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Perceptions of music listening for pain management: a multi-method study

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ABSTRACT

Objectives Music listening for pain relief is well studied in diverse healthcare settings, but its implementation remains challenging. While healthcare providers generally have a positive attitude, there is a lack of knowledge about healthcare recipients' perceptions and attitudes. Therefore, the aim of this study is to explore healthcare recipients' perceptions of listening to music for pain management, focusing on their general attitudes, implementation strategies and subjective experiences of how music helps (or does not help).

Design A multi-method study comprising a quantitative survey and qualitative interviews. It is a follow-up conducted 6 months after a randomised experimental study, which assessed the influence of different music genres on pain tolerance. At the end of the original experiment, participants received advice on listening to music in painful situations.

Setting Rotterdam, The Netherlands.

Participants The survey involved 169 participants (age mean 30.6, SD 9.8; 61.9% female) who participated in the initial trial. Following this, 20 in-depth interviews were conducted.

Outcome measures Perceptions of music for pain management were investigated, revealing general trends in the quantitative survey data. Data-led thematic analysis of the qualitative interviews focused on individual perceptions.

Results Participants showed a high willingness to use music for pain relief, particularly for so-called emotional pain (eg, anxiety, stress and heartbreak). Individual attitudes varied regarding different situations, types of music and types of pain. Barriers such as not considering the option and social sensitivity within healthcare contexts were discussed. A proactive approach by healthcare professionals and autonomy of healthcare recipients were suggested to overcome these barriers. Interestingly, the 'wrong' type of music or the 'wrong' situation were mentioned as non-beneficial or even harmful.

Conclusions Awareness of individual needs and potential negative effects is crucial for the use of music for pain relief. A proactive and personalised approach is needed to effectively implement music in healthcare.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The multi-method approach investigates both general and individual perceptions of music listening for pain management, offering a nuanced overview.
⇒ The relatively young and highly educated study population is not representative of the general population, which is a limitation of this study.
⇒ This study is of an exploratory nature and provides valuable insights for implementation strategies and optimisation of music listening in healthcare, which need to be tested in actual patient populations.

INTRODUCTION

Throughout the history of medicine, music has been recognised for its therapeutic potential.[1] Integrating music into pain management strategies represents a promising, non-pharmacological approach to improve patient outcomes.[2] Consequently, music is increasingly being integrated into clinical practices. For instance, a national guideline on the use of music in the perioperative process was published in the Netherlands in 2023.[3] Numerous studies have highlighted the benefits of music in alleviating pain, reducing anxiety and enhancing overall well-being.[4–8] There are several theories on how music alleviates pain, including distraction, hormone release and emotional regulation.[9] While medical research objectively demonstrates the impact of music on the human body,[10–12] the subjective experience of music listening in the context of pain has not been adequately studied.

Different forms of music engagement, such as music therapy, active music making and listening to recorded music, have been shown to be effective in various healthcare settings.[7 13 14] Listening to recorded music is often studied on a larger scale using objective outcomes and is viewed as an intervention with no discernible side effects.[4 15] Many (clinical) studies looking at the effect of music listening have focused solely on positive outcomes, potentially overlooking situations where music might be counterproductive. Given that the experience of listening to music (in healthcare-related situations) is highly subjective, it is crucial to capture these perceptions in an exploratory manner.[16 17] This approach could give more

insights into the effects of music in healthcare, both positive and potentially negative.

Despite the growing body of evidence, the implementation of music in clinical practice remains challenging due to various barriers such as funding, time to prepare playlists and staff turnover.[18 19] Other commonly documented barriers when implementing guidelines in clinical practice include poor communication between healthcare providers, inadequate knowledge and lack of motivation.[20] While healthcare professionals are generally supportive and research on this topic is extensive,[21 22] there remains a significant gap in understanding how healthcare recipients themselves perceive the use of music as a therapeutic tool. Currently, individuals' thoughts about music for pain relief, their willingness to incorporate it into their pain management routines, and their perspectives on the most effective and accepted strategies for its implementation are not well documented.

This study aims to explore healthcare recipients' perceptions of listening to music for pain management, focusing on their general attitudes, implementation strategies and subjective experiences of how music helps (or does not help). Through a multi-method approach, we hope to provide comprehensive insight into public attitudes toward this topic and contribute to the development of effective, patient-centred strategies for integrating music into pain management practices.

