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Title: Exploring the use of Vibroacoustic treatment for managing chronic pain and comorbid mood disorders : A mixed methods study

Year: 2019

Version: Accepted version (Final draft)

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Please cite the original version:

Campbell, E., Hynynen, J., Burger, B., & Ala-Ruona, E. (2019). Exploring the use of Vibroacoustic treatment for managing chronic pain and comorbid mood disorders : A mixed methods study. *Nordic Journal of Music Therapy*, 28(4), 291-314.

<https://doi.org/10.1080/08098131.2019.1604565>

Exploring the use of Vibroacoustic Treatment for managing chronic pain and comorbid mood disorders: A mixed methods study

Introduction: Chronic pain is a worldwide issue with common comorbidities of depression and anxiety, altogether inhibiting one's personal relationships and capability to work. Music has long been used as a means to improve pain and mood, and the tactile application of music has shown promising and beneficial results for the treatment of both psychological and physical symptoms. VA treatment uses low frequency sinusoidal sound vibration (20-120Hz) supported by client-preferred music listening and therapeutic interaction. **Methods:** Using mixed methods, this study addresses the addition of a self-care VA intervention to maintain the effects of practitioner-led VA treatments and to increase patients' independence in managing their symptoms. After baseline measurements, VA treatment was delivered to 5 patients at a rehabilitation unit by a trained VA practitioner, followed by self-care at home and a washout phase with no treatments. Quantitative outcome measures included Visual Analogue Scales for pain and mood, and Beck's Depression Inventory and the anxiety subscale of Hospital Anxiety and Depression Scale. Qualitative data comprised practitioner clinical notes and participant evaluation forms. **Results:** Quantitative outcomes suggest VA treatment is beneficial for pain and mood relief and that a self-care intervention has the potential to prolong positive outcomes. Qualitative findings suggest that patients found the sessions at the hospital useful and empowering but the self-care treatments comparatively weak. **Discussion:** Future studies may address the difficulty in conducting self-care and the importance of the client-practitioner relationship in supporting this activity for those suffering from chronic pain and comorbid mood disorders.

Keywords: vibroacoustic; chronic pain; depression; anxiety; self-care

Introduction

Access to pain management is a fundamental human right (Declaration of Montréal, 2011). There is inadequate knowledge regarding both the underlying mechanisms of chronic pain and suitable and tenable approaches to its management. As a psychophysiological phenomenon (Garland, 2012), chronic pain presents with

comorbidities such as depression, anxiety, social phobia, and panic disorder (Castro et al., 2009; Gureje, 2008; Scott et al., 2007). Pain may act as a catalyst towards disease severity by aggravating depressive symptoms, thereby increasing disability and social isolation, indicating a bi-directional relationship (Kiecolt-Glaser, McGuire, Robles, & Glaser, 2002; Woo, 2010). Combined anxiety and depression are more common in those suffering from chronic pain than pain with either mood disorder alone (Scott et al., 2007) and addressing these interconnected symptoms is heightened by their subjective nature. Furthermore, negative pain-related emotions materialise as biobehavioural processes, influencing how pain is perceived, thus begetting further suffering. These interconnected physiological, psychological / emotional, and behavioural aspects are critical issues in pain management. As mood disturbances and nociception (sensory response to pain) share pathways and neurotransmitters in the brain, a precedent exists for treating these concurrently using approaches addressing both (Scott et al., 2007).

Music listening for chronic pain relief

Music listening has been proffered for pain relief due to the ease of delivery, low provisional cost, and absence of side-effects. The effects of music intervention may be based on neurophysiological responses specific to pain and music, working on sensory, cognitive, affective, and behavioural components (Guétin et al., 2012). Music medicine – music listening offered by a healthcare professional (Bradt et al., 2015) – was shown to be effective for reducing analgesic use (Lee, 2016). Lee states that music medicine is used to distract, reduce tension, and promote relaxation. Music listening has significantly improved chronic pain, anxiety, and depression and reduced medication consumption (Guétin et al., 2012). Linnemann and colleagues (2015) found music listening in daily life may lead to successful pain management as activation and relaxation predicted an increase in participants' sense of control over their pain. Garza-

Villarreal et al. (2014) found patients' pain was significantly reduced when listening to their preferred music.

Music listeners who have chronic pain describe music as having the possibility to increase energy and lift one's spirits; further, sad music can help release negative feelings or support altering pain perception and enhancing physical relaxation (Gold & Clare, 2012). Alleviating mood and increasing relaxation significantly relieves pain, highlighting again the pain-mood relationship. The authors posit that using music to provide "positive emotional experiences" (p. 559) could offer a meaningful mode of coping with chronic pain.

Vibroacoustic Treatment - a tactile and auditory music intervention

Although most studies focus on auditory music reception, music may also be tactually experienced. Vibroacoustic (VA) treatment is comprised of three elements: low frequency sound vibration (20-120Hz), music listening, and therapeutic interaction (Campbell, Hynynen, & Ala-Ruona, 2017). This intervention is often used within music therapy practice (Ala-Ruona & Punkanen, 2017). The low frequency stimulation is delivered through specially designed recliner chairs, mattresses, or smaller portable devices. The sensation felt when receiving the stimulus may be compared to a wave-like sensation or a massage. Experimentation (Wigram, 1996) showed people consistently feel the same frequencies in similar places on their bodies, for example, 40 Hz is felt strongest in the calves/thighs. This response of the body to particular frequencies in particular areas has been referred to as *resonance*.

