ABSTRACT

Objective To explore the characteristics and outcomes of vibroacoustic therapy (VAT) in adults experiencing pain. To give directions for future research and clinical applications of VAT in pain management for adults.

Design Scoping review.

Data sources BMC, CINAHL Plus, Cochrane Library, EBSCOhost, EMBASE, Epistemionkos, ERIC, MEDLINE complete, Scopus, Web of Science, Google Scholar, ProQuest, hand search in unpublished sources.

Study selection All quantitative and qualitative research studies and systematic reviews, without any date or language limit.

Data extraction Two independent reviewers extracted data on the study design, location and setting, the causes of pain, participants, vibroacoustic intervention, measurement tools, and key findings related to pain.

Results From 430 records, 20 were included for narrative synthesis. Fifteen studies researched chronic pain, two studies acute pain, two studies both types of pain and one study experimentally induced pain. The description of VAT applied in studies usually included the description of the research experiments, vibroacoustic devices and frequencies of sinusoidal sound. There was high heterogeneity in study protocols, however, 40 Hz was predominantly used, most sessions ranged between 20 and 45 min, and the frequency of treatment was higher for acute pain (daily) compared with chronic pain (daily to once a week). Outcomes related to pain focused mainly on perceived pain; however, other surrogate measures were also considered, for example, an increased number of treatment days or pain medication usage.

Conclusions Research in this area is too sparse to identify properties of VAT that are beneficial for pain management. We suggest VAT researchers describe a minimum of four measurements—frequency, amplitude, pulsation and loudness. Randomised controlled trials are needed to establish reliable scientific proof of VAT effectiveness for both acute and chronic pain. Furthermore, clinical practice would benefit from researchers’ experiences and preferences of vibroacoustic treatment and its psychosocial components.

INTRODUCTION

Vibroacoustic therapy (VAT) is a complementary psychosocial approach in rehabilitation defined as ‘a combination of low-frequency sound vibration, (and) music listening combined with therapeutic interaction’ (p. 128). Synonyms and other related terms for VAT are vibroacoustic treatment, physioacoustic therapy, rhythmic sensory stimulation and vibroacoustic music, and it is sometimes referred to as a vibrotactile intervention. Vibroacoustic stimuli can be delivered using various devices that are based on sound-induced sinusoidal waves. Other devices in vibration therapies, such as whole-body vibration (WBV), are based on mechanical rather than sound vibration. As there may be essential differences between WBV and VAT in terms of application methods and results, this review focuses solely on the effects of sinusoidal sound-based vibration. The variables of low-frequency sound (LFS) interventions may include frequencies (measured in Hz), amplitude (refers to the intensity of a sound wave, perceived by the ear as loudness), pulsation or cycle (refers to the speed of the amplitude change) and loudness or strength that is associated with amplitude and its energy.2

Although the effects of the various VAT parameters such as amplitude are relatively unknown, previous authors have addressed the impact of specific frequencies (Hz). In Tony Wigram’s work on VAT and the physical responses to certain frequencies, when commonly used frequencies such as 50, 68 or 86 Hz were applied, participants perceived...
the sensation in similar areas of their bodies (chest, shoulders and head). However, when 40 Hz was applied, given that larger muscles’ resonant frequencies are generally lower, the stimulation was perceived in for example, the thigh muscles, as well as affording a general relaxation response. This has also been repeatedly found in clinical practice. Neurological studies also show that the brain communicates with itself on the gamma frequency band (which centres around 40 Hz). When a disruption to this band occurs, VAT may act as a driving force to reset this dysfunction.9

Some authors8 10 recommend using VAT to treat acute and chronic pain. Previous research on pain response theories, such as the neuromatrix pain theory11 and the potential impact of an induced relaxation response,12 proposes first affording a pleasant physical sensation, as compared with one which causes pain (see also reference13), to reset the destructive response one develops over time to and from chronic pain, thereby enabling the potential for a therapeutic process in which one can understand and respond to the biopsychosocial factors associated with chronic pain.14 VAT has been used for pain management in postoperative conditions15 and syndromes such as fibromyalgia,16 Ehler-Danlos syndrome17 and temporomandibular disorders, among others. It is hypothesised that the combination of the two vibrational components used in VAT—auditory music and LFS vibrations—may be effective in pain management.18 19 The effectiveness of music in pain management has been investigated mainly by music therapists,20 21 whereas the effectiveness of low frequency vibration was found mainly within the literature on WBV.7 Reporting on VAT has often omitted information on specific technologies or LFS parameters (eg, the frequency or amplitude), despite these elements being potentially determinative of effectiveness. Therefore, this scoping review attempts to compile and analyse data related to VAT characteristics (especially characteristics of the LFS stimulus) and outcomes related to pain. Furthermore, this study is not limited only to studies of effectiveness but aims to provide an overview of the field of VAT and pain (also including qualitative studies) and open a discussion about the specifics of this methodology. Based on the findings, it will be possible to determine if the research evidence found would be sufficient for conducting a systematic review of effectiveness or another type of systematic review. According to the Joanna Briggs Institute (JBI),22 the scoping review is the most appropriate design for mapping and discussing intervention characteristics or concepts and their evidence sources.

Although there is some primary research on VAT and pain, a search of Epistemonikos, Cochrane Reviews, JBI Evidence Synthesis, Open Science Framework and Prospero showed no published or ongoing systematic/scoping review. The objective of this scoping review was to search for and analyse all available evidence on VAT used for the treatment of pain in all adult populations across the world. The PCC format was used to formulate two review questions.23

Review question 1: ‘What are the characteristics of vibroacoustic therapy described in research studies in adults with pain?’

Review question 2: ‘What are the outcomes related to pain in studies on vibroacoustic therapy in adults with pain?’

METHODOLOGY

The proposed scoping review was conducted in accordance with the JBI methodology for scoping reviews.23 The objectives, inclusion criteria and methods for this scoping review were specified and documented in a protocol registered in Open Science Framework: https://osf.io/6c3uh/. Only one deviation from the protocol was a decision to accept relevant conference abstracts.

Inclusion criteria:

► Participants: the review considered studies that included any adult populations older than 18 years suffering from pain.

► Concept: the review considered studies on sinusoidal, sound-induced, low-frequency vibration (applied locally or to the whole body) without therapeutic interaction (ie, applied solely as a stimulus but not as part of a therapeutic relationship) and with or without music listening (so-called VA treatment). Excluded were studies using technologies based on resonance (without technologically modified sinusoidal sound) or mechanical oscillations (eg, WBV) that is, sinusoidal vibration and displacement through oscillating platforms not comprising sound vibration.

► Context: the review considered studies conducted in a broad range of institutions or therapeutic settings without limitations (including self-care applications at home).

► Types of sources: the review considered all quantitative and qualitative research studies as well as systematic reviews. Text, opinion papers, clinical reports, systematic reviews and bachelor and diploma theses were excluded. No date or language limits were set, but the title and abstract had to at least be available in English.

The searched databases were: Bibliographia Medica Čechoslovaca (BMČ, the Medvik interface), CINAHL Plus, Cochrane Library, EBSCOhost, EBM Reviews, EMBASE, Epistemonikos, ERIC, MEDLINE complete, Scopus and Web of Science. Sources of unpublished studies and grey literature searches included ProQuest and Google Scholar. A manual search was carried out in the publication Music Vibration and Health,24 in the Annual Newsletter Soundeffects focused on VAT (Volume 4, 2007) and in all the issues of the journal Music and Medicine. The reference list of all relevant studies was screened for additional studies. The search was conducted on 6 March 2020 and updated on 9 January 2022. See the full-search strategy for each database supplemented by tables with the results in online supplemental appendix A.
Following the search, all identified citations were collated and uploaded into Zotero-5.0.85, and duplicates removed. Titles and abstracts were then screened by two independent reviewers (JK and KK) for assessment against the inclusion criteria for the review. Potentially relevant studies were retrieved in full, and their full texts were assessed in detail against the inclusion criteria by two independent reviewers (JK and KK). Any disagreements that arose between the reviewers at each stage of the study selection process were resolved through discussion or with a third reviewer (EAC or MK). Studies excluded based on full-text analyses are in online supplemental appendix B with reasons for exclusion. The results of the search are reported in full below (figure 1) using a Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA-ScR) flow diagram.

Furthermore, data were extracted by two independent reviewers (LK and KK) using a data extraction tool developed by the authors (see online supplemental appendix C). Any disagreements that arose between the reviewers were resolved in discussion with a third reviewer (EAC or MK). The extracted data were presented in tabular form in a manner aligned with the scoring review objectives. Finally, the studies were sorted alphabetically; the extracted data were presented in the table in online supplemental appendices D and E, accompanied by a narrative summary.

Patient and public involvement
No patient was involved in the study.

RESULTS
The final data set from the original search from 3 March 2020 comprised of 16 studies (results from the updated search are described in section 3.3). Studies included participants with different forms of pain. Eleven studies were focused on chronic pain,15 33 one study on experimental induced pain34 (from this point onwards referred to only as experimental pain), one study included patients with acute and chronic pain35 and one study did not specify the type of pain (probably both acute and chronic pain patients were included).3 Chronic pain included different types of presumed musculoskeletal pain (mostly fibromyalgia), psychosomatic and neuropathic conditions,2 4 16 26–32 55 and, least prevalent, Ehlers-Danlos Syndrome Hypermobility Type.17 The acute pain15 33 studies included postoperative pain after gynaecological surgeries, after a total knee replacement and after an ankle sprain.35 Experimental pain was evaluated in university students after exercise-induced muscle pain.34

The chronic pain studies were published beginning in 199135 with increasing frequency in recent years (eg, eight publications after 2017). Both studies on acute pain were published in 1997; the Chesky and Michel study from 1991 only included a short case study of a patient with acute pain. The one study on experimental pain was published in 2012.34 Four of the studies on chronic pain were from Canada,16 17 30 31 four from Finland,2 4 26 27 three from the USA,28 29 35 and one from Estonia.32 The studies on acute pain were from the USA,15 33 35 and the study on experimental pain was from Canada.34 The study without specification of type of pain was done in the USA.3 Most studies were conducted in a clinical setting except for five studies with self-treatment in a home setting2 27 28 30 31 (two studies were divided into two parts with the first realised in hospital and the second at home2 27 and three studies at universities).30 31 35

The number of participants ranged from 11 17 26 to 56.5 In most studies, the number of participants needed to achieve sufficient power had been underestimated, as noted by some authors.31 Concerning participants’ gender, the 230 females (F) far-exceeded the 82 males (M) in the pooled sample of all studies. The gender ratio in the samples according to the types of pain was 176F/66M for chronic pain, 30F/9M for acute pain and 22F/4M for experimental pain. The age range of the participants was 18 to 70 years.32

The studies were grouped according to research design; this was based on the levels of evidence paradigm from the JBI guidelines.36 Two studies on acute pain15 33 and one study on experimental pain34 were classified as quasi-experimental prospectively controlled studies. Moreover, Chesky and Michel included one case study on acute pain in their paper.35 In the area of chronic pain research, there were three randomised controlled trials,26 30 31 one quasi-experimental prospectively controlled study,29 five case series2 4 16 27 31 32 and four case studies.17 26 35 The one study that did not specify the type of pain was classified
as a case series. Three studies used a mixed-methods design with a qualitative part; however, only two of these included qualitative findings relevant to pain and VAT. No study with a qualitative design was found.

