

SUBMITTED VERSION

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The human health effects of singing bowls: a systematic review

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The human health effects of singing bowls: a systematic review

Abstract

Objective: The objective of this study was to determine the human health effects (beneficial or adverse) of any singing bowl therapies.

Design: A systematic review was conducted.

Setting: The setting was not specified, so it could include clinical and non-clinical settings.

Intervention: Studies of any intervention predominantly involving singing bowls (e.g. playing singing bowls, listening to singing bowls) were eligible for inclusion. The comparison interventions were not specified, and studies without comparisons (e.g. pre-post studies) were also considered potentially relevant.

Main outcome measures: Any human health outcome was investigated.

Results: The effects of singing bowls on human health were investigated in four peer-reviewed studies, one of which investigated patients with metastatic cancer, and another those with chronic spinal pain. Low-level designs were used in two studies. Improvements in distress, positive and negative affect, anxiety, depression, fatigue, tension, anger, confusion and vigour were reported, as were improvements in blood pressure, heart rate, respiratory rate, peripheral capillary oxygen saturation, cutaneous conductance, and anterior-frontal alpha values.

Conclusions: Given there were few studies and the potential risk of methodological bias, we cannot recommend singing bowl therapies at this stage. As the evidence suggests positive health effects we recommend that future studies consider the effect of singing bowl therapist using more robust study methods, allowing for evidence-based recommendations to be made to reduce the disease burden.

Keywords: Singing bowl, meditation, music therapy, health, systematic review

Highlights

- Singing bowls combine elements of meditation and music therapy
- The health effects of singing bowls have been investigated in three studies
- There is some evidence to suggest mental health and cardiovascular benefits
- Future studies should use more robust designs and minimise potential biases

Background

Non-communicable diseases are a major burden of disease globally, with low back pain, migraines, age-related hearing loss, iron-deficiency anaemia, major depression, neck pain, other musculoskeletal disorders, diabetes, anxiety disorders and falls listed as the top 10 causes of years lived with disability globally.¹ Cost-effective, accessible prevention and management strategies for these conditions are required to reduce this burden. Music therapy and meditation may play such a role.

Rationale

Music has had a long cross-cultural tradition,² with the earliest musical instruments (flutes made from bones or ivory of animals including vultures and mammoths) dating back 35 000 years.³ Music has played a role in rituals, as well as healing. Music therapy was promoted by Pythagoras, Aristotle and Hippocrates, and has had an enduring role in healing since.⁴ There is supporting evidence for positive outcomes from contemporary music therapy targeting a range of health conditions,⁵⁻¹² including mental illness¹² and pain.¹¹ Similarly, meditation has a long tradition in health and well-being with contemporary evidence indicating that meditation is effective in managing some of the leading causes of years lived with disability, such as depression,¹³ anxiety,¹³ and pain conditions.^{13, 14}

Singing bowls have been associated with Tibetan culture, and are friction idiophones.¹⁵ They are traditionally made of bronze alloys,¹⁶ and more recently quartz crystal,¹⁷ and are played by rubbing the rim of the bowl with a leather-wrapped or wooden mallet; they may also be struck.¹⁶ The bowls have been used as part of religious ceremonies, including meditation.¹⁶ Therapies involving singing bowls combine some of the elements of both meditation and music therapy, and may therefore provide an effective strategy for reducing the symptoms of some of the conditions identified above as being the leading causes of years lived with disability. Indeed, singing bowl therapies have now been implemented in hospital treatments.¹⁸

Despite an anecdotal, recent increase in interest and engagement in therapies involving singing bowls, the human health effects of playing and/or listening to singing bowls has not previously been

examined in a systematic review; the highest level of evidence for supporting (or otherwise) the efficacy of clinical interventions.¹⁹ The objective of this systematic review is therefore to determine any human health effects (beneficial or adverse) of singing bowl therapies in any population, to fill the identified evidence gap and to provide recommendations for the potential public health and/or clinical use of singing bowls.