METHODS

The present study is a follow-up conducted 6 months after a randomised experimental trial on the influence of music genres on pain tolerance.[23] In this trial, healthy volunteers underwent a cold pressor test as a pain stimulus while listening to different music genres. Participants in the original trial were healthy volunteers aged 18 years and older, with specific exclusion criteria to ensure valid results and participant safety. These criteria included factors such as recent alcohol or drug use, chronic or acute pain conditions, cardiovascular diseases and hearing problems. Only participants who completed the original trial were invited to participate, with inclusion criteria matching those of the original trial.[23] The eligibility criteria of this follow-up study are provided in table 1.

Directly after participation in the original trial, participants received music listening advice. This advice included both written information and a personal conversation with one of the researchers. In the advice, participants were recommended to listen to music during procedures or situations in healthcare where pain, anxiety and/or stress could arise in the next 6 months. Other than the post-trial advice, the original trial did not promote music listening. The participants were told that an invitation for a follow-up study would be sent by email after 6 months if they provided specific informed consent. Six months after the original trial, participants were recruited for this follow-up study via email, with invitations to join the survey (online) and/or participate in an interview (either online or in person at Erasmus Medical Centre). This follow-up study follows a multi-method approach, where both qualitative and quantitative data were collected in parallel and analysed separately. After these analyses, the findings from both data sources were compared and merged to draw comprehensive conclusions.

Table 1 Overview of the inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
Adults ≥18 years	Significant hearing impairment
Sufficient knowledge of Dutch or English language	Presence of acute or chronic pain during the original trial
Provision of written informed consent	Medical history of cardiovascular diseases during the original trial
	Use of antidepressants or other psychiatric medication during the original trial
	Use of pain medication (within 12 hours), recreational drugs (within 24 hours) or alcohol level >0.5‰ before the original trial

Survey (quantitative data)

The follow-up survey was developed iteratively by the research team with input from pain researchers and sociologists, following the Strengthening the Reporting of Observational Studies in Epidemiology guidelines for reporting observational cohort studies (online supplemental table 1). The survey included multiple-choice and open questions on demographics, music listening behaviour, health status, pain experiences and attitudes toward music listening in healthcare. An overview of the survey questions is provided in online supplemental table 2. The survey was sent via Qualtrics software (V.2020, Qualtrics, Provo, UT). Data were collected between February and April 2024. Several reminders were sent for up to 2 months, and a raffle for gift vouchers was sent to encourage participation. It took approximately 10 min to complete the survey.

Interviews (qualitative data)

In-depth semi-structured interviews were conducted via an interview guide developed by the research team (online supplemental table 3). The guide included open-ended questions to inductively explore participants' perspectives on music for pain management. Interviews were performed between March and May 2024, either online or in person, and lasted 30–45 min. All interviews were audio-recorded with consent, and notes were taken to capture non-verbal cues. Participants received a €25 gift voucher. To ensure that the group was as heterogeneous as possible, individuals of various ages and educational backgrounds were invited to participate. Data saturation was reached after 20 interviews.

Analysis

The quantitative (survey) data were analysed with SPSS (IBM Corp, Chicago, USA) V.28.0. Descriptive analyses were performed using means and SD for continuous data. For categorical data, frequencies and percentages were used. To investigate the relationship of certain baseline characteristics (such as age, gender and music importance) on the willingness to listen to music in the different situations and on the overall effectiveness rating, linear multivariable regression analyses were conducted. For the qualitative (interview) data, data-led thematic analysis informed by grounded theory was conducted.[24] First, author RC (female researcher with expertise in conducting qualitative interviews and no personal relationship with any of the participants) performed all interviews. Next, the anonymised interview transcripts were individually coded by authors ASB, ESvdVB and RC and assigned to different subthemes, following the guidelines of thematic analysis and the Standards for Reporting Qualitative Research (online supplemental table 4).[25–27] This coding was conducted independently by the three individual authors, and the results were compared and discussed in the axial coding phase to ensure consistency. Finally, the found themes were compared with the themes from the survey results in the selective coding phase to ensure reliability. This resulted in the three overarching dimensions that structure the results section. Additionally, notes regarding non-verbal cues (eg, facial expressions, vocal nuances, gestures) were written down during the interviews and considered during the coding process to provide a more comprehensive understanding of the participants' responses. In the results section, survey and interview data are presented together per theme, ensuring a comprehensive view of the different findings. Moreover, quotes from the interviews are used to provide context and depth to the quantitative results.