In music listening interventions, client preference is important; however, the intention of using music in VA treatment is to support physical and psychological relaxation (Grocke & Wigram, 2007), so further factors may be considered. Grocke and

Wigram note that music without unpredictable changes in volume, tempo, or harmony may elicit a relaxation response.

Finally, the interaction/support from the practitioner is an essential element to VA treatment. Adequate client preparation and application of the intervention, and effective closure of potential responses to treatment (e.g., physical sensations, mental imagery) is required to ensure goal-oriented therapeutic outcomes (Grocke & Wigram, 2007).

Oscillation and dysfunction with chronic pain

A resonant frequency – the frequency at which a system responds to applied oscillation by resonating or entraining with said frequency – manifests as a complex and dynamic response due to the high damping effect from the body (Griffin, 2004). The effects of vibroacoustics relate to direct oscillation or resonance of the body when frequencies are applied (Punikanen & Ala-Ruona, 2012). Resonance is linked not only to this physical resonance in the body but is posited to stem from oscillation within the brain (Llinás, 2003; Bartel et al., 2017). The symptoms and comorbidities of chronic pain points towards oscillation dysfunction playing a significant role in developing and maintaining chronic pain (Ploner, Sorg, & Gross, 2016). Thalamocortical dysfunction – disrupted gamma oscillations around 40 Hz – may be amended by applying tactile vibration such as in VA treatment (Bartel et al., 2017). VA research has been conducted on frequencies around 40 Hz under the hypothesis that it may act as a driving force for rhythmic (re)entrainment of this disrupted thalamocortical loop (Bartel et al., 2017).

VA treatment for pain

The relatively limited research conducted on VA for chronic pain relief has reported clinically relevant outcomes for various types of pain. Fibromyalgia patients

showed statistical and clinical improvement in pain (Naghdi, Ahonen, Macario, & Bartel, 2015) after 10 low frequency treatments (23 minutes at 40 Hz). Patients with chronic pain (e.g., chronic pain syndrome) and comorbid psychological issues (e.g., depression) showed clinically relevant improvements in pain, mood, and relaxation after 10 sessions (approx. 37 minutes each) with 40 Hz-centric treatment programmes, patient-preferred music listening, and therapeutic interaction (Campbell et al., 2017). In adults with spinal cord and brain injuries, symptoms including spasticity, pain, physical discomfort, and anxiety were significantly improved after four to five 40 Hz VA treatment sessions lasting 23 minutes (Rüütel, Vinkel, & Eelmäe, 2017). Except in one study (Campbell et al., 2017), follow-up has not been conducted, but results suggest effects may fade after time.

Self-care for pain management

Although pain prevalence is acknowledged, patients report inadequate treatment (Breivik et al., 2006). Obstacles include patients' reluctance to seek treatment, and perceived patient-practitioner communication barriers; chronic pain self-care programmes supplementary to therapeutic interventions are being developed to counteract this (Ruelman, Karoly, & Enders, 2012). Self-care allows for an individualised approach, as patients may be best suited to assessing the procedures most beneficial for themselves. Patients' belief that something is helpful may also be important. Healthcare providers believe self-care is the first step in pain management (Kovačević et al., 2018). Reported outcomes include significant reductions in pain intensity, and depressive and anxious symptoms (Mehlsen, Heegaard, & Frostholm, 2015), increased perceived control (Ruelman et al., 2012), and improved mental health and quality of life (Miaskowski et al., 2004). Healthcare personnel play an integral role in supporting (e.g. giving advice, encouragement) the process (Mann, Fort &

VanDenKerhof, 2013). Without this, chronically ill patients abandon their practices when overwhelmed by their symptoms or if feeling unsupported (Godfrey et al., 2010).

Rationale

Music – including tactile – interventions have both physiological and psychological effects on us, situated within a biopsychosocial framework. VA treatment includes: (1) the music listening experience, shown to be effective for pain, depression, and anxiety relief, (2) the tactile stimulus, beneficial for both physical and psychological symptoms, and (3) support from the practitioner, important in ensuring processing (of potentially evoked sensations, emotions, memories, or images) and in helping to achieve therapeutic outcomes defined by the patient and practitioner. Acknowledging these combinative roles and self-care's potential to reduce pain and improve mental health, the rationale to explore the combination of VA treatment and a self-care phase applied to manage chronic pain and comorbid symptoms exists.

Aim

The aims of this study were to measure patients' pain and mood outcomes after VA treatment within a naturalistic medical setting followed by self-care practice conducted at home, and to assess individual responses to the treatment conditions. To address this aim, the following research questions were posed:

RQ 1: Does VA treatment alleviate chronic pain, depression, and anxiety, and does self-care maintain these potential effects?

RQ2: What were the individuals' responses to the treatments?

RQ3: How do the themes which emerged from the qualitative analysis inform the interpretation of the quantitative pain and mood scores reported in each phase?

We sought to answer RQ1 with self-report quantitative scales and to answer RQ2 exploring participants responses to the treatments recorded in the practitioner's clinical notes and in the patients' evaluations of the treatments and procedure of the pilot study (evaluation form). RQ3 was addressed in the integration of the quantitative and qualitative outcomes.

