it was more pertinent to focus specifically on the term "music therapy". To complement the results obtained, an additional search was conducted in another electronic database specialised in healthcare environments and their relation to architecture: The Knowledge Repository for The Center for Health Design. In addition, the "Spanish Technical Code" (CTE-DHBR) was manually included.

The article selection process was based on specific inclusion criteria. Only publications from the last 10 years (2014–2024) were included, and those focused on hospital settings, including hospitalisation, home care, and/or isolation, such as during the COVID-19 pandemic. The publications had to focus primarily on music, excluding those that combined therapy with other sensory approaches (e.g. visual or tactile). Furthermore, only articles written in English or Spanish were included, with a preference for those available in open access. Review articles (narrative and systematic), university theses, book reviews, monographs, duplicate articles, and those without a clearly defined design or methodology were excluded. Articles focusing on specific pathologies, such as epileptic episodes triggered by musical stimuli, were also excluded, as they represent a distinct line of study that warrants attention in future research.



Adapted from Source: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal. pmed1000097.

Figure 1. Methodology. Flow diagram in four levels.

From the initial search, 293 potential articles were identified across both databases. Additionally, one article was manually added to examine current regulations in Spain. Subsequently, three duplicate articles were removed. After reviewing the titles and abstracts, 93 articles were excluded. The remaining 199 articles underwent an eligibility assessment based on the inclusion and exclusion criteria. Finally, 68 articles were selected in this study. (Figure 1).

3. RESULTS

3.1 Systematic Review

3.1.1 Sample

Out of the 67 articles about MT selected for review, 77.62% focused on adult patients [1–52], while 22.38% examined paediatric populations [53–67]. The results were consistently positive across all studies, with 95.52% [1–49, 51, 53, 55–67] reporting statistically significant outcomes. The remaining 4.47% indicated improvements, though not at a level of statistical significance [50, 52, 54]. One additional article [68] discusses current acoustical technical regulations.

3.1.2 Physiological and Psychological benefits

Studies indicate that MT induces relaxation and activates the parasympathetic system, leading to reduced heart rate and muscle activity in ICU patients [1]. It has also proven effective in alleviating symptoms of depression and stress in patients in conventional hospital rooms [2,46]. In surgical settings, MT significantly enhances perceived quality of life [3] and reduces preoperative anxiety [4,5,6,7,25], while also improving relaxation, blood pressure, respiratory rate, and heart rate [5-7,10,19,23-25]. Additional benefits include decreased nausea and vomiting [6], reduced postoperative pain, and greater haemodynamic stability [7,8,10]. Also, the use of MT has been associated with improved emotional well-being after surgery [8]. In less invasive procedures, MT significantly improves pain management, anxiety, and comfort both during and after interventions [9,11-13,15,16,18,20-25]. It is also linked to reduced stress [16] and fear [17], as well as increased participation in rehabilitation [38]. Additionally, it lowers adverse events related to intubation [19] and serves as an effective distractor from negative surgical stimuli [10]. Music interventions have reduced the need for sedatives during or after procedures [12,13,14] and improved patient cooperation [23].

In long-term treatments such as dialysis, palliative care, and oncology, patients exposed to music reported a higher perceived quality of life [26,28,30,31,34], alongside reduced anxiety, fear, distress, and depression [27,28,30,31,32,34,48], as well as decreased fatigue [32,34] and pain levels [33].

For pregnant women, music significantly improved test reactivity, increased foetal movements, and enhanced maternal satisfaction [29]. In conventional hospitalisations, it notably reduced anxiety, increased oxygen saturation, and improved sleep quality, while also promoting emotional well-being and positive subjective experiences [36,37]. In patients with spinal cord injuries, it has been linked to improved mood, appetite, and energy levels [37], whereas in those with chronic liver disease, it has demonstrated benefits in reducing depression, anxiety, and improving liver function [39].

Among healthcare professionals, music interventions positively influenced noise perception and sleep quality [40]. In individuals with cognitive decline, it enhanced memory recovery, orientation, neurological function, and autonomy in daily activities [41,51]. In stroke patients, vocal music supported cognitive and linguistic recovery, particularly in cases of aphasia [43]. In schizophrenia, music improved functional brain connectivity, enhancing integration of visual, emotional, and motor processing areas, which correlated with reduced psychiatric symptoms [42].