Patient and public involvement

Patients and the public were not involved in developing the research questions, study design or analysis.

RESULTS

In total, 169 participants conducted the follow-up survey, and 20 participated in the interviews (figure 1). An overview of the survey demographics (table 2) revealed that the participants were predominantly female (61.9%), higher educated (88.8%) and of different ages, with the majority being younger adults (mean 30.6, SD 9.8). Accordingly, in the interviews, the participants were primarily female (60%) and higher educated (90%), with a mean age of 34.7 years (online supplemental table 5). In the survey, the average rating of music importance was 8.9 in general and 8.3 for well-being (10-point Likert scale). In the interviews, almost all participants found music important for their life, functioning and well-being. There was a fair distribution in terms of music listening behaviour and pain experienced in the last 6 months in both surveys and interviews. Although some participants experienced daily pain at the time of their study participation (eg, broken leg, postsurgery), there were no participants with chronic pain.

Attitude toward music for pain management

In both surveys and interviews, most participants wanted to listen to music when experiencing pain (figure 2). Notably, both survey and interview data highlighted that participants were more inclined to listen to music for so-called 'emotional pain' (such as anxiety, stress and heartbreak) and for overall (mental) well-being than for physical pain. For survey participants who had experienced pain, anxiety and/or stress and had listened to music in the past 6 months (85.0%), the perceived effect of music (10-point Likert scale) was higher for stress (7.8±1.6) and anxiety (7.0±2.2) than its perceived effect on pain alone (5.2±2.2). In the interviews, all participants believed that music helped with pain relief, primarily by serving as a distraction and influencing emotions, which was mentioned by everyone at least once. Other working mechanisms of music discussed were positive associations, memories, placebo effects and motivation to persevere. All survey participants discussed their (different and sometimes highly specific) beliefs and expectations about which music would (not) work for them.

The survey results revealed several trends, such as a lower willingness to listen to music when experiencing headaches (3.1±2.5 on a 10-point Likert scale) than in other situations, such as during surgery (8.1±1.6) or in the waiting room (6.6±2.6). For painful medical procedures, most survey participants preferred to listen to music either during the procedure (79.9%) or for a longer period before (64.5%), with a preference for using their own equipment (67.5%). Looking at the influence of participants' baseline characteristics, some trends emerged regarding their willingness to listen to music in different situations and the overall effectiveness rating (online supplemental table 6). For instance, participants who attributed higher importance to music for their well-being were more likely to want to listen to music during surgery (β 0.34, 95% CI 0.12 to 0.57, p=0.003), and in emotionally challenging situations (β 0.36, 95% CI 0.18 to 0.53, p<0.001). Additionally, female participants (β 1.47, 95% CI 0.64 to 2.30, p<0.001) and those who listen to music more frequently in their daily lives (β 0.26, 95% CI 0.08 to 0.45, p=0.006) tended to prefer listening to music in the waiting room. The interviews revealed that the willingness to listen to music and the choice of music were influenced by diverse factors that strongly varied among individuals. For example, participant 12 (male, 31–40 years) explained:

> For me, it depends on the season. Last year, I had a root canal treatment. When I went outside, everything actually hurt quite a bit. However, the sun was shining, and because of that, I chose to play some chill house music, which helped me.