Methods

We employed a mixed methods approach with quantitative and qualitative data collected in a convergent-parallel design (Bradt, Burns, & Creswell, 2013). The quantitative (self-report scales for pain, depression, and anxiety) and qualitative (practitioner's clinical notes and participant evaluation forms) data allowed us to utilise the strengths of both, with integration for comparing and contrasting outcomes.

Upon receiving ethics approval (ETL: R16078), patients with chronic pain at [blinded] referred by their physician for VA treatment were approached by the practitioner and informed about the pilot study's design, treatments, and aims. The practitioner assessed patients' eligibility according to the inclusion criteria of suffering from chronic pain and potential depressive/anxious symptoms. Individuals who were pregnant, had inflammation, or were suffering from severe psychological issues (e.g., psychosis) were not included. This sample was representative of the patients treated at this unit and followed a purposive sampling method. Potential participants diagnosed with various types of chronic pain were screened for comorbid mood disorders using Beck's Depression Inventory-II (BDI-II), a widely accepted tool for assessing intensity of depression in psychiatric and normal populations and the Hospital Anxiety and Depression-Anxiety subscale (HADS-A), widely used in both medical and psychiatric contexts (Smarr & Keefer, 2011).

Participants

Six participants partook in this study. One participant was excluded from analysis because his pain-related symptoms were minimal. The mean age of the remaining two females and three males was 44.8(±8.08) years (range 33-55). Demographics are summarised in Table 1.

[Insert Table 1 here]

Devices

Two devices were used to deliver the low frequency sound vibration stimuli: a Next Wave Physioacoustic Chair (see *Picture 1* in the supplementary web material) and a Taikofon FeelSound Player, a small portable cushion (see *Picture 2* in the supplementary web material).

[Picture 1 & Picture 2 as supplemental web materials]

Physioacoustic chair

Sonus Health Editor v3.26c computer software is used to play the treatment programmes through the loudspeakers located in the neck, back, thigh, and calf regions of the chair. The seatback and leg rests of this recliner chair can be adjusted by remote control. The frequency range is 27.13–113.22 Hz. The chair is designated as a low-risk, non-invasive treatment and is approved by the Food and Drug Administration (FDA) in the USA, the Canadian Standards Association (CSA), and the British Standards Institution (BSI) with permissible claims of pain and stress relief, muscle relaxation, and improved blood and lymphatic circulation.

Taikofon

The Taikofon FeelSound Player, a cushion-like device, has built-in speakers and sound vibration or music can be played via audio cable or Bluetooth. The frequency range is 20–20,000 Hz. To play the stimulus, participants were given an android mobile phone (Huawei Y5) with one VA treatment programme installed. Due to the size of this cushion, it can easily be placed anywhere on the body, for instance, the lower back.

Stimuli

A 37-minute programme was used with the Physioacoustic chair played through Sonus Health Editor v3.26c computer software and a 23-minute programme with the Taikofon played through the Huawei device. Both programmes were the same for all participants, however the intensity of the programme through the Physioacoustic chair was adjusted according to each patient's needs and participants could individually adjust the volume of the self-care programme at home.

The VA treatment programme parameters delivered through the Physioacoustic chair using are *time, frequency, scan, speed, cycle, strength, and action*. The 37-minute programme has several phases lasting from two to three minutes focusing on 40 Hz but ranging from 29.15–61.04 Hz. This programme was used because 40 Hz has been shown to be useful for pain relief (Naghdi et al., 2015), with the potential to act as a driving force for thalamocortical oscillatory regulation (Bartel et al., 2017). Practice-based evidence also shows it is useful in managing pain and mood disorders (Campbell, et al., 2017). The massage-like sensation is simultaneously afforded by several elements; *scan* refers to the constant frequency changes around the fundamental of each phase. This helps reduce potential side effects, as high levels of low frequency sound can be associated with nausea and panic (Wigram, 1997, p.11). *Cycle* is also referred to

as *pulsation*; it corresponds to the speed of the amplitude change, that is, the time taken to complete a full cycle from silence to the designated peak volume. In this programme, each cycle lasted an average of 11.09 seconds. In practice, a longer cycle relaxes, whilst a shorter cycle energises. The *strength* can be globally adjusted or specific to each speaker; a particular body part, for instance, the lower back, may be targeted in this way. Treatment programme strength is generally lower when a process begins so the patient can become accustomed to the sensation. *Action* is the directional movement; the programme either moves from head-to-toe, vice-versa, or remains fixed. The speed of this *action* is also dictated by *cycle*: the faster the cycle, the faster the directional movement.

With Taikofon, a 23-minute 40 Hz programme was used with all participants. As this is a smaller, portable device, the parameters of the treatment programme pertain only to the *strength*, that is, the volume, which could be individually adjusted, and *cycle*, approximately seven seconds long. The mobile phone through which the programme is played is used to adjust the volume.

Procedure

The protocol (see *Figure 1*) consisted of four phases. Phase I was a one-week baseline measurement phase. There were no VA treatments during this time. Phase II comprised VA treatment sessions offered by a trained practitioner using the Physioacoustic chair. The practitioner, with a background in occupational healthcare, has been trained by the Vibrac Skille-Lehikoinen Centre for Vibroacoustic Therapy and Research. Participants received eight VA treatment sessions delivered bi-weekly for one month. In Phase III participants conducted five self-care VA treatments per week for one month in their homes. They were instructed to conduct self-care from Mondays–

Fridays at the same time each day, to position themselves comfortably (e.g. sitting or lying down), and to listen to the same music as during Phase II, making a note of where they positioned the Taikofon device on their body during self-care. Finally, Phase IV was a month-long washout period; participants did not receive VA treatments.