Methods

The review protocol was reported <reference removed for blinding> prior to commencing the review.

Data sources

A systematic search of seven library databases (Cochrane Library database, Ovid Medline, Web of Science (all databases), Scopus, Cumulative Index to Nursing and Allied Health Literature (EbscoHost), Health Source (EbscoHost), and Embase was conducted in October 2019, with the terms “singing bowl” OR “singing bowls” searched in the title, abstract and keyword fields. No limits were applied to the search.

Inclusion/ exclusion criteria

All identified studies were exported into Endnote X9, where duplicates were removed, before screening the titles and abstracts for potential inclusion. Eligibility criteria are primary studies (qualitative and quantitative) reported in full within peer-reviewed journals, and investigating any human health effects of using or listening to any type of singing bowl. Studies using singing bowls as part of music or sound therapy were only included if singing bowls were the main type of sound therapy. The citation lists (Scopus, Web of Science and Google Scholar) and reference lists of all included studies were checked for additional potentially relevant studies, and were then screened, using the criteria outlined above. Study inclusion/ exclusion was determined by the two reviewers independently.

Data extraction

Relevant data from the included studies were manually extracted, independently by the two reviewers, into a purpose-built spreadsheet, with the headings study design, year(s), location and setting, population and sample characteristics, details of the intervention(s) (e.g. duration, frequency, type of bowls used), outcomes and outcome measures, the timing of data collection, compliance, statistical methods used, and study findings (both beneficial and adverse health outcomes). All types of summary measures were reported.

Included quantitative studies were allocated to the National Health and Medical Research Council (NHMRC)¹⁹ Hierarchy of Evidence for intervention studies, and methodological bias was examined using the Physiotherapy Evidence Database (PEDro) scale;²⁰ a valid and reliable assessment tool.²¹⁻²³ The PEDro scale is the only assessment tool for methodological bias, to our knowledge, that has undergone Rasch analysis;²¹ thus, strengthening the validity and reliability of the tool. Although the PEDro scale was designed primarily for use with randomised controlled trials, the scale has been used with non-randomised controlled trials as well,²⁴⁻²⁶ with some of the validity and reliability testing also including non-randomised controlled trials.²¹ Assessment of methodological bias was only conducted for study designs of level III_1 and above, due to inherent biases in lower level designs.^{24, 27, 28} Allocation of studies to the NHMRC Hierarchy and assessment of methodological bias were conducted independently by the two reviewers.

Data synthesis

Data were synthesised descriptively.

Results

Study characteristics

A total of 74 studies were obtained from the database search, and the full texts of seven of these studies^{17, 29-34} were screened for potential inclusion. Four studies^{17, 29, 33, 34} were ultimately included in

our review (Figure 1), with details of these studies reported in Table 1. Three^{17, 33, 34} of the four studies were published in the last five years; two^{17, 33} were conducted in the United States of America, and one each were from Italy³⁴ and Germany.²⁹ Landry³³ conducted a randomised cross-over trial (NHMRC Level II) and Wepner et al.²⁹ conducted a randomised controlled trial (NHMRC Level II), while Bidin et al.³⁴ and Goldsby et al.¹⁷ used pre-post designs (NHMRC Level IV). Owing to the use of a lower level design for the other studies, potential methodological bias was only assessed for two studies^{33,29}. Landry's³³ study scored 60% on the PEDro scale, with concealed allocation and blinding of the participant, therapist and assessor not being reported. Wepner et al.'s²⁹ study scored 30% on the PEDro scale, having not reported concealing allocation, comparisons of the groups at baseline, blinding (participant, therapist or assessor), whether any data were missing, and whether all participants received the treatment as intended (or analysed by "intention to treat").