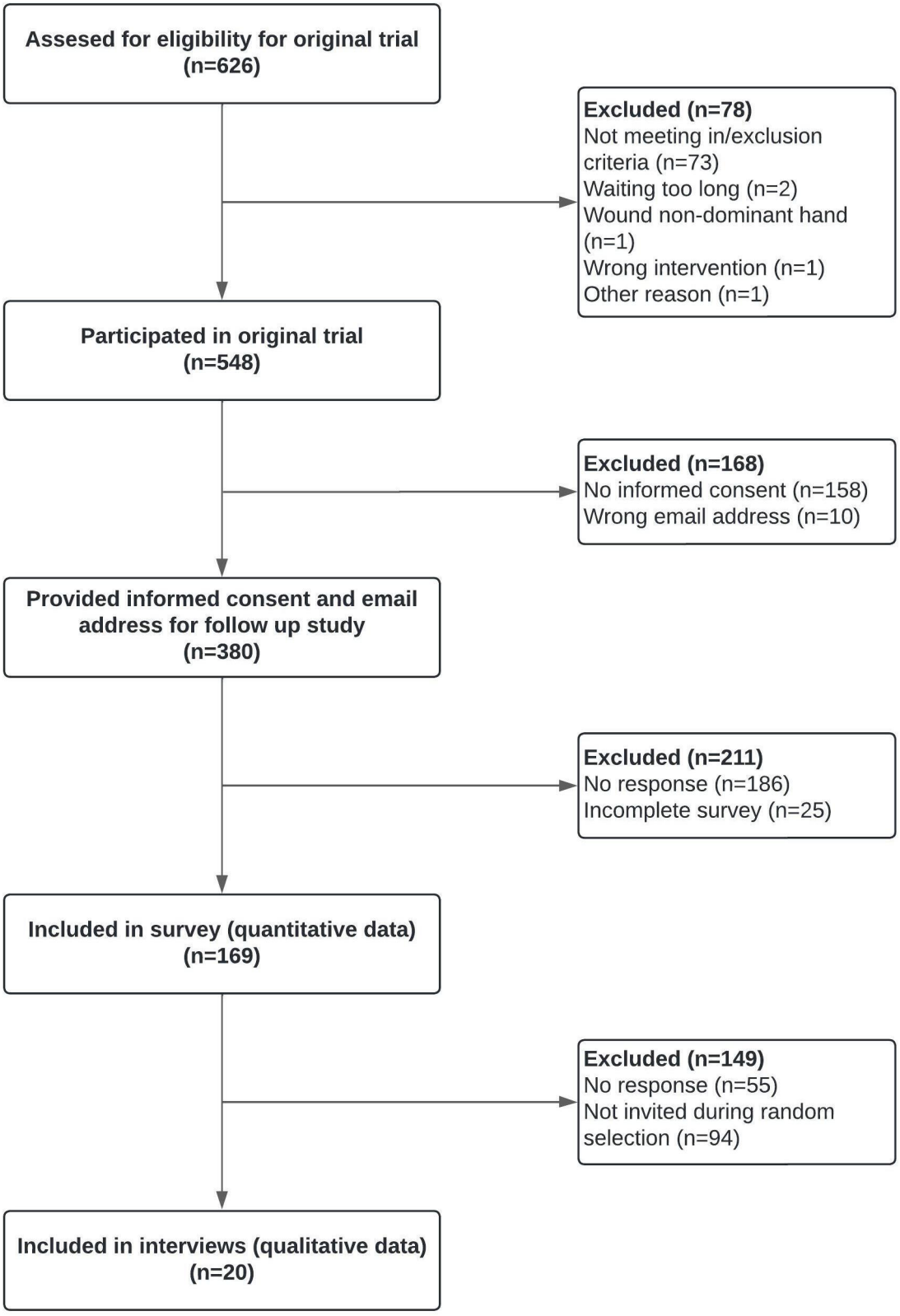

Figure 1 Flow diagram of study participants. Flow diagram of participants included in the survey (n=169) and interviews (n=20), with reasons for exclusion per recruitment phase, starting with the original trial.[23]

Most interview participants indicated a preference for music that aligns with their personal tastes. However, they generally chose harder/upbeat music in situations associated with acute pain, whereas more classical/relaxing music was preferred when they were admitted to the hospital and experienced pain. For example, participant 14 (male, 31–40 years) stated, 'I think that being able to endure pain for as long as possible, hardstyle [up-tempo

Table 2 Baseline characteristics of survey participants

Characteristic	N	Value
Age (mean±SD)	169	30.6±9.8
Gender (%)	168	
Female	104	61.9
Male	62	36.9
Other	2	1.2
Level of education (%)*	169	
Lower	5	3
Medium	14	8.3
Higher	150	88.8
Language of survey (%)	169	
Dutch	163	96.4
English	6	3.6
Music importance—general† (mean±SD)	168	8.9±1.1
Music importance—well-being† (mean±SD)	169	8.3±1.5
Daily music listening hours (%)	169	
<0.5 hours	7	4.1
0.5–1 hour	16	9.5
1–2 hours	47	27.8
2–4 hours	54	32
4–6 hours	30	17.7
>6 hours	15	8.9
Pain in the last 6 months (%)	166	
Daily	11	6.6
Several times per week	24	14.5
One time per week	17	10.2
Several times per month	30	18.1
One time per month	30	18.1
Less than one time per month	35	21.1
Other	5	3
Not at all	14	8.4
Chronic pain	0	0

*The level of education is based on the International Standard Classification of Education.
†10-point Likert scale.

electronic dance music subgenre] music would work better'.