[Insert Figure 1 here]

Assessment

Quantitative outcomes

The quantitative outcomes were Visual Analogue Scales for both pain (VAS-P) and mood (VAS-M), Beck's Depression Inventory-II (BDI-II), to assess depression, and the anxiety subscale of the Hospital Anxiety and Depression Scale (HADS-A) for anxiety.

A Visual Analogue Scale (VAS) is a 10cm horizontal line with anchors on either end. The anchors in this study for pain were 0=worst pain imaginable and 100=no pain; for mood, these were 0=depressed and 100=happy. The VAS is widely implemented due to ease of use (Younger, McCue, & Mackey, 2009). Test-retest reliability is reported as $r = 0.94$ for pain (Hawker et al., 2011) and $r = 0.82$ for mood (Ahearn & Carroll, 1996). The patient was asked to mark these lines to represent their current pain intensity and mood.

Beck's Depression Inventory-II (BDI-II) is a self-complete, 21-item self-report psychometric test measuring severity of depressive symptoms (Smarr & Keefer, 2011). Items are rated on a four-point scale from 0 (e.g., "I do not feel like a failure") to 3 (e.g., "I feel I am a total failure as a person"). Depression severity is represented by the sum of the scores across items. The scale used is validated in Finnish (Suija et al., 2012) and

can be used to measure both baseline severity and responsiveness to treatment.

Cronbach's α , an objective measure of a scale's internal consistency or reliability, was reported as 0.92 for outpatients and 0.93 for college students (Smarr & Keefer, 2011).

The anxiety subscale of the Hospital Anxiety and Depression Scale (HADS-A) is a self-complete scale to assess the non-somatic cognitive and emotional aspects of anxiety in general medical populations. It has seven items that are rated on a four-point scale (e.g., "I feel 'wound up'" ranging from 0=not at all to 3=most of the time). The reliability of HADS-A ranges from $\alpha=0.78-0.93$ (Smarr & Keefer, 2011).

VAS-P and VAS-M, BDI-II, and HADS-A were taken at intake in Phase I and at the end of Phases II, III, and IV. VAS-P and VAS-M were also assessed two more times during baseline (Phase I total: 3), before and after each VA treatment (Phase II total: 16), before and after each self-care treatment (Phase III total: 40) and three times per week during washout (Phase IV total: 12). Each participant completed 71 VAS-P and VAS-M and four BDI-II and HADS-A. As this was an exploratory study, we wished to garner as much information as possible on the variability of the patients' pain and mood during the process, especially since few studies have been conducted on this topic and that self-care was a novel addition to VA treatment. Pre- and post-treatment VAS-P and VAS-M outcomes were thus collected in both treatment phases.

Qualitative outcomes

The qualitative outcome measures included the practitioner's clinical observations/notes (including participants' verbal reports recorded by the practitioner throughout the process) and participants' process evaluation. The practitioner made notes after each session with a client, reporting on patients' self-assessments, an important element in the communication between healthcare professionals in this

multidisciplinary team. All verbal interaction between the client and practitioner pertaining to their treatment response was recorded but no formal template was used because patients' responses can be variable and freedom to report all types of responses is desired. These notes, sent to the primary physician after the process had ended, included recommendations for future treatment phases. In the evaluation form, participants were asked to opine on (a) each treatment phase, (b) the devices used in the study, and (c) to express whether their symptoms returned, remained the same, or improved during the washout period.

Data analysis

Quantitative data

Due to the difficulty in assessing and meta-analysing pain management intervention outcomes, the Initiative on Methods, Measurement, and Pain Assessment in Clinical Trials (IMMPACT) outlined a standard set of measures to foster meaningful comparison. The consensus statement (Dworkin et al., 2008) recommends margins for the smallest clinically relevant change in patient outcomes called the Minimal Clinically Important Difference (MCID). The following benchmarks for minimal, moderate, and substantial clinical change for pain relief are suggested: a 10-20% reduction on the VAS corresponds to the MCID in patient reported outcomes; $\geq 30\%$ reflects at least a moderate change, and $\geq 50\%$ reflects substantial improvement. Additionally, Jensen, Chen, and Brugger (2003) recommended interpretation cut-off points¹: 0-24mm (severe pain); 25-55mm (moderate pain); 56-95mm (mild pain); 96-100 (no pain).

¹ Jensen and colleagues' recommendations for VAS were based on the anchors the 0=no pain; 100=worst pain imaginable. As this study implemented the opposite (i.e. 0=worst pain imaginable) as is standard protocol at this facility, the guidelines presented here are inverted.

BDI-II scores can be interpreted as follows: 0–13 minimal depression; 14–19 mild depression; 20–28 moderate depression; 29–63 severe depression. Dworkin et al. (2008)'s category change (e.g., from *moderate* to *mild* depression) and 5-point reduction benchmarks are used here.

HADS-A scores can be interpreted as: 0–7 normal; 8–10 borderline, and 11–21 abnormal anxiety. The MCID for the anxiety sub-scale in HADS-A is suggested as a decrease of 1.57 points (Puhan, Frey, Büchi, & Schünemann, 2008).

Data were analysed using SPSS (IBM SPSS Statistics for Macintosh, Version 24.0). Means and standard deviations were calculated per phase per participant; these were used to see possible individual change within phases, using Dworkin and colleagues' (2008) interpretation guidelines for assessment of change, and Jensen and colleagues' (2003) interpretation guidelines for contextualisation of pain and mood changes.