Wepner et al.²⁹ investigated the impact of singing bowl therapy for those with chronic, spinal pain, comparing singing bowl therapy (with the quartz bowl struck while placed on the participant's back), a placebo treatment (where the bowl was not struck), and a control group (no intervention). Bidin et al.³⁴ investigated individual singing bowl therapies in patients with metastatic cancer, while Landry³³ investigated the addition of singing bowls to a meditation (in comparison with silence followed by meditation), both in 'healthy' adults. Goldsby et al.¹⁷ investigated a group meditation session with singing bowls being played in an undefined population. Bidin et al.³⁴ and Goldsby et al.¹⁷ also utilised other instruments along with the singing bowls, however singing bowls predominated. None of the studies involved participants playing the singing bowls themselves, instead they listened to the bowls, and in Bidin et al.'s³⁴ and Wepner et al.'s²⁹ studies the bowls were placed on specific points of the participants' bodies. Bidin et al.'s³⁴ intervention was carried out over three months (six sessions in total) and Wepner et al.'s²⁹ over four weeks (six sessions in total), while the other two studies only investigated single sessions (see Table 1 for details of the interventions).

A range of outcomes was investigated across the four studies. These outcomes included pain, tension, anger, confusion, distress, anxiety/depression, fatigue, quality of life, disability, positive affect, negative affect, sleep duration, blood pressure, heart rate, heart rate variability, respiratory rate, cutaneous conductance, peripheral capillary oxygen saturation, and electroencephalogram measures (see Table 1).

Study findings

The results of the subjective measures will be discussed first, followed by the objective measures. Singing bowl therapy resulted in a significant decrease in both positive and negative affect in Landry's³³ study, however this decrease was also evidence in the comparison group (silence followed by meditation), with no significant time x intervention interaction detected. Wepner et al.²⁹ found significant time x group interactions for current pain intensity and pain intensity on average over the past four weeks. The only significant change in subjective measures reported by Bidin et al.³⁴ was an increase in distress when measured using the Distress Thermometer, but not when using the Psychological Distress Inventory. Although Bidin et al.³⁴ reported no significant change in anxiety, depression and fatigue, Goldsby et al.¹⁷ reported significant improvements in each of these outcomes. In addition, Goldsby et al.¹⁷ reported a significant reduction in tension, anger, confusion and vigor, while it was unclear whether any change in pain was statistically significant. Bidin et al.³⁴ also found that the treatment did not result in an improvement in quality of life (see Table 1 for details). Goldsby et al.¹⁷ also stratified their analysis by age and naïvity with singing bowl therapies (i.e. no previous exposure) for anxiety, depression and tension (see Table 1 for the results).

Landry³³ and Bidin et al.³⁴ both investigated objective outcomes. Landry³³ reported that there were significant reductions in both systolic and diastolic blood pressure and heart rate from baseline to post-treatment, however these findings were also detected in the comparison group, and there was only a significant intervention x time interaction for the systolic blood pressure and heart rate. Bidin et al.³⁴ also reported significant reductions in resting heart rate, respiratory rate, tonic and phasic

cutaneous conductance and anterior-frontal alpha values from the electroencephalogram, and a significant increase in heart rate variability and peripheral capillary oxygen saturation. There were no significant differences in the objective measures in Wepner et al.'s²⁹ study.

Compliance was only applicable to Bidin et al.'s³⁴ study, which was of a longer duration. The overall reported compliance was 83%, with reasons for non-attendance reported as other appointments or a worsening of clinical conditions. Five participants in Landry's³³ cross-over study did not return for their second session (second intervention following the cross-over). No adverse events were reported, however only Landry³³ clearly reported that no adverse events had occurred.