Implementation of music in healthcare

An overview of the perceived barriers and optimal situation of music implementation in healthcare is shown in figure 3. The primary reason survey participants did not listen to music in a healthcare situation was that they had not considered it/did not remember the advice given (91.7%). Other reasons were mostly personal and social factors, such as feeling that there was no time (29.2%) and considering it impolite or awkward to ask (20.8%). A minority of survey and interview participants mentioned practical factors, which were limited to technical issues, such as uncertainty about equipment availability. In the interviews, a frequently perceived barrier to listening to (their own) music was the perceived social sensitivity to this topic. Both survey and interview participants indicated that a more proactive approach by healthcare professionals in suggesting or advising music listening would be highly beneficial. For example, participant 2 (female, 21–30 years) explained, 'If they suggested listening to music, it would be easier. I don't think I would quickly ask myself, 'Can I put on my techno music?' because it's not very socially accepted and you might also bother others'.

Nearly all interview participants emphasised the importance of having control and autonomy in selecting the type of music, the equipment and the context in which to listen to it. Preferences for listening to music varied significantly based on the situation and personal preferences. Another crucial factor was the need for information about the possibility of listening to music before a planned (surgical) procedure. Finally, nearly all participants mentioned the importance of healthcare providers offering options and taking personal (music) preferences into account. For example, participant 13 (female, 31–40 years) explained:

> The optimal situation for me would be to have options. Do you want it in the room, headphones, or earphones? And also what kind of music do you want to listen to? And whether you want music at all. That all choices are left to you.

Potential negative effects of music in healthcare

During the interviews, many participants mentioned situations dependent on factors such as the type of pain and mood, where music might not be beneficial or even disadvantageous to them. Those factors were highly individual; for example, while participant 4 (female, 21–30 years) mentioned that 'With a headache, I would truly like to listen to music'. Participant 9 (male, 31–40 years), in contrast, stated, 'Therefore, it [the music] would work very counterproductively there [with headaches] because the stimuli are part of the cause of the pain'.

Other interview participants mentioned potential negative effects of music in certain situations. For example, participant 4 (female, 21–30 years) discussed the fear of developing negative associations with a piece of music after listening to it in a painful context:

> I don't know if I would want to hear music immediately after surgery. You always wake up so confused from anaesthesia. I'm not sure if listening to music right away would later make you associate the music with the anaesthesia.

Overall, the type of music emerged as a crucial factor. Interview participants mentioned that music linked to certain memories could work averse. For example,