Qualitative data

Qualitative content analysis was used to analyse all qualitative data (Elo & Kyngäs, 2008). Raw data were prepared in a common document and analysed by Author 1, with a member check completed by Practitioner. An inductive approach of deriving categories was used so as to stay as close as possible to the experiences of the participants, allowing the findings to emerge from the raw data (Thomas, 2006). The coding process was guided by the research question “*What were the individuals' responses to the treatments?*”, providing a focus for the analysis rather than expectations regarding specific findings. The documents were read through to make sense of them as a whole. The first round consisted of open coding. A code assigns interpreted meaning to data to locate patterns and develop categories (Saldaña, 2016)

and are the bones of the analysis from which one constructs the skeleton (Charmaz, 2006). Next, a general description of the subject was abstracted and formulated, each lower-level category derived from several readings of this raw data and the upper-level (main) categories founded on the evaluation aim. These were identified by marked text sections translating into emerging categories. Several readings and revisions of these categories were conducted to identify (non)common elements, so that common elements would be grouped under the same category when meanings were similar. To convey the emerged lower- and upper-level categories, illustrative quotes were selected based on the initial marked sections to display the core of each category.

Integrated data

After the separate analysis of the quantitative and qualitative data, these were compared and (non)congruent findings contrasted, with a joint display of these participants' experiences after VA treatment and self-care. As the mixed methods design pertained to a parallel-convergent design, in which both data sets were collected simultaneously for answering questions pertaining to the same phenomenon, the qualitative data supported the quantitative in exploring the participants' responses to the treatment. The quantitative pain and mood data were merged with the qualitative descriptions of the participants' experiences such that when a participant reported on pain, the same instance was explored in the qualitative themes. Experiences expressed in the qualitative themes were compared and contrasted with the quantitative changes reported by each participant.

Results

Quantitative results

The quantitative data were used to answer RQ1: *Does VA treatment alleviate chronic pain, depression, and anxiety, and does self-care maintain these potential effects?* Mean pain and mood scores for each individual participant per phase are shown in Table 2 marked with Dworkin and colleagues' (2008) MCID guidelines. BDI-II and HADS-A scores are also shown in Table 2. Due to participant heterogeneity and small sample size, mean scores across all participants are not presented, however Jensen et al.'s (2003) interpretation guidelines are presented per phase to discuss all participants' change throughout the process. Participants completed (P1) 72%, (P2) 77%, (P3) 85%, (P4) 100%, and (P5) 97% of VAS outcomes measures and all but P1 and P2 completed 100% of BDI-II and HADS-A outcomes.

[Insert Table 2 here]

Pain

All participants apart from P5 presented with *moderate* pain at baseline and their pain was *mild* in Phase II post-treatment. P1, P3, and P4 returned to *moderate* pain during Phase III, however P3 had *mild* pain during Phase IV. P2 remained in the *mild* category for the remainder of the process and P5 had *mild* pain throughout.

When participants' pain remained in the same category (e.g., P5), the change within the phases could be seen through the MCID interpretations. From Phase I to IIb, all participants recorded at least MCID; P2, P3, and P4 reported *substantial* improvement. From Phase IIa to IIb, P1 and P5 reported MCID, P2 reported *moderate* improvement, and P3 reported *substantial* improvement. From Phase I to IIIb, P2 and P4 reported *substantial* improvement and P3 reached the MCID. From Phase IIIa to

IIIb, P2, P3, and P4 reported the MCID. Improvements from Phase I to IV for P1 and P5 were MCID, *moderate* for P2 and P4, and *substantial* for P3.

Mood

All participants apart from P3 were *moderate* at baseline. P3 remained in the *mild* category throughout whilst P5 remained *moderate*. P1, P2, and P4 changed to *mild* in Phase II. P2 remained *mild* until the end, P4 was *moderate* from Phase III onwards, and P1 was *severe* in Phase IIIa but *moderate* from Phase IIIb until the end.

From Phase I to IIb, all participants reported MCID, with P1 reporting substantial improvement. Within Phase II, only P1 recorded MCID. From Phase I to IIIb, P1 reported *substantial* worsening, but positive MCID from Phase IIIa to IIIb. P1 and P3 had MCID from Phase I to IV. P3, although only in the *mild* category throughout, reached the MCID in Phase II and reported improvement also in Phases III and IV. P5 – persistently *moderate* – also reported improvement in each phase, reaching MCID in Phase II. P4 reported worsening mood in all phases, yet within Phase II was *mild* and the worsening scores were only marginal from Phase IIIa to IV.

Depression

In Phase I, P1 and P4 had *severe* depression, P3 and P5 had *moderate* depression, and P2 had *mild* depression (see *Figure 2*). Minimal clinically important change was recorded by P2, P5, and P4. Although P4 remained in the same category (*severe*) throughout the study, clinically important change was still achieved, represented by a 6-point decrease in Phase II. P5 changed two categories, from *moderate* to *minimal*, and P2 improved from *mild* to *minimal*. P1 and P4 remained in the *severe* category and P3 remained in the *moderate* category throughout. P1 and P2 did not complete the BDI-II or HADS-A at the end of Phase II.