This review’s findings are presented in two subsections according to the review questions: the first dealing with information on the characteristics of VAT and the second describing the pain-related outcomes.

The characteristics of vibroacoustic therapy
There was high variability in treatment protocols, VA devices and LFS treatment programme properties. The typical length of a session ranged between 20 and 45 min with one exception in the acute pain study that applied VAT before, during and after physiotherapy, with the whole process lasting 40–50 min. Some sessions included therapeutic discussion between patient and therapist.

Some studies applied VAT in a single session and some over several consecutive days. The regularity of the VAT sessions varied from taking place once to several times per week. In acute pain studies, the stimulation was delivered once to three times per day, while this ranged from twice a day to once per week in chronic pain studies. There was also high variability in the treatment procedures within the session. Several studies implemented treatment phases with wash-out periods and combinations with other stimuli or VA treatment programmes.

The most commonly used VA devices as follows: the Next Wave Physioacoustic Chair, the Sound Oasis VTS1000 (also the Next Wave system), the Music Vibration Table, MVT, the Taikofon FeelSound Player for self-application at home, the Multivib 10 mattress, the Somatron and the SL5 Nexneuro.

One of these devices—the Taikofon Feel Sound Player—was applied for local stimulation; the other devices were capable of delivering whole-body or upper-body (Sound Oasis VTS1000) LFS application. There was a wide range of frequencies applied (lower end of the range was 26 Hz) during the whole treatment process and within individual sessions, for example, because of a scanning/radar-like effect in which there is a focal frequency and two frequencies either side to which the vibration ‘scans’. This is used in the Physioacoustic System to avoid numbness; 40 Hz was most applied across all studies. It was used either as the single frequency, or as the fundamental frequency within a treatment programme for all sessions. Only some studies included information about the duration of the VA treatment programme parameters, spectral analysis of the vibration, music, or the patient positioning.

Most studies included listening to music as part of the treatment, except for two studies on chronic pain and the experimental pain study that did not use any music. Two studies let the participants choose whether to use music or silence in addition to LFS. Findings from two studies were related to the role of music as part of the VA treatment:

- One study found LFS to be more effective with music compared with LFS alone.
- Participants noted that music was a more potent stimulus for the affective dimension than LFS.
- Some of the various musical instruments seemed to be able to hold patients’ attention longer than others.

Several VA treatment programmes were mentioned—General Relaxation, Energise and Sleep.

Outcomes related to pain
Most data were collected using quantitative measurement tools, with some qualitative methods also utilised. Nearly all studies (except Chesky and Michel) used the Visual Analogue Scale for Pain (VAS-P) or its modifications. Various forms of questionnaires, usually standardised, were used: McGill Melzack Present Pain Intensity scale, Brief Pain Inventory-Short Form, Revised Fibromyalgia Impact Questionnaire (FIQ), McGill Pain Questionnaires (MPQ), Tender Point Index (TPI) Test, Dolorimeter Pain Threshold Test (TPA) and Pain Disability Index (PDI). Some studies collected data on the use of pain medication, the duration of sitting and standing time without pain or duration of pain relief. Some studies were complemented by qualitative information either from the therapists or participants.

Some outcomes indicated pain relief after VAT. These were analysed according to the type of pain (acute, chronic and experimental) and according to the study design with specific attention given to the presence or absence of a control group.

Both studies on acute pain with a quasi-experimental design reported some pain relief. In one of these studies, statistical significance between experimental and control groups was reported on 1 out of the 6 days of daily VAT sessions. Among other outcomes was a decline in the use of intravenous pain medication and positive verbal feedback of patients about their VAT experience. One case study on acute pain reported pain relief after one VAT session. There was no statistical difference between the experimental and control groups in the study exploring experimental pain using a quasi-experimental design. Among the three studies on chronic pain that used control groups, one reported pain relief with statistical significance. Another study showed better scores for reduction of pain although not statistically significant—in the experimental group compared with the control group. The same study observed significantly decreased pressure pain thresholds (in TPA and TPI scores). Janzen and colleagues did not observe significant differences between groups (except for statistically significantly improved pain interference in the control group). Howard used a cross-over design and did not find any differences between VAT and listening to self-selected songs.

The studies with an observational design used pretest post-test measurements on individual participants (in case studies) or whole samples (in case series). Of the five
studies where significance was calculated, four studies showed significant pain relief, whereas one found no difference. In the four studies with descriptive statistics, trends showing improvement rather than worsening in pain sensation are reported.

Table 1 (see the end of Results) shows the designs of studies on chronic pain with emphasis on control and intervention, where applicable and the effect of VAT on the perception of pain. This table also includes the study that does not specify type of pain but probably included at least some patients with chronic pain.

Some studies included a qualitative part and identified several categories closely connected to pain in the context of VA treatment. Those findings concerned reactions reporting immediate pain relief after the VA sessions and recurrence of pain in some phases of the research experiment, comparisons between sessions in hospital (useful and empowering) and self-care treatment (comparatively weak), active involvement in seeking pain relief, integrating the self-care practice into daily life befitting schedules and needs, and observations of any relaxation response leading to pain relief.

Updated search results
During the updated search (conducted on 9 January 2022), we found three research studies (one double-blind RCT pilot study, one pretest-post-test study without a control group, one case study) and one RCT protocol published at ClinicalTrials.gov. The three studies include participants with chronic pain caused by Ehler-Danlos syndrome, postherpetic neuralgia and chronic musculoskeletal pain. Interventions were delivered using the Sound Oasis VTS1000 using the ‘Energise’ programme, a wearable music player (XINYIBAO), and a Pacini-Medico ApS chair device playing rhythmically aligned music. All studies reported improvements on pain sensation due to the intervention (although Eshuis et al reported significant improvements in the active control group). Vuong et al also applied the concept of intervention responders and non-responders according to the Minimal Clinically Important Difference (MCID) as a means of tracking clinically relevant improvement. However, the findings do not change the outcomes of the initial search. Table 1 includes the relevant findings from this updated search.

On top of the three published studies, we found one RCT protocol on VAT and chronic back pain registered at clinicaltrials.gov (NCT04468516), last updated 16 September 2021, participants not yet recruited.

Discussion
The findings of this scoping review show that research on the use of VAT for managing pain has been increasing in recent years, and the majority of the publications are from English-speaking countries. The use of VAT may be somewhat controversial (mainly caused by the lack of and quality of scientific evidence, discussed later). This scoping review offers suggestions on how to improve inconsistencies in the description of VAT in research studies and how to address challenges typical in researching VAT and pain-related outcomes.

Characteristics of vibroacoustic therapy
There were significant differences in research design, technologies and the properties of the LFS stimulation. The disparity in reporting of intervention characteristics, treatment procedures, types of pain, duration and frequency of intervention and additional potentially uncontrolled aspects of the experimental research have added to the difficulty in interpreting its efficacy and comparison across studies. In most studies, comprehensive information on the characteristics of the LFS stimulation is challenging to find, mainly in studies published earlier. Most studies only report the frequencies of the LFS treatment programme/stimulus (with particular interest in 40 Hz frequency), while other characteristics of LFS are described inconsistently. Researchers should use comparable treatment and measurement procedures as much as possible. Standardised reporting will encourage more thoughtful planning of experiments as well as enable efficacy reviews once enough systematic and well-reported research is available. The following reporting suggestions may support transparency in reporting:

► The description of LFS could include frequency, amplitude, pulsation and loudness. Duration of stimulus (time and days), and area of the body to which it is applied (whole body and local) could also be included.

► Given the many unknowns in effectiveness, we suggest using 40 Hz, sessions lasting at least 20 min, more frequent applications for acute pain (daily) and further concentration on the psychological impact of music listening on pain perception, as recommended by Campbell et al (2019). This recommendation could also be applied in clinical practice until more evidence on effectiveness is available.

► Currently, it is not known how long the effects of VAT last; follow-up measurements are needed to assess this.