For family caregivers, music significantly reduced the perceived burden of caregiving [44]. In emergency units, it lowered anxiety, improved vital signs, and reduced pain perception [45,46].

In neonatal care, music positively influenced white matter integrity [53], reduced pain and crying, and increased oxygen saturation in infants [55]. Parents reported music therapy as beneficial [56]. During sleep, it decreased respiratory rate and increased oxygen saturation in patients. Also, fear and anger reactivity at one to two years of age was similar to that of full-term infants. Magnetic Resonance Imaging findings indicated that MT promotes functional brain activity and connectivity in preterm infants [57]. Also, some articles demonstrate that Individual MT was more effective than Environmental MT in noise reduction, and both approaches contribute to neurocognitive development by providing a more stable and healthier acoustic environment [58,61]. For mothers into NICU´s settings, music interventions reduced symptoms of depression [59,62] and anxiety [59,60,62,65], while also improving neonatal pain management [66].

In paediatric hospitalisations, music significantly enhanced perceived enjoyment and quality of life [63,64], while reducing blood pressure and heart rate through alpha wave stimulation. Non-verbal music has been shown to be an effective intervention for reducing anxiety and stabilising vital signs in hospitalised children [67].

3.1.3 Session format

47 studies employed recorded music therapy [2–4, 6–25, 28–32, 35, 37–39, 41–47, 49, 51, 52, 55, 63, 65–67], 5 studies utilised a combination of recorded and live music [36, 48, 50, 58, 64], and 15 studies implemented live music [1, 5, 26, 27, 33, 34, 40, 53, 54, 56, 57, 59–62].

3.1.4 Instruments and audio delivery methods

The analysed studies incorporated a wide variety of musical elements. Some interventions used string instruments, including guitars, violins, monocords, and cellos [1, 5, 26, 27, 34, 36, 40, 48, 60, 61, 62]. Others employed percussion instruments, such as ocean drums [1, 60], wind instruments, including clarinets, flutes, and oboes [5, 26, 27], as well as rotational percussion instruments, such as sansulas (idiophones) [1, 53, 57, 59]. Additionally, some studies included keyboards or pianos [26, 27, 48]. In certain cases, the voice was also used as an instrument [1, 30, 33, 34, 40, 48, 50, 53, 54, 56–62]. Regarding audio delivery methods, these can be classified into three categories: headphones with music players [2–4, 6–8, 10–15, 18, 19–22, 24, 25, 31, 35, 36–39, 41, 43, 44–47, 52, 67], speakers [8, 9, 16, 18, 23, 28, 29, 42, 49, 51, 55, 58, 63–66], and the voice [1, 30, 33, 34, 40, 48, 50, 53, 54, 56–62]. A few studies did not specify the exact type of device or instrument used [17, 32].

3.1.5 Type of music

Two studies have employed different types of music to induce calmness and relaxation, prioritising simple harmonic melodies with fluid and descending progressions while avoiding dissonances and abrupt dynamics [1,36]. Compositions featuring predominantly natural, non-verbal harmonics have been used [2,7,9,10,33,46,47,58,63,65], as well as classical and contemporary songs adapted to the instrumental genre [5,26,27,40], Mozart's Sonata for Two Pianos in D major, K. 448 [6,42], traditional classical music [29,31,51,52,67], and pieces that hold personal or emotional significance for the listener [7,12,18,20,22,33,35,37,48,54,58]. Participants were also given the option to choose from a selection of soft and calming music, including light music, folk songs, opera, and pop music [8,13,18,23,35,44]. Additionally, soft, non-percussive melodies played on instruments such as the piano, violin, guitar, or flute have been employed [11,25,28,32,49,66], alongside positive affirmations with relaxing background music [14], nature sounds [15], and genres such as jazz, lounge, and meditation music [16,22,24,30,45,51]. Instrumental and vocal music has also been reported [17,34,60-62], as well as romantic and religious music [21,31], traditional Chinese music based on the five-phase theory [38,39], songs with lyrics, particularly from pop, rock, and schlager genres [43], long-lasting instrumental sounds [53,57,59], and both slow and fast rhythms [55].