Anxiety

P1 and P3 were in the *normal* category at baseline (Phase I), P2 was *borderline*, and P4 and P5 were in the *abnormal* category as measured by their HADS-A scores (see *Figure 3*). P2 and P5 reported clinically important changes in category and reduced their score by 5 and 9 points respectively. P1's anxiety increased by 2 points during washout. P3 had more anxiety in Phase II, showed clinical improvement in Phase III, and returned to baseline score in Phase IV, although this was still within the *normal* range. Finally, P4 temporarily changed to the *borderline* category (Phase II) but was more anxious in Phase IV than in the other three phases.

Qualitative results

The qualitative data were used to answer RQ2: *What were the individuals' responses to the treatments?* Four main categories – *Relief, Recurrence, Evaluation, and Proactive Involvement* (see *Table 3*) – with nine categories – *Improved Symptoms, Medication Changes, Retained Effects, Returning Symptoms, Positive Experience, Challenges in Self-care, Less Rigid Design, Seeking Relief, and Self-care Activities* – emerged from analysis. Category descriptions and illustrative quotes are presented to support the generated categories.

[Insert Table 3 here]

Relief

Improved symptoms

Pain relief, increased range of movement and relaxation, reduced stiffness and stress, and improvement in quality of sleep were reported by participants during Phase II. Immediate pain relief after the VA sessions positively affected functioning, for

instance, greater range of movement in the neck whilst driving after the sessions. The practitioner observed that participants could relax well during the Phase II treatments; occasionally falling asleep during the treatments. P5 told that she felt increasingly relaxed as Phase II progressed and that it calmed her mind, working more on a psychological than physical level. P2 showed such an energy and mood increase that her spouse wondered whether she had started new medication. The practitioner noted P5 was grateful for the experience and reflected on the overall process, having noticed the deterioration during the washout phase: “This helped me a lot; many thanks!”

Medication changes

P5 reported she had not needed analgesics at all in Phases II or III. P4 also reported a change in medication; he had noted that the VA treatment [Phase II] had “found pains” in his wrists, ankles, knees, hips, and shoulders. After he stopped taking hypertension medication, these pains were reduced. Although the treatment brought out these pains, he also felt that he had been “completely treated” – comparing the sensation to a strong massage – and felt it was a positive experience.

Retained effects

During Phase II, effects after the sessions were reported as improved quality of sleep lasting two or three nights afterwards, but also that symptoms remained similar to Phase III when all treatments had stopped (mood, P1, P3, & P4). P4 wrote that his pain reduced and mood improved during Phase IV and was sleeping better.

Recurrence

Two participants (P3 and P5) reported their pain got noticeably worse during

Phase IV. Quality of sleep also deteriorated after Phases II (P4) and IV ended (P2). P3 expressed difficulty in managing his pain after Phase II had ended: “The pains did not stay away”. Symptoms such as sweating increased during self-care for P3; P5’s menopause symptoms and panic attacks returned during Phase IV.

Evaluation

Positive experience

Participants found the experience positive, “empowering” (P2), an “interesting experiment” (P3), that the practitioner was good (P5), and that the sessions relieved panic (P1). P5 tried for years to find a method of symptom relief; VA treatment was effective when nothing else was.

Self-care challenges

There were some challenges in self-care. Participants placed the cushion at their lower back (P3, P4), upper back (P5), or neck/shoulder area (P1, P2), but found it hard to place it so as to most efficiently feel the vibrations (P1, P3). More choice of treatment programme was also desired (P5).

All participants felt the Taikofon’s effects were not close to those of the VA chair. However, P5 found some benefit in the Taikofon as her neck/shoulders were not as stiff during Phase III as during either Phase I or IV. During Phase IV, she noticed how beneficial both Phase II and III were, as she returned to a poor condition during washout. P1 found the outcome measures bothersome and tedious, and P3 reported the self-care as a “compulsory commitment”.

P1 did not initially engage in self-care at all. The practitioner called him on the telephone to check on his progress and only after reassurance and further instruction from the practitioner did P1 begin to conduct the self-care sessions. Without the input of Practitioner, P1 would have lacked the motivation to use the self-care device.

Less rigid design

The practitioner recommended a new treatment phase at the facility for P1, P2, P3, and P4 with a more intensive, massage-like programme. P5 commented that different treatment programmes could also be used. She was also recommended more treatments, however, the senior physician suggested she try different approaches due to the long waiting lists at the facility.

Proactive involvement

Seeking relief

P3 found the experiment interesting; he tries to receive all the help he can in managing with his diagnosis. P5 gets bi-monthly massages to ease her symptoms, from which she has relief for several days. With VA treatment, the same effect lasted longer.

Self-care activities

P1 stopped smoking three weeks before the end of the study, and P4 stopped 3.5 months before starting the study, taking proactive steps towards improving his general health. P3 and P5 attended monthly physiotherapy, P3 also visiting the psychiatric nurse several times per month for extra support. These proactive approaches to self-care suggest a positive change in the participants' mentality towards improving their own health status.

Integrated results

The two data sets were merged to answer RQ3: *How do the qualitative themes inform the interpretation of the quantitative pain and mood scores reported in each phase?* These are narratively presented according to physical, psychological, and other symptoms reported by the participants and a joint display is presented in *Table 4*.