Vibroacoustic therapy and outcomes related to pain
Most studies measured changes in pain sensation combined with other measurements, such as pain medication dosage. In this review, we found that studies on acute postoperative and experimentally induced pain (all of them being quasi-experimental studies) describe a decrease in pain sensation over time. However, the differences between experimental and control groups were mostly statistically insignificant (or both groups were significantly improved, such as in Eshuis et al). Acute pain literature is rather scarce, with small sample sizes and other methodological issues. One example of this is Shivani et al, in which frequencies between 6 and 14 kHz were used, with small sample sizes and with no significant results, yet suggestive of having potential effects in a larger sample. When exploring the effects of VAT on acute pain, it is necessary to take the expected spontaneous pain
| Author, reference | Design | Pain relief (subjective scale, usually VAS-P) | Statistical significance |
|------------------|--------|----------------------------------|--------------------------|
| **Chronic pain—experimental** | | | |
| Chesky et al<sup>28</sup> | PseudoRCT (prospective, randomised, double-blinded, (pseudo) placebo-controlled parallel intervention, 1.d) | ✓ | ✗ |
| Control: Constant 20 Hz sine wave signal with the same music. <br>Intervention: Music with vibration using the MVT | | | |
| Janzen et al<sup>30</sup> | RCT (with two parallel arms (control group), double-blind, 1.c). | ✓ | Improvement within groups with statistical significance p<0.005. However, not when two groups compared. |
| Control: Vibrotactile stimulation from randomly intermittent sounds consisting of complex wave gamma-range noise with pitch peaks at 33 and 45 Hz. <br>Intervention: 40 Hz, continuous sine wave. | | | |
| Eshuis et al 2021<sup>37</sup> | RCT (International multicentre, randomised, double-blind, pilot trial, 1.c) | ✓ | ✗ |
| Control: music with higher-frequency vibration (200–300 Hz) <br>Intervention: music with low-frequency stimulation (20–100 Hz) | | | |
| Howard<sup>31</sup> | RCT (cross-over design without a control group, 2.d) | ✓ | ✗ |
| Control: Music-listening to 25 self-selected songs. <br>Intervention: Vibroacoustic chair with music. | | | |
| **Chronic pain—quasi-experimental** | | | |
| Chesky<sup>29</sup> | Quasi-experimental prospectively controlled study (2.c) | ✓ | P<0.001 |
| Control: Two control groups: music alone and 100 Hz sine wave with no music. <br>Intervention: Low-frequency sound with music using MVT | | (for both control groups) | (for both control groups) |
| Vuong et al<sup>38</sup> | Pretest post-test study without control group (2.d) | ✓ | P<0.05 |
| Intervention: Self-administered intervention using Sound Oasis VTS1000 device and the programme ‘Energise’ | | (for 73% of participants) | |
| **Chronic pain—observational (case series)** | | | |
| Campbell et al<sup>4</sup> | Case series (4.c) | ✓ | NA |
| Naghd<sup>23</sup> | Case series (4.c) | ✓ | NA |
| Campbell et al<sup>2</sup> | Case series with mixed design (4.c for quantitative part) | ✓ | NA |
| Campbell et al<sup>4</sup> | Case series with mixed design (4.c for quantitative part) | ✓ | (in 5/8 improvement, in 3/8 minimal worsening) |
| Naghd<sup>16</sup> | Case series (4.c) | ✓ | NA |
| Patrick<sup>5</sup> | Case series—single session, types of pain not specified (4.c) | ✓ | P<0.001 |
| Rüütel et al<sup>32</sup> | Observational study without a control group (4.c) | ✓ | ✓ P<0.05 |
| **Chronic pain—observational (case study)** | | | |
| Chesky<sup>27</sup> | Case studies of 3 participants with different types of pain (4.c) | ✓ | NA |
| Campbell et al<sup>26</sup> | Case study with mixed design (4.d), 1 participant | ✓ | NA |
| Picard et al<sup>24</sup> | Case study (4.d), 1 participant | ✓ | NA |
| Wang et al<sup>39</sup> | Case study (4.d), 1 participant | ✓ | NA |

MVT, Music Vibration Table; NA, not applicable; RCT, randomised controlled trial; VAS-P, Visual Analogue Scale for Pain.
relief due to the body’s healing processes after an injury or surgery (or other causes of acute pain) into account, as well as the unethicality of delivering inadequate pain management. Therefore, researchers must compare the results of both VAT and control groups in relation to a comprehensive pain management plan (including medication). In brief, RCTs with optimal sample size that would explore the effects of VAT on the subjective pain perception and pain medication usage (or on other pain relief methods) are needed to understand the possible effects of VAT on acute pain.

More primary evidence of the effectiveness of VAT has been conducted on chronic pain, however, mostly in the form of observational studies. These studies (with the exception of Picard et al)27 have shown an improvement compared with findings from three double-blinded randomised controlled trials.28 30 37 Research on VAT and chronic pain would also benefit from RCTs with optimal sample size. However, it is neither easy to blind the participants, nor find a true sham in VAT research (see extraction process of a study by Janzen et al).30 This constitutes a serious methodological issue mainly because of the subjective nature of pain and outcome measures used to assess change. Considering the results presented here, it does not seem that any sound-induced vibration could be considered a fully adequate control intervention with any certainty. We suggest researchers explore the suitability of the following options:

▸ Using music or sound as a control (eg, experimental group with VAT and control group only with music without LFS).

▸ To design RCTs that compare VAT against conventional methods for managing pain (eg, RCT with a group receiving physical therapy, a group with both physical therapy and VAT and a group with VAT only).42

▸ There are alternatives to RCT methodologies that may be considered for future research in VAT, for example, using dose-responsive curves or demonstration of loss of effect during a washout period (however, this procedure is not applicable to acute pain research). Furthermore, researchers should consider applying the MCID as a means of understanding the clinically important change in pain scores to supplement other methods, since the patient’s subjective response to the pain (especially in chronic pain patients) is potentially more relevant than objective measures.

Outcome assessors should not be present for the duration of VAT application, thus ensuring their blinding (as was done by Janzen et al)40 and Chesky et al.28 We strongly recommend that researchers describe the whole research process in greater detail,43 documenting and explaining any decisions made.

Apart from effectiveness, there may be many other important details related to a patient’s experience and preferences that are useful for clinicians and gained primarily from qualitative data.44 However, no relevant qualitative studies were found in this review.

The strength of this scoping review is a comprehensive database search and collaboration in a team consisting of many specialisations—VAT (EAC), music therapy (EAC and JK), medicine (LK), nursing (JM), physiology, methodology and epidemiology (MK) and special education (JK, VR, KK and DS). This is the first complete overview of VAT in adult patients with pain. There are also some weaknesses of this scoping review (see PRISMA for Scoping Review Checklist in online supplemental appendix F):

▸ We limited the selection to the availability of an abstract written in the English language. There may be papers in various languages not fulfilling this criterion.

▸ Relevant information concerning the review questions was missing in some studies. We did not approach the authors of these papers.

Conclusions

Research on the effects of VAT on pain deals mainly with chronic pain. There is considerable heterogeneity in the characteristics of VA treatment/therapy and research designs. Although most studies indicate the positive effect of VAT on both acute and chronic pain populations, the effectiveness must be established based on reliable scientific proofs. Studies using an RCT design or alternative approaches with control groups should be considered in order to reduce issues related to blinding participants, and the subjectivity of measurements and other methodological challenges should be carefully discussed.

For researchers and practitioners in the field, we recommend using 40Hz, stimulation lasting at least 20 min, more frequent treatment for acute pain (daily) and the use of music listening to impact the psychological aspect of pain perception. Reporting in the studies should at least include measurements of frequency (Hz), amplitude, pulsation and loudness (dB).

Further research is needed to explore properties of VAT that are effective for pain management with replication studies to confirm previous results. Qualitative evidence on patients’ experiences could be beneficial for the development of VAT clinical practice and research. Foundational work for VAT is still sparse and a better understanding of how individuals respond to the treatment would in turn inform larger, controlled studies.

Author affiliations

1The Institute of Special Education Studies, Center of Evidence-based Education and Arts Therapies: A JBI Affiliated Group, and Institute of Special Education Studies, Palacky University Olomouc Faculty of Education, Olomouc, Olomoucký, Czech Republic

2VIBRAC Skille-Lehikoinen Centre for Vibroacoustic Therapy and Research; Caritas Association for the Karlsruhe Region, Ettingen Germany; University of Jyväskylä, Jyväskylä, Finland

3The Czech National Centre for Evidence-Based Healthcare and Knowledge Translation (Cochrane Czech Republic; Czech CEBHC; JBI Centre of Excellence, Masaryk University GRADE Centre), Institute of Biostatistics and Analyses, Masaryk University Faculty of Medicine, Brno, Jihomoravský, Czech Republic

4Center of Evidence-based Education and Arts Therapies: A JBI Affiliated Group, and Department of Anthropology and Health Education, Palacky University Olomouc Faculty of Education, Olomouc, Olomoucký, Czech Republic
is non-commercial and license their derivative works on different terms, provided the original work is permitted others to distribute, remix, adapt, build upon this work non-commercially.

Supplemental material

Data availability statement

No data are available.

Supplemental material

This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

Open access

This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: http://creativecommons.org/licenses/by-nc/4.0/

ORCID iDs

Jiří Kantor http://orcid.org/0000-0001-6016-3408
Dagmar Sedláčková http://orcid.org/0000-0001-7221-3724
Miloslav Klugar http://orcid.org/0000-0002-2804-7295