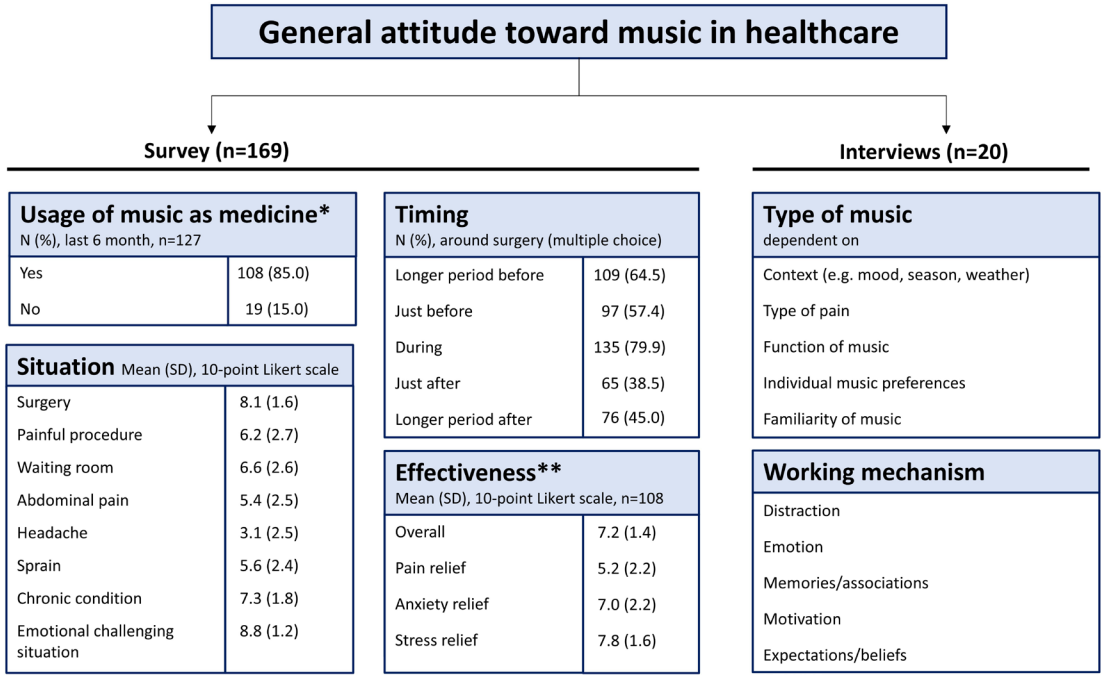

Figure 2 Summary of general attitudes toward music in healthcare. The figure shows the key findings on the general attitudes toward music in healthcare from survey (left) and interview (right) data. *Participants who experienced pain, anxiety and/or stress in a healthcare-related situation within the last 6 months. **Participants who experienced pain, anxiety and/or stress and listened to music in the past 6 months.

participant 13 (female, 31–40 years) noted, 'If you happen to play the wrong song with specific memories, I don't think it necessarily helps at that moment'.

Almost all interview participants mentioned that disliked music would not help them and could even have the opposite effect. For example, participant 15 (female, 31–40 years) states: 'As long as I find the music enjoyable. I don't need classical music. That won't help me, on the contrary. I also find jazz very annoying. It won't help me'.

Some participants mentioned that the wrong type of music could discourage them from listening to music in healthcare. For example, participant 11 (female, 31–40 years) explained: 'Earlier this year, I had an MRI scan. You could get headphones, but they only have two Dutch

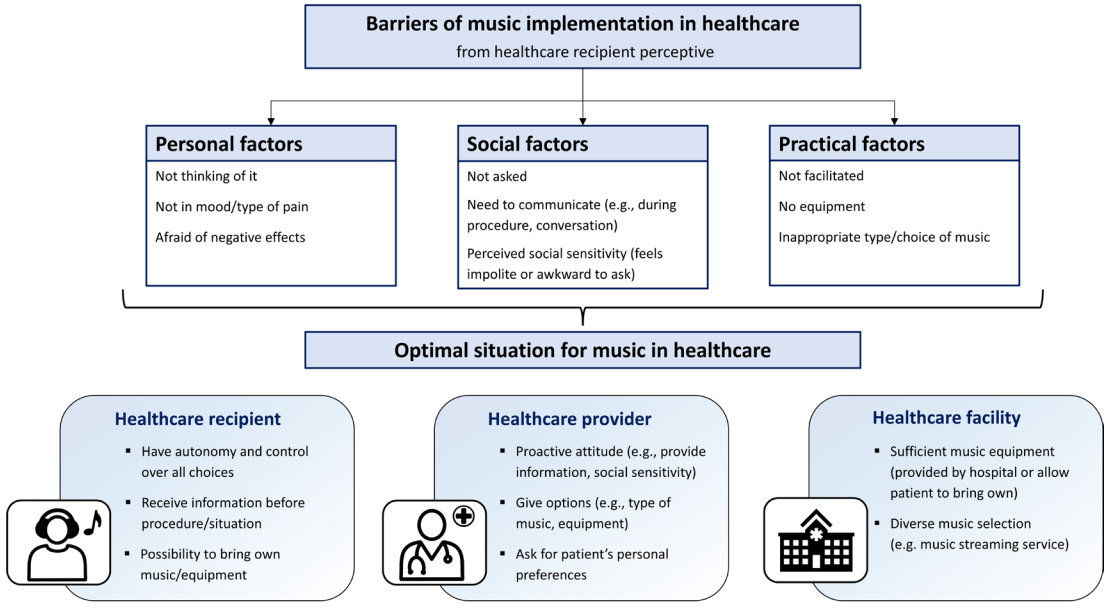

Figure 3 Perceived barriers and optimal situation for music implementation in healthcare. The figure illustrates the perceived barriers (upper section) and optimal situation (lower section) for music implementation in healthcare from the perspective of healthcare recipients. Thematic analysis of both survey and interview data identified personal, social and practical factors that pose barriers to music listening in healthcare settings. Based on these factors, participants described the optimal situation for music in healthcare, addressing healthcare recipients, healthcare providers and healthcare facilities.

radio stations. I don't want that. I'd rather listen to the noise of the scan'.