3.1.6 Sound intensity or volume

Among the studies that report decibel levels, the following ranges were identified: live music with a maximum of 65 dB [1]; recordings with volume adjusted according to listener preference, without a specified limit

[2,3,11,12,18,21,31,35,37,39,41,44-47]; recordings with volume adjusted according to preference, but with an unspecified decibel limit [4,8,65]; recordings with levels of up to 60-65 dB [7,10,22]; recordings with a maximum of 60 dB [13,38]; recordings within the range of 60-80 dB [14]; recordings with a limit of up to 55 dB [16]; and music for sleep induction within a range of 40-50 dB [38].
Other studies mention the use of low volume in loudspeakers [23], moderate levels when singing to children [53,57,59], loudspeakers with a range of 50-60 dB [55], and levels of 35-45 dB in paediatric settings [66].

3.1.7 Other sound characteristics

Studies reporting decibels and frequencies identified the following characteristics: slow and stable rhythms [1,17,32,48], slow and rhythmic music [31], music at 60-80 BPM [3,16,25,51,65], 60-90 BPM [9], under 72 BPM [13], neural beats at 20 Hz, reduced to 10 Hz [15], frequencies from 1 to 30 Hz [22], wideband with a 192 kHz sampling rate and 24-bit depth, and audible bandwidth with 44.1 kHz and 16-bit depth [49]. For certain respiratory activities, 65 BPM is used, and for stimulating airway function (chest percussion), 112 BPM [63].

3.1.8 Session duration and repetition

The duration of MT sessions ranges from 10 to 60 minutes, with an average of approximately 35 minutes. Most of the analysed studies report a frequency of 2 to 4 sessions per week [1,2,17,18,21,25-27,29,30,32,34,40,47-49,51,53,54,56-62,64,67]. A few studies have implemented one session per day for 7 to 10 consecutive days [5,28,37,38,44], or daily sessions for up to 1 month [42,50], 2 months [39,43], 4 months [41], or, in the case of home hospitalisation, daily sessions for 6 months [8]. In contrast, for surgical or certain outpatient patients, a single session was sufficient to produce significant beneficial effects [3,4,6,7,9,10-16,19,20,22-24,31,33,35,45,52,55,65,66]. Only one study reported that the number of sessions was determined based on individual needs [46].

3.1.9 Settings

The hospital areas studied included adult ICUs [1,40,46], neonatal ICUs [53,54,56,57,58,59,60,61,62,65,66], palliative care units [34,48], standard hospital rooms [2,5,8,35,36,37,38,39,41,63,64,67], post-anesthesia care units [3,6,21,52], operating rooms [4,5,7,10,13,14,16,19,20-22,24], hospital corridors [5], minimally invasive surgical procedure rooms [9,11,12,15,17], medical examination rooms for PET scans or other imaging studies [18,23,28,29,32], long-term treatment rooms for chemotherapy or dialysis [26,27,30,31,33], psychiatric patient rooms [42], home settings [43,44], emergency units [45,47], acoustically specialized rooms for MT sessions [49,50], common areas [51], and ophthalmology consultation rooms [55].

3.2 Current regulations

In addition to complying with the functional plan, the design and construction of hospital infrastructure must adhere to the current regulations in Spain regarding noise control. In this regard, two key regulations must be considered: the Technical Building Code (CTE), specifically the Basic Document DB-HR Protection Against Noise (2007) [68], and the Noise Law (Nº37/2003). The difference between these two regulations lies in their scope of application. While the Noise Law establishes environmental noise limits and regulates sources of acoustic pollution, the DB-HR of the CTE defines the criteria for acoustic insulation in buildings to minimise noise transmission between spaces.
Regarding the maximum permitted noise levels, the Noise Law, as outlined in Royal Decree 1367/2007, stipulates that in the external environment of healthcare areas, noise levels must not exceed 45 decibels (dB(A)) during the day and 35 dB(A) at night. Inside hospital buildings, the maximum permissible levels are: 50 dB(A) in common areas during the day and 40 dB(A) at night; 45 dB(A) in rooms during the day and 30 dB(A) at night; and in bedrooms, 30 dB(A) during the day and 25 dB(A) at night.
Meanwhile, the DB-HR of the CTE stipulates that each room must be considered a protected use unit, requiring a minimum insulation of 50 dB(A) between adjacent spaces. Additionally, acoustic insulation towards corridors must meet the same minimum value of 50 dB(A), while operable elements, such as doors and windows, must provide insulation of at least 30 dB(A). Facades must also comply with this regulation.