REFERENCES

1 Punkanen M, Ala-Ruona E. Contemporary vibroacoustic therapy: perspectives on clinical practice, research, and training. Music Med 2012;4:128–35.
2 Campbell EA, Hynynen J, Burger B, et al. Exploring the use of vibroacoustic treatment for managing chronic pain and comorbid mood disorders: a mixed methods study. Nordic J Music Ther 2019;28:291–314.
3 Lehtikoinen P. Physioacoustic therapy. In: Dileo C, Wigram T, eds. Music vibration and health. Cherry Hill: Jeffrey Books, 1997.
4 Campbell EA, Hynynen J, Ala-Ruona E. Vibroacoustic treatment for chronic pain and mood disorders in a specialized healthcare setting. Music Med 2017;9:187–97.
5 Patrick G. The effects of vibroacoustic music on symptom reduction inducing the relaxation response through good vibrations. IEEE Eng. in medicine and biology magazine 1999;18:97–100.
6 Walters CL. The psychological and physiological effects of Vibrotactile stimulation, via a Somatron, on patients awaiting scheduled gynaecological surgery. J Music Ther 1996;33:261–87.
7 Dong Y, Wang W, Zheng J, et al. Whole body vibration exercise for chronic musculoskeletal pain: a systematic review and meta-analysis of randomized controlled trials. Arch Phys Med Rehabil 2019;100:2167–78.
8 Wigram T. The effects of vibroacoustic therapy on clinical and non-clinical populations. PHD. Thesis, London University, London, UK 1996.
9 Bartel LR, Chen R, Alain C, et al. Vibroacoustic stimulation and brain oscillation: from basic research to clinical application. Music Med 2017:9:153–66.
10 Boyd-Brewer C, McCaffrey R. Vibroacoustic sound therapy improves pain management and more. Holist Nurs Pract 2004;18:111–8.
11 Melzack R. Pain and the neuromatrix in the brain. J Dent Educ 2001:65:1378–82.
12 Benson H, Klipper MW. The relaxation response. New York: HarperCollins, 1975.
13 Punkanen M. “On a journey to mind and emotions”- the physioacoustic method and music therapy in drug rehabilitation. In dialogue and debate-conference proceedings of the 10th World Congress on Music Therapy. 1333 2004.
14 Campbell EA. Vibroacoustic treatment and self-care for managing the chronic pain experience: an operational model. JUy dissertations. Jyväskylä, Finland: University of Jyväskylä, 2019.
15 Burke M, Thomas K. Use of physioacoustic therapy to reduce pain during physical therapy for total knee replacement patients over age 55. In: Wigram T, Dileo C, eds. Music vibration and health. Cherry Hill, NJ: Jeffrey Books, 1997: 99–106.
16 Naghash A, Ahonen H, Macario P, et al. The effect of low-frequency sound stimulation on patients with fibromyalgia: a clinical study. Pain Res Manag 2015;20:621–7.
17 Picard LM, Bartel LR, Gordon AS. Vibroacoustic therapy for Ehlers-Danlos syndrome: a case study. Ann Clin Case Rep 2018;3:1504. http://www.annaccaserp.com/pdfs/accr-v3-id1504.pdf
18 Hollins M, McDermott K, Harper D. How does vibration reduce pain? Perception 2014;43:70–84.
19 Cepeda MS, Carr DB, Lau J. Music for pain relief. Cochrane Database Syst Rev 2006;2:CD004843.
20 Lin C-L, Hwang S-L, Jiang P, et al. Effect of music therapy on pain after orthopedic surgery—a systematic review and meta-analysis. Pain Pract 2020;20:422–36.
21 Gao Y, Wei Y, Yang W, et al. The effectiveness of music therapy for terminally ill patients: a meta-analysis and systematic review. J Pain Symptom Manage 2019;57:319–29.
22 Peters MDJ, Marnie C, Tricco AC, et al. Updated methodological guidance for the conduct of scoping reviews. JBI Evid Synth 2020;18:2119–26.
23 Peters MDJ, Godfrey C, McInerney P. Chapter 11: Scoping Reviews (2020 version). In: Aromatias E, Munn Z, eds. Joanna briggs institute reviewer’s manual, 2020. https://reviewersmanual.joannabriggs.org/.
24 Wigram T, Dileo C. Music, vibration and health. Cherry Hill, NJ: Jeffrey Books, 1997.
25 Tricco AC, Lillie E, Zarin W, et al. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. Ann Intern Med 2018;169:487–73.
26 Campbell E, Burger B, Ala-Ruona E. A single-case, mixed methods study exploring the role of music listening in vibroacoustic treatment. voices: a world forum for music therapy 2019;19:27.
27 Campbell EA, Hynynen J, Burger B, et al. Vibroacoustic treatment to improve functioning and ability to work: a multidisciplinary approach to chronic pain rehabilitation. Disabil Rehabil 2021;43:1–18.
28 Chesky K, Russell IU, Lopez Y, et al. Fibromyalgia tender point pain: a double-blind, placebo-controlled pilot study of music vibration using the music vibration table ™. J Musculoskelet Pain 2019;25:13–22.
29 Chesky K. The effects of music and music vibration using the MVT on the relief of rheumatoid arthritis pain. Dissertation. In: Abstracts international 1992:53:2725B.
30 Braun Janzen T, Penaduro D, Picard L, et al. A parallel randomized controlled trial examining the effects of rhythmic sensory stimulation on fibromyalgia symptoms. PLoS One 2019;14:e0221201.
31 Howard A. Music medicine: an alternative approach for managing symptoms of temporomandibular disorder. Dissertation. Toronto, Canada: University of Toronto, 2017.
32 Rüütel E, Vinkl T, Eelmäe P. The effects of short-term vibroacoustic treatment on spasticity and perceived health conditions of patients with spinal cord and brain injuries. Music Med 2017;9:202–8.
33 Burke M. Effects of Physioacoustic® intervention on pain management of postoperative gynaecological patients. In: Wigram T, Dileo C, eds. Music vibration and health. Cherry Hill, NJ: Jeffrey Books, 1997: 107–24.
34 Tiidus PM, Markoullakis R, Murray D, et al. Physioacoustic therapy: placebo effect on recovery from exercise-induced muscle damage. Acta Kinesiologicae Universitas Tartuensis 2012;13:117–28.
35 Chesky KS, Michel E. Impact of the music vibration table (MVT): developing a technology and conceptual model for pain relief. Music Therapy Perspectives 1991;9:32–8.
36 Klugarová J. Vyhledávání nejlepších dostupných vědeckých důkazů. [Searching for the best scientific evidence]. In: Klugarová J, Marečková J, Olomouc Eds.; eds. Evidence based healthcare: Zdravotnictví Založené Na Vědeckých Důkazech. 1st edn. Czech Republic: Univerzita Palackého v Olomouci, 2015: 17–33.

37 Eshuis TA, Stuijt PJ, Timmerman H, et al. Music and low-frequency vibrations for the treatment of chronic musculoskeletal pain in elderly: a pilot study. *PLoS One* 2021;16:e0259394.

38 Vuong V, Mosabibir A, Panteduro D, et al. Effects of rhythmic sensory stimulation on ehlers–danlos syndrome: a pilot study. *Pain Res Manag* 2020;2020:3586767.

39 Wang X, Ye J, Yang B, et al. Low frequency sound stimulation greatly improved the outcome of a refractory postherpetic neuralgia patient with mood and sleep disorder: a case report. *Ann Palliat Med* 2021;10:11221–5.

40 Ahonen H. Low frequency research—client populations and common frequencies used—literature review, 2007. Available: https://www.researchgate.net/publication/319016221_Low_frequency_research-client_populations_and_common_frequencies_used-literature_review

41 Shivani A, Kiran Rao U, Abhilash G. Impact of vibroacoustic sound therapy on dental pain relief. *Res J Biotechnol* 2021;16:30–5.

42 Sluka KA. Mechanisms and management of pain for the physical therapist. Wolters Kluwer, 2016: 19–32.

43 Kantor J, Kantorová L, Marečková J, et al. Potential of vibroacoustic therapy in persons with cerebral palsy: an advanced narrative review. *Int J Environ Res Public Health* 2019;16:3940.

44 Oravec Set al. Naše skúsenosti s kombinovanou liečbou V rámci rehabilitácie pacientov s chronickou bolest’ou. *Rehabilitácia* 2012;49:139–44.

45 Moher D, Liberati A, et al, The PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med* 2009;6:7.
The full search strategy for each database

CINAHL plus
S1: AB "vibroacoustic therap*" OR "vibro-acoustic therap*" OR "vibroacoustic treatment" OR "vibroacoustic music" OR "vibroacoustic sound" OR physioacoustic* OR "rhythmic sensory stimulation" OR "physio acoustic sound" OR somatron OR "low-frequency sound stimulation" OR "music vibration table" OR "vibrotactile intervention"

S2: AB pain OR ache OR ail OR soreness

S3: S1+S2

Cochrane Library:
("vibroacoustic therap*" OR "vibro-acoustic therap*" OR "vibroacoustic treatment" OR "vibroacoustic music" OR "vibroacoustic sound" OR physioacoustic* OR "rhythmic sensory stimulation" OR "physio acoustic sound" OR somatron OR "low-frequency sound stimulation" OR "music vibration table" OR "vibrotactile intervention"):ti,ab,kw AND (pain OR ache OR ail OR soreness):ti,ab,kw

EMBASE:
#1: 'vibroacoustic therap*':ab,ti OR 'vibro-acoustic therap*':ab,ti OR 'vibroacoustic treatment':ab,ti OR 'vibroacoustic music':ab,ti OR 'vibroacoustic sound':ab,ti OR physioacoustic*:ab,ti OR 'rhythmic sensory stimulation':ab,ti OR 'physio acoustic sound':ab,ti OR somatron:ab,ti OR 'low-frequency sound stimulation':ab,ti OR 'music vibration table':ab,ti OR 'vibrotactile intervention':ab,ti

#2: pain:ab,ti OR ache:ab,ti OR ail:ab,ti OR soreness:ab,ti

#3: #1 AND #2

EBM Reviews:
("vibroacoustic therapy" or "vibro-acoustic therapy" or "vibroacoustic treatment" or "vibroacoustic music" or "vibroacoustic sound" or physioacoustic* or "rhythmic sensory stimulation" or "physio acoustic sound" or somatron or "low-frequency sound stimulation" or "music vibration table" or "vibrotactile intervention").ab. and (pain or ache or ail or soreness).ab.

EBSCOHost:
S1: AB "vibroacoustic therap*" OR "vibro-acoustic therap*" OR "vibroacoustic treatment" OR "vibroacoustic music" OR "vibroacoustic sound" OR physioacoustic* OR "rhythmic sen-
sory stimulation" OR "physio acoustic sound" OR somatron OR "low-frequency sound stimulation" OR "music vibration table" OR "vibrotactile intervention"

S2: AB pain OR ache OR ail OR soreness

S3: S1+S2

These databases were searched through EbscoHost search platform: Academic Search Ultimate, OpenDissertations, Atla Religion Database with AtlaSerials, Business Source Complete, Central & Eastern European Academic Source, eBook Collection (EBSCOhost), ERIC, European Views of the Americas: 1493 to 1750, Film & Television Literature Index with Full Text, GreenFILE, Library, Information Science & Technology Abstracts, MEDLINE Complete, APA PsycArticles, APA PsycInfo, Regional Business News, RILM Abstracts of Music Literature with Full Text, SocINDEX with Full Text, SPORTDiscus with Full Text, and MEDLINE.

Epistemonikos:

(title:("vibroacoustic therap*" OR "vibro-acoustic therap*" OR "vibroacoustic treatment" OR "vibroacoustic music" OR "vibroacoustic sound" OR physioacoustic* OR "rhythmic sensory stimulation" OR "physio acoustic sound" OR somatron OR "low-frequency sound stimulation" OR "music vibration table" OR "vibrotactile intervention") OR abstract:("vibroacoustic therap*" OR "vibro-acoustic therap*" OR "vibroacoustic treatment" OR "vibroacoustic music" OR "vibroacoustic sound" OR physioacoustic* OR "rhythmic sensory stimulation" OR "physio acoustic sound" OR somatron OR "low-frequency sound stimulation" OR "music vibration table" OR "vibrotactile intervention")) AND (title:(pain OR ache OR ail OR soreness) OR abstract:(pain OR ache OR ail OR soreness))

ERIC:

abstract:("vibroacoustic therapy" OR "vibro-acoustic therapy" OR "vibroacoustic treatment" OR "vibroacoustic music" OR "vibroacoustic sound" OR physioacoustic* OR "rhythmic sensory stimulation" OR "physio acoustic sound" OR somatron OR "low-frequency sound stimulation" OR "music vibration table" OR "vibrotactile intervention") AND abstract:(pain OR ache OR ail)

Google Scholar:

Adult AND "vibroacoustic therapy" AND pain

Medvik/BMC:

1. abstrakt: "vibroacoustic therap*" or "vibro-acoustic therap*" or "vibroacoustic treatment" or "vibroacoustic music" or "vibroacoustic sound" or "physioacoustic*" or "rhythmic sensory stimulation"
2. abstrakt: "physio acoustic sound" or somatron or "low-frequency sound stimulation" or "music vibration table" or "vibrotactile intervention"

3. 1 AND 2

4. abstrakt: pain or ache or ail or soreness

5. 3 AND 4

Medline Complete:
"AB "vibroacoustic therap*" OR "vibro-acoustic therap*" OR "vibroacoustic treatment" OR "vibroacoustic music" OR "vibroacoustic sound" OR physioacoustic* OR "rhythmic sensory stimulation" OR "physio acoustic sound" OR somatron OR "low-frequency sound stimulation" OR "music vibration table" OR "vibrotactile intervention"

"AB

ProQuest:
ab("vibroacoustic therap**" OR "vibro-acoustic therap**" OR "vibroacoustic treatment" OR "vibroacoustic music" OR "vibroacoustic sound" OR physioacoustic* OR "rhythmic sensory stimulation" OR "physio acoustic sound" OR somatron OR "low-frequency sound stimulation" OR "music vibration table" OR "vibrotactile intervention") AND ab(pain OR ache OR ail OR soreness)

These databases were searched through ProQuest search platform: Coronavirus Research Database, Ebook Central, Literature Online, ProQuest Central, and Screen Studies Collection.