DISCUSSION

This multi-method study explored the perceptions of healthcare recipients regarding listening to music in healthcare. In general, participants wanted to use music for pain management. Although participants were relatively homogenous in terms of music importance, their attitudes toward the type of music and specific situations varied. In healthcare-related situations, participants encounter certain barriers when listening to music. Our results show that several personal, social and practical aspects need to be considered when implementing music in healthcare. In particular, the role of autonomy and control for patients has emerged as an important factor, making it crucial to consider personal preferences. In other words, music is not a one-size-fits-all intervention but should be tailored to the individual, the setting and the type of pain. Moreover, healthcare professionals should adopt a more proactive approach in facilitating music in healthcare, offering options and demonstrating social sensitivity. Finally, it is important to recognise that the 'wrong' type of music or the 'wrong' situation could have a non-beneficial or even harmful effect.

Attitude toward music for pain management

To our knowledge, this multi-method study is among the first to explore perceptions of music for pain management from the perspective of healthcare recipients. Our study focuses on listening to recorded music, which differs from music therapy and live-music interventions that include, for example, interaction with a therapist or performing musician. Previous research has highlighted the positive attitudes of healthcare professionals toward music as a therapeutic intervention.[2 21] Similarly, our results revealed a positive attitude of participants toward the use of music for pain relief in healthcare-related settings. Our data indicate that listening to music for so-called emotional pain (such as anxiety, stress and heartbreak) was more intuitive for participants than listening to music for physical pain. Extensive research has documented the positive effects of music on both emotional pain (eg, anxiety, stress and psychiatric disorders) and physical pain (eg, surgery, dental procedures and experimental nociceptive pain) in different healthcare settings.[4 28–30] Although pain is defined as a sensory and emotional experience, it is traditionally researched and treated separately from emotions.[31] However, physical pain and emotions share overlapping conceptual and neuroanatomical spaces and can influence each other. While the complete mechanisms of music's effect on pain are not fully understood, music-induced emotions may play a key role in pain alleviation.[9 32 33] Therefore, although participants intuitively separated the effects of music on emotional and physical pain, these aspects influence each other and should not be considered separately when evaluating the impact of music on pain. In addition, participants mostly believed that music worked for pain relief as a distraction. Central pain processing can be modulated by several factors, such as pain context, mood and cognitive set, with attention and distraction as important dimensions.[34] Previous studies on the pain-relieving effects of music have predominantly measured these factors quantitatively.[12 32 35 36] In our study, we focused on the subjective experience, revealing that distraction and emotions are commonly experienced factors in pain modulation by music. Additionally, some participants mentioned contextual factors such as the placebo effect and their beliefs or expectations about which music would (not) help them.

Implementation of music in healthcare

Previous research has shown that patients are generally willing to listen to music, which aligns with our findings.[37] However, certain barriers significantly impact the successful implementation of music in healthcare.[18 21] From the healthcare providers' perspective, these barriers include knowledge about the intervention, decision-making processes and patient turnover timing. From the patients' perspective, a lack of knowledge and awareness prevents them from using music for pain relief. While qualitative research has explored healthcare providers' views on music in healthcare,[21] our study focuses on recipients' perspectives, combining qualitative and quantitative methods for more nuanced conclusions. One common barrier was that participants simply did not consider/remember listening to music, and healthcare providers did not suggest it. Social acceptability was also a concern, such as the feeling that it is impolite or awkward to ask for music, which could be addressed by healthcare providers taking a more proactive role in offering information and guidance. Our results highlight that autonomy and control are crucial. Participants expressed that choices regarding music for pain management (eg, type of music, equipment, timing) should be left to them. This finding is in line with previous studies that showed that listening to the preferred type of music is most efficient for pain relief.[23 38 39] A study by Howlin *et al* described the link between perceived control and the analgesic benefits of music in an experimental setting, but this link has not been thoroughly investigated in clinical settings.[40 41] Willingness to listen to music varied among individuals depending on the situation and type of pain. The quantitative analysis indicated that individual characteristics such as gender, music-listening behaviour and importance attributed to music for well-being can influence these decisions, while the qualitative interviews further emphasised the individuality of music listening in healthcare. Our study population highly valued music, but the general population might have a higher percentage of individuals not wanting to engage with music in healthcare. Overall, our results emphasise the need to tailor music interventions to individual needs and preferences. Providing options in terms of the type of music and listening situations, along with a proactive

approach from healthcare providers, could facilitate the implementation of music in healthcare.