Physical symptoms

Phase II showed participants' pain improved from pre- to post-treatment measures, except for P4 who presented a non-clinically relevant deterioration. This was also seen in the qualitative findings; participants reported feeling immediate pain relief and the practitioner also noticed they were increasingly able to relax during Phase II. P4's worsening VAS-P was explained in the qualitative findings, in which he reported the treatment "finding pains"; he began to notice new pains in his body, a similar experience to that of a full-body massage. He also fell, injuring himself during this phase. P5 improved in both Phase II and III (VAS-P); her qualitative reports support this. She did not need to take analgesics at all during either of these phases. She also reported that VA felt like a massage, but the effects of VA lasted longer. All participants (apart from P1) recorded improved pain levels from Phase IIIa to IIIb. Quantitative results from P3 and P5 are, however, not supported by the qualitative reports. Both participants had less pain (VAS-P) in Phase IV than Phase IIIb (although not compared to Phase I), but both reported that they noticed their pain getting noticeably worse during washout.

Psychological symptoms

All participants – except P4 – recorded mood improvement in Phases II and III with VAS-M. The worsening in pain for P4 was also seen in his worsening mood recorded with VAS-M. His depressive symptoms (BDI-II) worsened in Phases III and IV although he reported his mood improved during the washout. The psychological effects of the treatment were in fact reported as more prominent for P5 than were the physical, and this were represented also by her BDI-II and HADS-A outcomes. Her depressive and anxious symptoms had vastly improved during the Phase II sessions and remained so, although not seen in VAS-M. In contrast to Phase IV quantitative outcomes, the qualitative findings showed that her panic attacks returned during this time. P2 reported improvement in Phase II and III and her Phase IV scores were better than those at baseline, seen in VAS-M, BDI-II, and HADS-A. This was further supported by the qualitative findings; her mood had improved so noticeably that her spouse commented on it.

[Insert Table 4 here]

Other symptoms

Participants reported changes in other symptoms throughout the process, which were recorded in the practitioner’s clinical notes. These included better quality of sleep, feeling empowered and less stressed, increased range of movement, and improvement in menopause symptoms beginning in Phase II. They reported their poor sleep, panic, and menopause symptoms returning during washout.

In answer to RQ1, the VAS-P, VAS-M, BDI-II, and HADS-A outcomes suggest that patients experience pain, depression, and anxiety relief from VA treatment. They also experienced some relief from self-care even though the stimulus itself was localised to a

smaller area and it felt much weaker than the chair at the facility. In answer to RQ2, qualitative findings indicate individuals experienced increased relaxation and improved quality of sleep, had no panic attacks, and felt empowered and mentally calmer in addition to the pain and mood relief from VA treatment. The self-care may have helped to maintain the effects from the VA treatment because participants reported symptoms returning during the washout phase, seen in both qualitative and quantitative reports. The most beneficial effects were recorded during Phase II, representative of the multiple speakers and whole-body sensation elicited from the chair compared to the relatively smaller size of the self-care cushion. Finally, in answer to RQ3, the qualitative findings were beneficial for providing further context to the quantitative outcomes that can be difficult to interpret, especially due to the subjective nature of pain. Although there was some inconsistency among the quantitative outcomes, the qualitative findings imply that participants felt benefit from both VA treatments at the facility with results suggestive of the potential of self-care.

Discussion

The aim of this mixed methods study was to explore whether patients with chronic pain and mood disorders experienced relief from VA treatment and if an additional self-care intervention would maintain these potential effects, as well as to explore variability in patient responses to this treatment modality and to the overall procedure. We combined quantitative scales assessing pain and mood (VAS-P, VAS-M, BDI-II, and HADS-A) with the qualitative documents from the process (practitioner's clinical notes and participant evaluation forms).

Our findings seem to be congruent with previous research that VA treatment positively impacts chronic pain, depression, and anxiety (Campbell et al., 2017; Naghdi et al., 2015; Rützel et al., 2017). They are also in line with previous findings that music

interventions reduce the need for medication (Guétin et al., 2012). We found the supportive role of the practitioner may be an important element in participants' adherence to the protocol exemplified by P1's delayed self-care initiation; contact with healthcare providers has been shown to improve patient outcomes, and telephone contact has proven particularly effective (Von Korff, Gruman, Schaefer, Curry, & Wagner, 1997). The role of the healthcare provider has been found to be that of a teacher or partner as well as a supervisor and that building up a partnership with the healthcare provider is an important element in self-care practices (Lorig & Holman, 2003). Although nuances exist between quantitative and qualitative data, our findings suggest self-care may be useful in maintaining the effects of VA treatment.

Quantitative results

Whilst there were minimal changes in the VAS-M scores, the BDI-II outcomes showed significant improvements for P2 and P5 and similar significant improvements for P2 and P5 in HADS-A outcomes. Although VAS-M has shown satisfactory evidence of reliability and validity, with high correlations ($r = 0.82$) comparing clinician VAS ratings to patients' BDI-II and VAS ratings (Ahearn & Carroll, 1996), patients may feel that the VAS does not represent the experience strongly enough, tending to rate oneself more severely than would clinicians (Ahearn, 1997).

Qualitative findings

Relaxation, exemplified in observations of reduced facial tension and falling asleep, is the most commonly reported treatment effect at this facility. This suggests that the whole-body relaxation effect, comparable to the effects of a deep massage (e.g., P5), may be key in promoting muscle relaxation and reducing tension thereby reducing pain. Evidence suggests eliciting a relaxation response through music listening (e.g., Gold &

Clare, 2012; Guétin et al., 2012) or VA treatment (Campbell et al., 2017) can be beneficial for reducing pain, increasing mobility, and reducing analgesic consumption. The importance of support for those with chronic illness is also reinforced. Chronically ill patients are forced to face their own vulnerability and reduced functionality; experiencing their body as a hindrance, struggling to understand their illness, searching for normalcy, and dealing with the loneliness of suffering are aspects of the experience, but independence and self-management alleviate these (Öhman, Söderberg, & Lundman, 2003).