Scopus:
( TITLE-ABS-KEY ("vibroacoustic therap**" OR "vibro-acoustic therap**" OR "vibroacoustic treatment" OR "vibroacoustic music" OR "vibroacoustic sound" OR physioacoustic* OR "rhythmic sensory stimulation") OR TITLE-ABS-KEY ("physio acoustic sound" OR somatron OR "low-frequency sound stimulation" OR "music vibration table" OR "vibrotactile intervention") AND TITLE-ABS-KEY ( pain OR ache OR ail OR soreness ) )

Web of Science:
#1: AB="(vibroacoustic therap**" OR "vibro-acoustic therap**" OR "vibroacoustic treatment" OR "vibroacoustic music" OR "vibroacoustic sound" OR physioacoustic* OR "rhythmic sensory stimulation" OR "physio acoustic sound" OR somatron OR "low-frequency sound stimulation" OR "music vibration table" OR "vibrotactile intervention")

#2: AB=(pain OR ache OR ail OR soreness)
#3: #2 AND #1
### Table 1: Table: Search results (from 6\textsuperscript{th} March 2020)

| Databases        | Intervention (I) (number of studies found) | Outcome (O) (number of studies found) | Results (I+O) (number of studies found) |
|------------------|-------------------------------------------|--------------------------------------|----------------------------------------|
| CINAHL plus      | 18                                        | 208,065                              | 4                                      |
| Cochrane Library | 17                                        | 175,881                              | 8                                      |
| EBM              | 15                                        | 148,078                              | 6                                      |
| EBSCOhost        | 212                                       | 1,675,205                            | 42                                     |
| Embase           | 59                                        | 929,054                              | 13                                     |
| Epistememonikos  | 4                                         | 53,639                               | 1                                      |
| ERIC             | 1                                         | 2,400                                | 0                                      |
| Medline Complete | 31                                        | 568,765                              | 6                                      |
| Medvik/BMČ       | 0                                         | 3,870                                | 0                                      |
| ProQuest         | 53                                        | 1,542,038                            | 13                                     |
| Scopus           | 111                                       | 1,156,704                            | 17                                     |
| Web of Science   | 35                                        | 472,707                              | 6                                      |
| Google Scholar   | 1,580                                     | 3,450,000                            | 262                                    |

### Table 2: Search results (update from 9\textsuperscript{th} January 2022)

| Databases        | Intervention (I) (number of studies found) | Outcome (O) (number of studies found) | Results (I+O) (number of studies found) |
|------------------|-------------------------------------------|--------------------------------------|----------------------------------------|
| CINAHL plus      | 22                                        | 226,239                              | 6                                      |
| Cochrane Library | 21                                        | 208,170                              | 10                                     |
| EBM              | 16                                        | 175,850                              | 4                                      |
| Database         | Title       | Source 1 | Source 2 | Source 3 |
|------------------|-------------|----------|----------|----------|
| EBSCOhost        |             | 238      | 1 899 221| 44       |
| Embase           |             | 72       | 929 054  | 19       |
| Epistemonikos    |             | 5        | 73 471   | 1        |
| ERIC             |             | 1 653    | 4 154    | 0        |
| Medline Complete |             | 44       | 651 026  | 8        |
| Medvik/BMČ       |             | 2        | 4 472    | 2        |
| ProQuest         |             | 56       | 11 746 907| 13       |
| Scopus           |             | 140      | 1 298 331| 22       |
| Web of Science   |             | 54       | 591 652  | 8        |
| Google Scholar   |             | 3 430    | 4 280 000| 291      |
Potentially relevant results found during the updated of the search (9th January 2022):

Eshuis TAH, Stuijt PJ, Timmerman H, Nielsen PML, Wolff AP, Soer R (2021) Music and low-frequency vibrations for the treatment of chronic musculoskeletal pain in elderly: A pilot study. PLoS ONE 16(11): e0259394. https://doi.org/10.1371/journal.pone.0259394

NCT04468516, et al. (2020). Treatment of Chronic Back Pain With Focused Vibroacoustic Stimulation https://clinicaltrials.gov/show/NCT04468516. Retrieved from http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=ccitr&NEWS=N&AN=CN-02134376. - R

VUONG, V., A. MOSABBIR, D. PANEDURO, L. PICARD, H. FAGHFOURY, M. EVANS, A. GORDON a L. BARTEL. Effects of Rhythmic Sensory Stimulation on Ehlers-Danlos Syndrome: A Pilot Study. Pain research [online]. 2020, 2020, 3586767 [cit. 2022-01-09]. ISSN 19181523. Dostupné z: doi:10.1155/2020/3586767

Not sure if VAT:

WANG, X., J. YE, B. YANG a J. XIANG. Low frequency sound stimulation greatly improved the outcome of a refractory postherpetic neuralgia patient with mood and sleep disorder: a case report. Annals of palliative medicine [online]. 2021, 10(10), 11221-11225 [cit. 2022-01-09]. ISSN 22245839. Dostupné z: doi:10.21037/apm-21-2513

Can not find fulltexts:

Shivani, A., Kiran Rao, U., Abhilash, G., Manjunatha, Ananya, M., Elsa, J. B., . . . Ravi, M. S. (2021). Impact of vibroacoustic sound therapy on dental pain relief. Research Journal of Biotechnology, 16(9), 30-35. Retrieved from www.scopus.com
Papers excluded based on the type of paper:

1. Boyd-Brewer C, Coope V. Effectiveness of vibroacoustic music for pain and symptom management in outpatient chemotherapy treatment. Proceedings of the First International Institute on the Arts in Healing; May 16–17; 2003; Florida Atlantic University, Boca Raton, FL.

2. Boyd-Brewer C, McCaffrey R. Vibroacoustic sound therapy improves pain management and more (2004) Holistic Nursing Practice, 18 (3), pp. 111-118.

3. Lin (2019). 音樂聲震治療對手機族頸部疼痛之效應. dap.library.tcu.edu.tw. http://www.dap.library.tcu.edu.tw/handle/987654321/5205

Studies not related to pain:

1. Ahonen H, Deek P, and Kroeker J. Low Frequency Sound Treatment Promoting Physical and Emotional Relaxation -Qualitative Study. International Journal of Psychosocial Rehabilitation [online]. 2012, 17(1), 45-58 [cit. 2020-03-29]. ISSN 14757192.

2. Butler C. (surgeon), & Butler PJ. (1997). Physioacoustic therapy with cardiac surgery patients. In Music vibration and health (s. 197–204). Jeffrey Books.

Studies not related to VAT:

1. Bieligmyer S, HELMERT E, HAUTZINGER M, and VAGEDES J. Feeling the sound - short-term effect of a vibroacoustic music intervention on well-being and subjectively assessed warmth distribution in cancer patients-A randomized controlled trial. Complementary Therapies In Medicine [online]. 2018, 40, 171-178 [cit. 2020-03-28]. DOI: 10.1016/j.ctim.2018.03.002. ISSN 18736963.

2. Drezevska M, Sieron A, Sliwinski Z. (b.r.). An assessment of analgestic effects of vibroacoustic therapy in treating pains. Ocena efektów analgetycznych terapii wibroakustycznej w leczeniu dolegliwości bólowych części lędźwiowo. Retrieved from: https://www.academia.edu/34958591/Ocena_efekt%C3%B3w_analgetycznych_terapii_Fizjoterapia_Polska

3. Kang DH, Lim HW, Lee WY., & Jee YS. (2018). Faster Recuperation of Pain and Musculoskeletal System through Vibroacoustic Sound Therapy. J Biol Med Res, 2(1), 5.

4. Lim E, Lim R, Suhaimi A, Chan BT, Wahab AK A. Treatment of chronic back pain using indirect vibroacoustic therapy: A pilot study(2018) Journal of Back and Musculoskeletal Rehabilitation, 31 (6), pp. 1041-1047.

5. Łukasiak A, Krystosiak M, Widlak P, and M. Woldańska-Okońska M. Evaluation of the effectiveness of vibroacoustic therapy treatment of patients with so-called "heel spur." A preliminary report. Ortopedia, Traumatologia, Rehabilitacja [online]. 2013, 15(1), 77-87 [cit. 2020-03-28]. DOI: 10.5604/15093492.1040522. ISSN 20844336.
6. Park JM, Park S, & Jee YS. (2019). Rehabilitation Program Combined with Local Vibroacoustics Improves Psychophysiological Conditions in Patients with ACL Reconstruction. *Medicina (Kaunas, Lithuania)*, 55(10), 659. [https://doi.org/10.3390/medicina55100659](https://doi.org/10.3390/medicina55100659)

7. Skopowska A, Biernacki M, Dekowska M, Ożóg P, and Grochowska A. The influence of vibroacoustic therapy on the functional status of patients with gonarthrosis. A preliminary report. *Rheumatology / Reumatologia* [online]. 2014, 52(5), 292-298 [cit. 2020-03-29]. DOI: 10.5114/reum.2014.46665. ISSN 00346233.

8. Shivani, A., Kiran Rao, U., Abhilash, G., Manjunatha, Ananya, M., Elsa, J.B., Vaman Rao, C., Ravi, M.S.(2021). Impact of vibroacoustic sound therapy on dental pain relief. *Research Journal of Biotechnology, 16* (9), pp. 30-35.

9. Stepień M, Piatkowski P, Rokicki R. The use of vibroacoustic therapy in patients after surgical treatment of Dupuytren's contracture [Zastosowanie terapii wibroakustycznej u pacjentów po leczeniu operacyjnym choroby Dupuytrena] (2012) Fizjoterapia Polska, 12 (4), pp. 355-362.