Discussion

In the first systematic review to examine the effect of singing bowls on human health outcomes, we identified four studies, all of which reported some evidence of a beneficial impact on human health. Benefits were reported in terms of distress, positive and negative affect, anxiety, depression, fatigue, tension, anger, confusion and vigour, as were improvements in blood pressure, heart rate, respiratory rate, peripheral capillary oxygen saturation, cutaneous conductance, and anterior-frontal alpha values. These findings, as well as additional reports of health benefits in non-peer-reviewed resources or as abstracts only,^{29, 35-39} suggest that the use of singing bowls may have health benefits, however the evidence as it stands is insufficient to recommend their use. In the following sections we discuss the findings of this review in more detail, and provide recommendations for future research into the health effects of singing bowls.

Two of the included studies^{17, 34} used pre-post designs, which is one of the lowest levels of evidence,¹⁹ owing to the inherent biases in this design. Pre-post designs are, however, appropriate in proving preliminary evidence for the feasibility of the intervention and the study methods, as was appropriately specified as the purpose of Bidin et al.'s³⁴ study. Landry's³³ and Wepner et al.'s²⁹ studies used a higher level study design, a randomised cross-over design, however bias may have been

introduced primarily due to the lack of blinding. The nature of singing bowl therapies means that both the therapist and the participant will know which intervention is being applied, hence only single-blinding of the assessor can feasibly be achieved. While triple blinding cannot be achieved, the lack of blinding is still a source of potential bias that should be addressed in future studies.

All of the studies included subjective outcome measures. Each of these measures results in ordinal data, not continuous data, yet none of the included studies referred to Rasch analyses to confirm the utility of the measure, and to transform the measures to interval-level data. The implications of not using measures that have undergone Rasch analysis has been described by Grimby et al.,⁴⁰ and limits our confidence in the findings of each of these studies. Furthermore, the clinical significance of all outcome measures reported in the three included studies were not discussed. It is therefore recommended that future studies that investigate the effect of singing bowls on human health either use scales that have undergone Rasch analysis and use the transformed interval-level scores, or conduct such an analysis using their data (with appropriate discussion of the clinical significance of the findings). Undertaking these steps will enable clinicians, and public health practitioners, to make clinical decisions and recommendations for the use of singing bowls as additional interventions to reduce the disease burden.

It will also be important for future studies to ascertain which aspects of singing bowl therapies result in the health benefits. It has been suggested that the benefit of singing bowls is the vibrations they create, not the sound itself.³⁶ If however, the sound itself results in a health benefit, then recordings of singing bowls could be used, making singing bowl therapies more accessible. None of the included studies investigated the effect of singing bowl therapies where the participant/patient played the bowls themselves. It is possible that playing the bowls may have additional benefits over passive therapies; playing a singing bowl requires the player to focus so that a steady speed and pressure is achieved, which may provide additional benefits, particularly in terms of relaxation.

Our search was comprehensive by searching seven databases using only terms related to the intervention, and screening the citation and reference lists of included studies. Furthermore, not limits regarding the language or year of publication were applied. We therefore believe that all relevant studies were obtained. If any studies had been missed their inclusion is unlikely to have changed the conclusions of this review.

Conclusion

We identified promising evidence for the health benefits of singing bowl therapies, however as research in this area is in its infancy, we cannot at this point recommend it as a form of therapy. Studies should continue to investigate the health effects of singing bowl therapies to confirm the benefits and safety of such therapy, including robust study designs, appropriate outcome measures, and consideration of the clinical significance of any identified changes in outcomes. With an increased size and quality of the evidence base we may be able to recommend singing bowl therapies as cost-effective, low risk therapies to reduce the prevalence and impact of some of the health conditions that result in the greatest burden of disease, including mental illness.

Conflicts of interest

The authors declare that there is no conflict of interest.