Multiple chronic conditions are difficult to manage, as the symptoms of one may aggravate those of another; social and emotional support is therefore necessary in self-care promotion (Bayliss, Steiner, Fernald, Crane, & Main, 2003). The balance between support from healthcare providers and sufficient independence to conduct self-care may be the goal of chronic illness treatment and management. In this case, the practitioner's role in supporting participants' adherence to the self-care protocol was important.

Additional self-care

The prepatent benefit of self-care as an addition to standard protocol of VA treatment for managing chronic pain may be seen firstly in the quantitative outcomes: participants reported increased pain during washout, possibly indicating the self-care intervention helped to maintain the effects of the Phase II sessions. Secondly, the qualitative findings show that pain returned during washout; other symptoms such as panic attacks that were under control during both Phases II and III also returned during Phase IV.

However, the qualitative findings simultaneously present nuanced experiences of the self-care intervention. The participants compared the effects of the Taikofon to those of the Physioacoustic chair – which, due to its relatively small size could not

produce the same whole-body effects one feels from the multiple loudspeakers in the recliner. Participants' self-care reports compared this stimulus to the Physioacoustic chair and could thus be interpreted as ineffective. Yet, the VAS outcomes suggest a potential benefit of the self-care sessions. Further, all participants used the audio cable to play the treatment programme; it transpired that played this way the stimulus was noticeably weaker at full volume compared to Bluetooth at half-volume, meaning the stimulus the participants received was not as intense as it could have been. This complicates the interpretation of the self-care phase effects; however, from the qualitative reports we know that there was some degree of benefit, even at this low volume. The importance of the self-care phase was not to compare the treatment conditions to each other, rather to explore whether positive outcomes from Phase II could be maintained with self-care.

Limitations to self-care practice

Physical or logistical limitations of conducting self-care were responses to the self-care phase and is a common element preventing patients with multiple chronic disease from engaging in self-care practices (Bayliss, Steiner, Fernald, Crane, & Main, 2003). Participants in this study did report this difficulty, suggesting that more support may be needed in these instances.

The challenges were also associated with the feeling of obligation; there was a copious amount of VAS-P and VAS-M to complete during this time, which may have negatively impacted participants' commitment and motivation, as well as their general perception of the effects. Self-care practices may be more beneficial when the impetus to carry them out and create one's own "relaxation space" comes from the patient themselves which may still be aided by practitioner support.

The role of the practitioner

An important aspect of VA treatment in general is the practitioner-client relationship. Under the assumption that participants would have pain and mood relief from Phase II supported by the practitioner, participants may ideally improve to the point of being able to continue and maintain these gains with less external support. Yet, this may be dependent on the severity of the depression/anxiety, as was the case for P1 and P4. They had severe depression throughout the study, which may have been a factor hindering progress due to low motivation associated with depression. Healthcare personnel (e.g., nurses) are strong sources of support, affecting patients in getting “[them] back on track” and providing “positive reinforcement” (Bair et al., 2009, p. 1286). Managing depression is a highly relevant way to self-manage pain, so that with relieving depressive symptoms, one has a greater desire and motivation to do things, which “makes pain more manageable” (p. 1285). P1 was reluctant at first to engage in self-care at all. At the half-way point in Phase III, P1 was motivated by Practitioner to start self-care, highlighting the potential importance of the practitioner-patient relationship and intermittent check-ups in self-care promotion. This has previously been found to be an important facet of self-care practice (Mann, Fort, & VanDenKerhof, 2013).

Limitations

As this was an uncontrolled study with a small sample size, the effects of confounding variables cannot be dismissed. The study looked at the individual responses of patients in this naturalistic setting and thus a randomised controlled trial was deemed inappropriate. Those treated at this facility also receive concurrent treatments, so the effects are cumulative to other treatments the participants may have

received (e.g., physiotherapy). The results give an impression of how this additional self-care intervention may be useful in multidisciplinary healthcare.

The reduced stimulation from the self-care device is also an interpretative limitation; future applications of this device should ensure that participants play the stimulus using Bluetooth for greater volume potential.

Conclusion

The present study explored the novel addition of self-care to VA treatment within a rehabilitation setting. Results suggest participants experienced reduced pain, anxiety, and depression, increased relaxation, improved quality of sleep, and empowerment from the treatment, but also highlighted the potential role that self-motivation plays in self-care and the need for support during this. The difficulty in managing chronic pain as a phenomenon is seen in the discrepancies between the quantitative and qualitative reports of self-care. The qualitative data were beneficial in exploring what quantitative outcomes mean in practice for patients with persistent pain and comorbid symptoms. Future studies may also address how more individualised treatment programmes would be clinically important for chronic pain patients, especially in congruence with other treatments such as physiotherapy. More detailed qualitative reports (e.g., diaries) would offer a valuable addition to single-case study explorations of this topic and may be especially beneficial for chronic pain patients due to individual variation. As the results suggest the importance of the practitioner's role in supporting therapeutic outcomes, future work should also address this aspect of the VA treatment triad more closely.

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