10. Weber, A., Busbridge, S., & Governo, R. (2020). Evaluation of the Efficacy of Musical Vibroacupuncture in Pain Relief: A Randomized Controlled Pilot Study. *Neuromodulation: Technology at the Neural Interface*. doi:10.1111/ner.13281

11. Zawiślak T, Turmiński P, Sokołowski K, Latosiewicz R, and Majcher P.(2016). An assessment of the efficacy of degenerative knee joint disease treatment using vibroacoustic therapy. EJMT 2(11) 2016 • European Journal of Medical Technology. Retrieved from: [http://www.medical-technologies.eu/upload/an_assessment_of_the_efficacy_of_degenerative_knee_joint_disease_treatment_using_vibroacoustic_therapy-zawiszlak1.pdf](http://www.medical-technologies.eu/upload/an_assessment_of_the_efficacy_of_degenerative_knee_joint_disease_treatment_using_vibroacoustic_therapy-zawiszlak1.pdf)

Studies that are part of an included source:

1. Campbell E A. (2019). Vibroacoustic treatment and self-care for managing the chronic pain experience: An operational model. *JYU dissertations*. (This is an unpublished duplicity to studies of Campbell et al. [2, 4, 17, 18])

2. Nct. (249n. l.). A Study of the Effect of Rhythmic Sensory Stimulation on Fibromyalgia. [https://clinicaltrials](https://clinicaltrials). This is a protocol of study of Janzen et al. [21]

3. Campbell E, and Ala-Ruona E. Efficacy of music therapy and vibroacoustic therapy for pain relief. *Nordic Journal of Music Therapy* [online]. 2016, 25, 14-15 [cit. 2020-03-28]. DOI: 10.1080/08098131.2016.1179889. ISSN 08098131. Conference abstract with data published later in Campbell et al. [4]
| Author, year |  |
|------------------|------------------|
| Design of the study |  |
| JBI level of evidence |  |
| Country, name of institution |  |
| Setting |  |
| Research sample (Number of participants, sample characteristics) |  |
| Causes of pain |  |
| VA device |  |
| Description of low frequency sound (Hz, amplitude, cycle…) |  |
| Measurements related to pain |  |
| Other types of measurement |  |
| Music used description |  |
| Data analysis |  |
| Intervention description |  |
| Results (Outcomes related to pain) |  |
### Extracted data table: Design, country / setting and sample

| Author, year, reference | Design, JBI level of evidence, country, name of institution/ setting | Research sample and causes of pain |
|-------------------------|---------------------------------------------------------------|-----------------------------------|
| Burke, 1997 [33]        | Quasi-experimental prospectively controlled study (2.c). USA Hospital | Number of participants: 32 enrolled, 20 completed (EG: 8, CG: 12; only females; total mean age: 50y; total age range: 27-69y) Causes of pain: Acute post-operative pain (gynecologic surgeries). |
| Burke, Thomas, 1997 [15]| Quasi-experimental prospectively controlled study (2.c). USA Duke University Medical Centre | Number of participants: 19 enrolled, 18 completed (EG: 9; F: 44.5%; M: 55.5%; mean age: 64.2y; CG: 9; F: 67%; M: 33%; mean age: 67y). Causes of pain: Patients after total knee replacement (due to osteoarthritis, rheumatoid arthritis). |
| Campbell et al., 2017 [4]| Case series (4.c) Finland Rehabilitation unit at Seinäjoki Central Hospital | Number of participants: 29 (F: 19; M: 10; mean age: 49.67y). Causes of pain: musculoskeletal pain and affective disorders. |
| Campbell et al., 2019 [26] | Case study with mixed design (4.c for quantitative part), qualitative part is not pain-related. Finland Music therapy clinic for Research and Training, University of Jyväskylä | Number of participants: 1 (F; 34 y). Causes of pain: Chronic pain – psychosomatic and musculoskeletal (causes unknown). Monthly medical check-ups. |
| Campbell et al., 2019 [2] | Case series with mixed design (4.c for quantitative part). Finland Rehabilitation Unit at Seinäjoki Central Hospital in South Ostrobothnia | Number of participants: 5 (F: 2; M: 3; age: 33-55y, mean 44.8y). Causes of pain: P1, P5 - intervertebral disc degeneration, rheumatism, P2 - spondylosis with myelopathy, fibromyalgia, P3 - myotonic disorder, chronic pain, P4 - rotary Cuff Syndrome. |
| Campbell et al., 2019 [27] | Case series with mixed design (4.d for quantitative part) Finland Specialized rehabilitation unit | Number of participants: 4 (F: 3; M: 1; age: 33-58y; mean 43.25y). Causes of pain: Painful musculoskeletal and neuropathic conditions (including fibromyalgia, lumbosacral spondylosis, etc.), possible comorbid depressive and anxious symptoms. |
| Chesky, et al., 1997 [28] | RCT double-blinded (1.c) USA Texas University Clinical Research Centre / hospital | Number of participants: 26 (EG: 13; CG: 13; F: 24; M: 2; age: 18-65y). Causes of pain: fibromyalgia (musculoskeletal pain). |
| Chesky, 1992 [29] | Quasi-experimental prospectively controlled study (2.c) USA Texas College of Osteopathic Medicine in Fort Worth / hospital | Number of participants: 27 (probably 9 participants in ever group; F: 23; M: 4; mean age 51.444 years). Causes of pain: Rheumatoid Arthritis (a functional class level of II or III). |
| Chesky, Michel, 1991 [35] | Case study (4.d) USA Texas Women’s University | 3 separate cases – graduate student/M with sprained ankle (1st case); 45/M with condition similar to osteoarthritis, probably with psychosocial etiology (2nd case); middle age/F with osteoarthritis (3rd case). |
| Howard, 2017 [31] | Quasi-experimental prospectively controlled study (2.c) Canada the University of Toronto VAT self-administered at home | Number of participants: 25 (F: 19; M: 6; age: 21-63y; mean age: 36y; time since diagnosis: 1-38y; mean: 7.4y). Causes of pain: temporomandibular disorder (myofascial chronic pain in orofacial area). |
| Study            | Design             | Setting                                      | Number of participants: | Causes of pain: |
|------------------|--------------------|----------------------------------------------|--------------------------|-----------------|
| Janzen et al., 2019 [30] | RCT double-blinded (1.c) | Canada Hospitals (Sinai Health System and the University of Toronto, VAT self-administered at home) | 50 enrolled, 38 completed (EG: 22; CG: 16; F: 46; M: 4; age: 22-68; mean age: 50 y). Causes of pain: fibromyalgia (mean duration of symptoms 7.9 y) | |
| Naghdi, 2015 [16] | Case series (4.c) | Canada University (probably) | 19 (F: 19; median age: 51y; median duration of fibromyalgia: 5.76 y) | Causes of pain: fibromyalgia. |
| Patrick [5]      | Case series (4.c) | USA National Institutes of Health | 272 hospital patients, only some participants reported to have pain (56) or headache (24). (21-67y; mean age: 43.7y; F 53%). Cause of pain: pain could be a symptom of various diagnoses. | |
| Picard et al., 2018 [17] | Case study (4.d) | Canada VAT self-administered at home. | 1 (M; 19y; student) | Cause of pain: Ehlers-Danlos Syndrome Hypermobility Type. |
| Rüütel et al., 2017 [32] | Case series (4.c) | Estonia Haapsalu Neurological Rehabilitation Centre / hospital | 53 enrolled, 44 completed (F: 19; M: 34; age 20-70 y) | Cause of pain: Musculoskeletal pain (after brain or spinal cord injuries). |
| Tiidus et al., 2008 [34] | Quasi-experimental prospectively controlled study (2.c) | Canada Wilfried Laurier University / university | 31 completed; experimental group (EG): 12; placebo group (PG): 12; control group (CG): 7; F: 24; M: 7; age 20.7 +/-3.1 y) | Cause of pain: healthy university students with exercise-induced muscle damage by eccentric isokinetic triceps contractions using the CYBEX Norm. |
### Extracted data table 2: Intervention and VAT device / LFS description