Potential negative effects of music in healthcare

Many studies have highlighted the positive effects of music in healthcare settings, such as reducing anxiety, stress and pain and improving overall well-being.[4 5 7 42] Assuming that music has no side effects, one might conclude that it is always a suitable option since it 'does no harm'. However, our study revealed that participants identified specific situations, moods and types of pain where they did not want to listen to music. Listening to music under those circumstances was described as non-beneficial or even harmful. Our results also revealed that music in the wrong situation, such as directly after surgery, could create negative associations. Moreover, music of a type that is considered 'wrong' or 'not preferred' by the individual could lead to non-beneficial or even negative effects. This aligns with the results of the original trial, which indicated that music preference, irrespective of the genre, predicted higher pain tolerance.[23] The results of this follow-up study suggest that while more preferred music had a positive effect on pain relief, less preferred music could also have a negative effect, potentially lowering pain tolerance in the original trial. Offering a single type of music (such as classical music, which is often used in clinical trials) may not be optimal for everyone, indicating a need for more personalised approaches.[4] To our knowledge, these possible negative effects have not been described before. Our findings suggest that being sensitive to individual preferences and contexts is crucial when using music in healthcare, as the wrong music in the wrong situation can actually do harm.

Limitations and future research

One limitation of this multi-method study is the relatively young and highly educated study population, which attributes slightly more importance to (listening to) music than the average population.[43] This population is not representative of the general population, particularly not of hospitalised patients who tend to be older. Additionally, while the study population was quite homogeneous in terms of high music importance, there were still many individual differences. Moreover, the participants in this study experienced barriers to use music in healthcare, which might be even more challenging for individuals with a lower value for music. Nevertheless, more research is needed to investigate the perceptions of patients with diverse backgrounds regarding music in healthcare. Next, enrolling participants who had volunteered in the original trial assessing music for pain relief had the strength that 85% used music as medicine and therefore provided an adequate sample for the study—but may also limit generalisability to the general population. Another limitation lies in the nature of this study, which assessed the subjective attitudes and experiences of overall healthy participants. These perceptions are important for understanding the perspective of healthcare recipients and improving implementation strategies. However, further research applying objective measurements in clinical settings under suitable (placebo) control conditions is needed to validate these findings. A final limitation is that the qualitative data analysis of this study was not based on a deductive conceptual framework. Given the multi-method approach and considering that this was the first study on this topic from a healthcare recipient perspective, we opted for an inductive, theme-led analysis based on the survey themes to remain open to novel findings. However, future research looking at music listening for pain relief from a healthcare recipient perspective should consider established implementation science frameworks, such as the Consolidated Framework for Implementation Research.[18 44]

CONCLUSION

In conclusion, this multi-method study reveals that healthcare recipients want to listen to music for pain relief. However, they encounter barriers to actually listening to music, which can be divided into personal, social and practical factors. A proactive approach by healthcare providers and giving autonomy and control to patients are crucial. Participants expressed highly individual attitudes and beliefs about which music would (not) help them. The wrong type of music in the wrong situation was experienced as non-beneficial and sometimes even harmful. In summary, tailoring music to individual needs and preferences is essential for implementing music for pain relief in healthcare.

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Contributors This study was designed by ESvdVB, ASB, JS, RC, MB and MK. Interviews were conducted by RC. The data were analysed by ESvdVB, ASB and RC, and the results were critically examined by all authors. ESvdVB and ASB had a primary role in preparing the manuscript, which was edited by JS, MB, RC and MK. All authors have approved the final version of the manuscript and agree to be accountable for all aspects of the work. ASB acted as guarantor.

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Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants. The protocol of the follow-up study (ETH2324-0398) was approved by the ESHCC Research Ethics Review Committee of Erasmus University Rotterdam (Rotterdam, The Netherlands). Participants gave informed consent to participate in the study before taking part.

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