4. DISCUSSION AND CONCLUSION

The results of this systematic review demonstrate that MT has a notably positive impact on patient health, with 95.52% of studies reporting statistically significant outcomes. MT has proven to be effective across a range of medical conditions, from reducing anxiety and stress to improving vital parameters such as blood pressure and heart rate, particularly in hospitalised, surgical, oncological, and chronically ill patients. Additionally, controlled MT has yielded beneficial effects on cognitive and emotional function, especially among individuals with neurological and psychiatric disorders, such as depression and schizophrenia.

In particular, the benefits of MT for paediatric populations include the reduction of pain and anxiety, as well as improved stability of vital signs in hospitalised children. In neonates, positive effects on brain maturation and oxygen saturation have highlighted the potential of MT in such delicate settings. However, it is essential to note that most studies focused on adult populations (77.62%), while paediatric populations comprised only 22.38%. This imbalance calls for further research to balance the samples.

Throughout the studies reviewed, recorded music was predominantly used, with fewer interventions involving live music. Nonetheless, the findings indicate that music, regardless of its format, is a versatile and effective therapeutic tool in various clinical contexts. The most used instruments included strings, percussion, wind, and keyboards, while the musical genres varied from classical pieces to personalised compositions. MT sessions typically lasted between 30 and 60 minutes, with a frequency of 2 to 4 times per week, although positive effects were also observed with single or extended sessions.

Despite these positive outcomes, the acoustic environment in hospitals presents challenges, including high ambient noise levels and poor sound insulation. This can attenuate MT's effectiveness. Decibel levels in some studies remain unclear, with 65 dB(A) being the highest reported, but this can be exceeded with instruments or other noise sources, raising concerns about regulatory compliance. Hence, architectural and acoustic control measures are essential to maximise MT's therapeutic potential and ensure regulatory adherence in hospital settings.

5. ARCHITECTURAL CONSIDERATIONS

Based on the findings of this study, some architectural considerations have emerged that could enhance the implementation of MT in hospital environments. The results suggest that the acoustic environment and spatial configuration within hospital settings play a significant role in optimizing the therapeutic effectiveness of MT. One potential approach is the incorporation of dedicated speakers for MT, which would ensure precise sound delivery tailored to therapeutic goals. Integrating these systems with advanced technologies could allow for the personalization of sound intensity and frequency, adjusting to the needs of individual patients.

Furthermore, the strategic placement of speakers should be carefully planned to avoid interference with medical devices, ensuring both the clarity of sound and the functionality of essential equipment. Patient rooms may benefit from sound isolation features that reduce external noise, while also adhering to regulations designed to protect hearing. This would contribute to preserving the therapeutic value of MT and enhancing its effectiveness.

Another potential consideration is the creation of dedicated MT rooms. These spaces would offer patients and their families a place to engage actively in therapeutic activities, from passive listening to interactive participation such as playing instruments. Additionally, these rooms could be designed to create a tranquil, supportive environment that fosters emotional healing.

For live therapy, in patient bedrooms, larger spaces could be provided to accommodate both patients and therapeutic instruments. This flexibility would allow for a more personalized approach to MT, where therapy could be adapted to the specific needs of each individual patient, thereby supporting the healing process.

Finally, the concept of sonic landscaping could also be explored to enrich the MT experience. By creating ambient sound environments that promote emotional states such as relaxation or focus, sonic landscaping can reduce noise disturbances and contribute to a serene atmosphere that complements the therapeutic goals of MT.

All these interventions must be carefully considered with appropriate construction solutions to ensure compliance with the relevant regulations.

6. LIMITATIONS

This article does not include studies involving deaf people. Also, as the research was conducted by humans, there is the potential for bias in study selection and interpretation.

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