| Author, year, reference | Intervention description | VA device and description of LFS |
|-------------------------|--------------------------|---------------------------------|
| Burke, 1997 [33]        | EG: VAT with music; 15-20 min. per session; 2-3 times a day for 5 days. CG: standard post-op procedures, no VAT, no music listening. | Physioacoustic Recliner® (not specified) 27-113Hz focused on the lower back |
| Burke, Thomas, 1997 [15] | Two groups: EG: VAT with music; applied before (10 min.), during (20-30 min.) and after physiotherapy (10 min.); once a day for 6 days after surgery. CG: physiotherapy (same as above, without VAT, without music); once a day for 6 days after surgery. | Physioacoustic Recliner® (not specified) Program 004 for legs and thighs Time 006 (30 min.) Volume 002 Strength 006 Music (Table) 003 Neck 004, Back 006, Thighs 007, Legs 007 |
| Campbell et al., 2017 [4] | VAT with music (and discussions with the practitioner), the most commonly used program General Relaxation. For 36 min. a session, 10 sessions once a week for 10 weeks. 23 participants received one set of VAT for 10 weeks. 6 participants received 2 sets of VAT with a pause between (10 weeks, 4 weeks, 10 weeks). | Physioacoustic chair Next Wave Range of the treatment programme: 27.13–61.04Hz Fundamental frequency: 40.27 Hz Length of pulsation cycle average: 11.09 s (range 7.76–16.25 s). |
| Campbell et al., 2019 [26] | VAT, music optional, combined with a therapeutic interview. 20 min. per session, 8 weekly sessions (4 sessions with music + LFS, 4 sessions only LFS without music, as per client’s preferences). Goal of this study was to explore the role of music in VAT. | Physioacoustic chair Next Wave with treatment programme frequencies ranging from 29-61Hz, with a focus on 40 Hz. The same VAT treatment programme was used each week. |
| Campbell et al., 2019 [2] | 4 stages: S1 - One week only baseline measurements. S2 - VAT1 intervention (in the hospital) – 37 min. per session; 8 sessions, twice a week for one month). S3 - VAT2 intervention with Taikofon (at home) – 23 min. per session, 5 sessions a week for 4 weeks. S4 - One month pause before the last measurement. Music used according to client preference. | VAT1 - Physioacoustic Chair Next Wave Fundamental frequency: 40Hz (scan range 29.15 to 61.04 Hz), each cycle lasted an average of 11.09 s. VAT2 – Taikofon FeelSound Player (a small portable cushion for VAT self-application) 40Hz (20-20000Hz range), strength individually adjusted, cycle approximately 7 s long. Locally applied. |
| Campbell et al., 2019 [27] | All participants received 2 interventions: VAT1: Physioacoustic recliner chair with music – 37 mins, 2 times per week for 5 weeks. Followed by a month’s pause. VAT2 - Taikofon (self-application at home) with music (23 mins, 4 times per week for 5 weeks. Followed by a month’s pause. | VAT1 – Physioacoustic Chair Next Wave: 27-113Hz range. Frequency used: 40 Hz. Vibration source located in the neck, back, thigh, and calf areas of the chair. VAT2 – Taikofon FeelSound player: 20-20 000Hz range. Frequency used: 40Hz Length of pulsation cycle average: 6.8 s Locally applied - to be chosen by participants |
| Chesky, et al., 1997 [28] | All participants received one 30 min. session with measurement immediately pre and post treatment: EG - music with vibration using the MVT™ CG – as a sham was used constant 20 Hz sine wave signal with the same music | Music Vibration Table (MVT™) Musically fluctuating vibrations 60-300 Hz at amplitudes of less than 100 µm at 100 Hz. The MVT was calibrated to produce vibrations of equal magnitude, the frequency profile attenuated the amplitude as the Hz increased i.e. lower frequencies must have a higher amplitude in order to be perceived as equal in magnitude to the higher frequencies. |
| Author, Year | Description |
|-------------|-------------|
| Chesky, 1992 [29] | One 30min. session. G1: LFS with music using MVT™ G2: music alone G3: 100Hz sine wave with no vibration or music |
| Chesky, Michel, 1991 [35] | 30 min. sessions – 1 session (1st case), 3 sessions (2nd case), 2 sessions (3rd case). Music choices were new age, instrumental piano music, and participants' own tape-recorded music. |
| Howard, 2017 [31] | Study with crossover design and data analysts blinded. All participants received 2 interventions at home with a 4-week washout period in between: Intervention 1: Vibroacoustic chair with music. Intervention 2: Music-listening to 25 self-selected songs. Both interventions 30 min. per session, 5-7 times per week for 3 weeks. 12 participants started with VAT, 13 participants started with music-listening. |
| Janzen et al., 2019 [30] | All participants received 25 sessions lasting 30 min., 5 days in a week for 5 weeks. Sinewave stimuli were experienced in whole body, but mainly around the lower-back and shoulder/head area as well as low-level hum. Interventions provided concomitant with usual care. |
| Naghdi, 2015 [16] | No music applied, only LFS. 23 min. per session, 10 sessions, twice a week for 5 weeks |
| Patrick [5] | 45 min. single sessions (10-min. introduction, 25 min. of music/vibration, 10 min. of debriefing). Music: “Balance” or “The Musical Body”. |
| Picard et al., 2018 [17] | 30 min. per session, 53 sessions over 29 consecutive days (mostly 2 sessions in a day) for 6 weeks (4 weeks of treatment followed by 2 weeks’ washout). No comparator. Vibroacoustic chair with programs of Sound Oasis: “Energize” for 1st session of the day, “Sleep” for 2nd session of the day, both consisting of 3 music tracks. |
| Rüütel et al., 2017 [32] | 23 min. per session, 5 sessions (55% of patients) or 4 sessions (45% of patients) on consecutive days. No comparator. VAT with original program developed by Skille, LFS combined with relaxing music, sounds of nature or combination of both according to the patient’s preference. |
| Tiidus et al., 2008 [34] | 3 groups: EG: 30 min. following exercise on day 1,2,3,4, PG: the same as the EG, but physioacoustic chair was turned off. CG: no treatment after exercise. |
### Extracted data table 3: Measurements and outcomes related to pain

| Author, year, reference | Measurements related to pain | Outcomes related to pain |
|-------------------------|-----------------------------|-------------------------|
| Burke, 1997 [33]        | McGill Melzack Present Pain Intensity (PPI) scale measured at the beginning and end of experiment. VAS-P measured in the morning, late afternoon and at bedtime every day (only day 1, 3 and 5 was analysed). | PPI: Not mentioned. Not statistically significant. Overall pain decrease: VAT group relief of pain 69%, CG by 53%. No VAS-P was statistically significant. Decline in the use of IV pain medication: EG (mean decrease 82%) compared to CG (72%). Not statistically significant. |
| Burke, Thomas, 1997 [15] | VAS-P measured before and after intervention each day. Pain Thermometer measured before and after intervention each day. | At the completion of their PT sessions EG reported less pain than CG 5 out of 6 days, but only day 6 with statistical significance (p<0.01). Changes in pain from pre to post PT – EG experienced less intense pain on 4 out of 6 days. All subjects in the VAT group gave positive verbal feedback about their experience: “relaxed, comfortable, pleasant, great”. |
| Campbell et al., 2017 [4] | VAS-P (0-100 mm; 0-max. pain, 100-no pain) measured at the beginning and end of each treatment phase that patients received. VAS-P outcome measures are standard practice at this unit (and include other outcomes such as range of movement, limb temperature). The pre- and post-treatment phase VAS-P are then sent to the senior physician in the rehabilitation ward as per standardised reporting protocols of this hospital. Only DS performed. | Group receiving one set of VAT sessions (n=23): VAS-P scores between beginning and end of experiment showed improvement by 18.96mm (SD = 25.37). Group receiving two sets of VAT sessions (n=6): VAS-P scores between beginning and end of first set improved by 16.83mm (SD=13.41) and between beginning and end of second set improved by 10.67 mm (SD=17.87). |
| Campbell et al., 2019 [26] | VAS-P (0-100 mm; 0-max. pain, 100-no pain) measured pre- and post-session for 8 weeks. Only DS performed. | Pre-test first session (69), post-test last session (93) with MCID. Comparison VAT-Music and VAT-Silence: Mean of all VAT-Music pre-treatment sessions (60.82) and all VAT-Music post-treatment sessions (65.25) Mean of all VAT-Silence pre-treatment sessions (85.75) and VAT-Silence post-treatment sessions (73.75). All measures performed on VAS-P. Better average scores for sessions with music. |
| Campbell et al., 2019 [2] | VAS-P (0-100 mm; 0-max. pain, 100-no pain) measured in all stages. For the stage 2 and 3 beginning measurement means coded S2a and S3a and end measurement means coded S2b/S3b. Qualitative: a) clinical notes, b) participant assessment forms. Measured at the beginning, after intervention 1, then again after a month’s pause, after intervention 2, and again after another month’s pause. = 5 measurements. Only DS performed. | Improvements from Phase I to IV for P1 and P5 were MCID, moderate for P2 and P4, and substantial for P3. Changes among stages: From S2a to S2b, all participants improved (at least MCID) except for P4. All participants (apart from P1) recorded improved pain levels from S3a to S3b (P2, P3, and P4 the MCID). Qualitative findings: Four main categories –Relief (eg. less medication, better functioning), Recurrence (worsening and difficulty with managing pain), Evaluation (the self-care treatments weak compared to hospital sessions), and Proactive Involvement). |
| Study                  | Categorical Measures | Quantitative part (VAS-P): |
|-----------------------|----------------------|-----------------------------|
| Campbell et al., 2019 | VAS-P (0-100 mm; 0-max. pain, 100-no pain). Measured at the start and end of phase 1 (followed by a month’s pause) and at the start and end of phase 2 and after another month’s pause (follow-up) = 5 measurements. Only DS performed. | P1: phase 1 (pre: 51, post: 60), phase 2 (pre: 40, post: 48), follow-up: 48. P2: phase 1 (pre: 52, post: 90), phase 2 (pre: 40, post: 31). P3: phase 1 (pre: 51, post: 95), phase 2 (pre: 95, post: 92), follow-up: 94. P4: phase 1 (pre: 82, post: 80), phase 2 (pre: 69, post: 88), follow-up: 70. Qualitative part: Four main themes identified, but only theme Approaches to symptom management directly connected to pain and VAT (with sub-themes as Integration of the self-care practice into their daily lives with adjusting it to suit their schedules and needs, and Relaxation since inducing a relaxation response afforded pain relief for participants). |
| Chesky et al., 1997   | VAS-P (100 cm) TPI-Tender Point Index test and TPA-Doliorimeter Pain Threshold test to measure pressure pain thresholds (measured pre and post treatment with blinded examiner) | VAS-P: Greater reduction of pain in EG, but no statistical significance between groups (p=0.78). Significant difference between groups in mean changes of pre/post TPI scores (p=0.04) as well as TPA scores (p=0.01) favouring EG. Changes within EG: significant improvement in TPI scores (p=0.001) and TPA scores (p=0.013) Changes within CG: significant improvement of smaller magnitude in the TPI (p=0.04), and no change in the TPA (p=0.9). |
| Chesky, 1992          | VAS-P (100 cm) McGill Pain Questionnaires (MPQ): to measure pain intensity. Measured taken pre and post treatment session. | VAS-P: Scores from G1 (mean pain relief = 5.961) were significantly greater than G2 (2.683) or G3 (0.739), p<0.001 MPQ: larger percentages of change for G1 (total 64%), than in G2 (24%) or G3 (-2%). Subjects of G2 showed a large percentage of change on the affective dimension of the MPQ (music was proved as a strong stimulus for affective dimension). |
| Chesky, Michel, 1991  | McGill pain questionnaire. Measured pre and post treatment session. | % decrease in pain after each session: 68% (1st case), 40%, 18% and 30% (2nd case), 60% and 70% (3rd case). Most of the changes were in sensory dimension (1st and 2nd cases); changes were in all dimensions for the 3rd case. The length of the pain relief reported after some sessions (3.5-4 hours). Brief description of participants’ experiences included (body sensations, effect of different music instruments on pain, etc.). |
| Howard, 2017          | VAS-P (0-100 mm) with four repeated measures, (1) pre-treatment 1, (2) post-treatment 1, (3) pre-treatment 2, and (4) post-treatment 2 (to assess pain felt within the past 7 days). VAS-P (measured daily to assess pain felt in that moment, following in-home music medicine treatment). | No statistical difference between two interventions, but pain scores decreased as expected over the course of all the study (2.64 points on VAS-P). No statistical significance probably due to the underestimated number of participants. TMD symptoms did not increase during the washout period. |
| Janzen et al., 2019   | Pre and post-treatment measurements (for pain): Revised Fibromyalgia Impact Questionnaire (FIQ) Brief Pain Inventory – Short Form Daily pre and post-intervention measurements (averaged to reflect changes on a week basis). 11-point Likert scale for daily pain | No significant difference between groups. Within groups (form baseline to post-intervention): significant changes in fibromyalgia symptoms (in both groups) and pain interference (only in CG, p<0.005). Daily pain ratings: pre and post-session measurement difference was significant in both groups (p<0.005), however no significant main effect of time, between pain ratings pre/post session with week treatment response, or intervention group. Clinically meaningful change in fibromyalgia symptoms severity (measured by FIQ) after 5 weeks: 40% participants, but no difference between groups. |
### Abbreviations used:
- ACL - Anterior cruciate ligament reconstruction
- BPI-SF – Brief Pain Inventory (Short Form)
- CG – control group
- DS – descriptive statistics
- EG – experimental group
- F – female
- FIQ – Revised Fibromyalgia Impact Questionnaire
- G – group of patients
- Hz – hertz
- IV medication – intravenous medication
- JBI - Joanne Briggs Institute
- LSF – low frequency sound
- M – male
- MCID – minimal clinically important difference
- min. – minutes
- MPQ – McGill Pain Questionnaires
- MVT – Music Vibration Table
- P – patient
- PDI – Pain disability index
- PIS – pain-related functional impairment
- PPI – McGill Melzack Present Pain Intensity
- PT – physiotherapy
- PSS – the severity of patient’s pain
- S – stage of treatment
- sec. – seconds
- SD – standard deviation
- TMD – temporomandibular disorder
- TPA – Dolorimeter Pain Threshold test
- TPI – Tender Point Index test
- VAS-P – visual analogue scales for pain (0-100 mm, when 0=no pain and 100=max. pain, if it is not stated in a different way)
- VAT – vibroacoustic therapy
- y – years

### Results from different studies:

| Study                          | Methodology                                                                 | Findings                                                                 |
|-------------------------------|----------------------------------------------------------------------------|-------------------------------------------------------------------------|
| Naghdi, 2015 [16]             | Pain disability index (Fibromyalgia impact questionnaire (FIQ, contains a scale for pain)) Sitting and standing without pain in minutes (based on participants self-report) Subjective rating of pain perception. Reported amount of pain medication. All measured before and after experiment and 2 weeks later. | PDI: improvement of 49.1% (p<0.0001). FIQ-reduction in pain impact 81% (p<0.0001) 79.68% of patients reporting a reduced dose of medication, and 26.32% of patients had completely discontinued use of pain medication. Subjective assessment of pain: improvement more than 70% in median. The length of time patients can sit increased significantly (p<0.0001), as did the length of time standing (p<0.0001). Symptom recurrence after 2 weeks of washout: 3 patients (15.8%) reported no symptoms, 68.4% experienced a recurrence of pain (within a mean of 8 days). |
| Patrick [5]                   | Measurements before and after VAT sessions. VAS-pain. Pain was the secondary outcome. | Mean % of symptom reduction: pain 53%, headache 58%. Pain scores: pre 64.96; post 30.33 (p<0.0001) Headache scores: pre 60.46; post 25.67 (p<0.0001) |
| Picard et al., 2018 [17]      | The Brief Pain Inventory (Short Form; BPI-SF) to measure the severity of patient’s pain (PSS) and pain-related functional impairment PIS. Measured on an 11-point scale (0-10). Measurements accomplished at study initiation and at the end of weeks 2, 4 and 6 (follow-up). | The PSS: 7.75 at baseline, unchanged at termination of treatment. The PIS: improved by 2.43 points from baseline (8.86) to termination of active treatment (6.43). The PSS increased by 0.25 points between the termination of treatment (7.75) and the follow-up (8.0). The PIS increased 1.14 points, from 6.43 at termination of therapy to 7.57 at final assessment, indicating a worsening in pain disability. |
| Rüütel et al., 2017 [32]      | Numerical rating scales (0-10) Measurements before and after VAT sessions on the 1st, 3rd, and 5th day of treatment (if the patient left rehabilitation centre the 4th day, the last measurement was accomplished the 4th day) | Statistical difference in subjectively assessed pain, difference in means before sessions (1.95) and after sessions (1.57), p<0.05. Effect of number of treatment days on pain significant (p<0.05) – longer interventions provide a better therapeutic effect. |
| Tiidus et al., 2008 [34]      | Numerical rating scales for pain (0-10). Measurements immediately pre and post the daily treatment (CG at the same time as other groups) in days 1, 2, 3, 4 and 7 (follow-up). | EG recovered soreness faster than CG but at a similar rate to PG (the effectiveness may be attributed to the placebo). In EG and PG no soreness by day 3. Soreness was elevated (p<0.05) in all groups on days 1-2 after exercise. |
| Author, year, reference | Design, JBI level of evidence, country, name of institution/setting | Research sample and causes of pain | Intervention description | VA device and description of LFS | Measurements related to pain | Outcomes related to pain |
|-------------------------|-------------------------------------------------|---------------------------------|--------------------------|-------------------------------|--------------------------|--------------------------|
| Eshuis et al. 2021 [37]| International multicenter, randomized, double-blind, pilot trial (1.c) | 45 patients’ data analyzed (1 dropout) Chronic musculoskeletal pain; Median intervention group age: 72 years, median control group age: 73; ratio 6/17 M/F and 6/16 respectively | High amplitude low frequency-music Impulse stimulation (HALF-MIS) – 20-100 Hz, or a variation thereof with higher-frequency vibration (200-300 Hz), considered an active control; rhythmically-aligned music administered through a headphone and synchronized vibrations via a belt around the waist. No description of the music (e.g., genre, characteristics); no more specific details about Hz from music-derived vibration | 8 treatments, 24 mins and 7 secs within 3 weeks; PaciniMedico ApS (chair with elastic belt with low-frequency audio transducer, headphones, central processing unit and a tablet for the interface. | Pain intensity measured using Numeric Rating Scale (NRS) 0=no pain-10=worst pain imaginable, measurements pre- and post-treatment (3 weeks) and at follow-up (6 weeks). Secondary outcomes: immediate pain relief (difference between NRS scores immediately before and after each treatment) and pain disability (Pain Disability Index, PDI). Analgesics Intake Scale for training medication. | No serious adverse events; both groups showed lower NRS scores post-treatment; no significant differences between groups. No changes in Pain Disability Index score over time. |
| Study | Type | Country | Participants | Intervention Details | Outcome Measures | Results |
|-------|------|---------|--------------|----------------------|------------------|---------|
| Vuong et al., 2020 [38] | Pre-test post-test study without control group (2.d) | Canada | 15 female patients with hypermobile Ehlers-Danlos syndrome with concomitant conditions such as anxiety, depression, etc. (14 completed the study), total mean age: 35.8y; total age range: 23-59y. | VAT self-administered daily for 30 minutes, five days per week. | Device Sound Oasis VTS1000, program “Energize” three tracks of LFS with music (41 Hz to 73 Hz with 41 Hz dominant; 36 Hz to 61 Hz with 41 Hz dominant; and 36 Hz to 65 Hz with 55 Hz dominant). Patients instructed to choose vibration intensity 15, music volume level 1-2. | the Brief Pain Inventory, Short Form (BPI-SF), semi-structured interviews (applied only post-treatment and after wash-out. Measured pre-treatment, post-treatment (after 4 weeks) and follow-up (after 2 weeks of wash-out period). | Posttreatment improvements were seen in 11 patients (73%), 3 patients (20%) worse outcomes. 6 participants (43%) were classified as “responders” to the device according to the minimal clinically important difference score and demonstrated significant improvements in pain interference but not pain severity (51.5 ± 16 preintervention vs. 43.5 ± 16.4 postintervention BPI score). Responders were significantly different in age (older) compared to non-responders |
| Wang et al., 2021 [39] | Case study (4.d) | China | 34-year-old male with history of 3.5 y of unsatisfactory pain treatment. | Treatment with VAT for more than 240 days, the sound stimulation for no less than a total of 2 hours total every day, comprising no more than 4 separate sessions. | A wearable music player with 35 low-sound subwoofers built into a vest (XINYIBAO®, Chengdu Melody Wellness Tech Company), LFS (mostly 40 Hz) with music. | Numeric rating scale for current, worst, best and average pain Global Pain Scale (GPS), both rated in the beginning, and after 30 / 120 / 240 days of treatment. | Decrease of pain (comparing day 0 to day 240 of treatment): current pain (8/4), worst pain (8/5), best pain (4/0), average pain (5/4). GPS (70/23). No side effects observed. Decrease in oral medications. |
Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist
| SECTION        | ITEM | PRISMA-ScR CHECKLIST ITEM                                                                 | REPORTED ON PAGE # |
|----------------|------|-------------------------------------------------------------------------------------------|--------------------|
| TITLE          | Title| Identify the report as a scoping review.                                                   | p. 1, p. 2        |
| ABSTRACT       | Structured summary | Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives. | pp. 2-3           |
| INTRODUCTION   | Rationale | Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach. | pp. 4-5           |
|                | Objectives | Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives. | p. 5              |
| METHODS        | Protocol and registration | Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number. | p. 5              |
|                | Eligibility criteria | Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale. | p. 6              |
|                | Information sources* | Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed. | p. 6, Appendix A  |
|                | Search | Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated. | Appendix A        |
|                | Selection of sources of evidence† | State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review. | p. 7              |
|                | Data charting process‡ | Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators. | p. 7, Appendix C, p. 18 |
| SECTION                             | ITEM | PRISMA-ScR CHECKLIST ITEM                                                                                                                                                                                                 | REPORTED ON PAGE # |
|------------------------------------|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| Data items                         | 11   | List and define all variables for which data were sought and any assumptions and simplifications made.                                                                                                                     | p. 7, Appendix C   |
| Critical appraisal of individual sources of evidence§ | 12   | If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).                                           | NA                 |
| Synthesis of results               | 13   | Describe the methods of handling and summarizing the data that were charted.                                                                                                                                               | Figure 1           |
| RESULTS                            |      |                                                                                                                                                                                                                         |                    |
| Selection of sources of evidence   | 14   | Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.                                                 | Figure 1, Appendix B|
| Characteristics of sources of evidence | 15   | For each source of evidence, present characteristics for which data were charted and provide the citations.                                                                                                              | Table 2            |
| Critical appraisal within sources of evidence | 16   | If done, present data on critical appraisal of included sources of evidence (see item 12).                                                                                                                                  | NA                 |
| Results of individual sources of evidence | 17   | For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.                                                                                     | Section 3 Results; Appendix D, E |
| Synthesis of results               | 18   | Summarize and/or present the charting results as they relate to the review questions and objectives.                                                                                                                     | Appendix D, F       |
| DISCUSSION                         |      |                                                                                                                                                                                                                         |                    |
| Summary of evidence                | 19   | Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.                  | Section 3 Results (pp. 7-14), table 1 |
| Limitations                        | 20   | Discuss the limitations of the scoping review process.                                                                                                                                                                   | p. 18              |
| Conclusions                        | 21   | Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.                                                                  | p. 18              |
| FUNDING                            |      |                                                                                                                                                                                                                         |                    |
| Funding                            | 22   | Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.                                               | p. 23              |

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.
* Where sources of evidence (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.
† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with information sources (see first footnote).

‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. Ann Intern Med. 2018;169:467-473. doi: 10.7326/M18-0850.