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Table 1: Study characteristics

	Wepner et al.²⁹	Landry³³	Bidin et al.³⁴	Goldsby et al.¹⁷
Study year	Not reported (published 2008)	Not reported (published 2014)	2014-2015	Not reported (published 2017)
Study country	Germany	United States of America	Italy	United States of America
Study design (NHMRC level)	Randomised controlled trial (II)	Randomised cross-over (II)	Pre-post (IV)	Pre-post (IV), although authors stated it was an observational study
PEDro criteria met (score)^a	1, 2, 10, 11 Score: 3/10	2, 4, 8, 9, 10, 11 Score: 6/10	Not applicable	Not applicable
Setting	Not reported	Community-based counseling	Clinical: Oncology unit	Clinic
Population & sample	Adults aged 20-60 yr. with chronic (>3 months), non-specific spinal pain. Sample size n=54 63.0% female Mean age 47.06 ± 9.329 yr. (range 29-60 yr.)	‘Healthy’ adults (not defined) Sample size n=56 (51 included) 69% female Mean age 50.5 ± 10yr. (range 26-69 yr.)	Out-patients with metastatic cancer (Bidin et al. ³⁴) Sample size n=12 50% female Age not reported	Population unclear Sample size n=62 85% females Age 49.7 ± 13.0 yr. (range 21-77 yr.)
Intervention(s)	<u>Intervention group:</u> 6 x 30 min sessions across 4 weeks. Sessions had 20 min of singing bowl therapies. Quartz singing bowls were used, which played the notes A, F or G. Bowl was placed on the participant’s back, struck at a level the participant found comfortable. <u>Placebo group:</u> as for intervention group, however bowl not played <u>Control group:</u> no intervention	<u>Intervention group:</u> 12 min of B flat singing bowl exposure + 20 min listening to directed relaxation recording. Participant and investigator on couch with bowl adjacent. The Investigator rubbed rim 15 sec., trail off to silence, then struck softly every 15 sec. x 4. Sequence repeated for 12 min. <u>Comparison group:</u> 12 min of silence + 20 min listening to directed relaxation recording Second session 2 weeks later (cross-over)	“Metodo Bagno Armonico [®] ” approach (citing Pigaiani ⁴¹) Three bowls of diameter 14-16, 23-26, and 28-32cm All bowls had 6-8 harmonics Tibetan singing bowls mainly, + some Feng Gong, wind chimes, and Tingsha Patients on massage bed or a tatami mat Bowls placed on specific point of the patient’s body No verbal relaxation instruction 6 individual, 1 hour treatments over three months. Frequency of intervention [interpreted as] once a week.	Group session Lying on yoga mats +/- pillow/blanket in half-circle, heads with at least 2 Tibetan singing bowls nearby, mainly Jambati (9-12 inches) ^b 30-80 Tibetan singing bowls mainly, + occasional crystal singing bowls, dorges (bells), Ting-shas (tiny cymbals), gongs, small bells, didgeridoos General sequence tingshas, Tibetan bowls, bells, crystal bowls, gongs, Tibetan bowls, played by musicians during meditation Participants asked to observe any sensations during meditation and to gently become aware of surroundings at end of ≅ 60 min session.

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	Wepner et al.²⁹	Landry³³	Bidin et al.³⁴	Goldsby et al.¹⁷
Outcomes & outcome measures	<p><u>Subjective measures</u> Current pain and average pain during last 4 weeks: visual analogue scale from 0 'no pain' to 100 'greatest pain imaginable'⁴²</p> <p>Disability: Roland-Morris Disability Questionnaire⁴³⁻⁴⁵</p> <p>Quality of life: Short Form 36⁴⁶</p> <p><u>Objective measures</u> Heart rate variability Sleep duration (measured using electrocardiogram)</p>	<p><u>Subjective measures</u> Positive and negative affect; schedule (citing Watson et al.⁴⁷)</p> <p><u>Objective measures</u> Blood pressure: Omron HEM-747-IC Heart rate: Omron HEM-747-IC 3 measurements at each time point, mean used for analysis. Details (position, rest time) not reported</p>	<p><u>Subjective measures⁵</u> Distress Thermom. (Jacobsen et al., 2005; Roth et al., 1998) & Psych. Distress Inventory (Morasso et al., 1996); Hospital Anxiety & Depression Scale (Zigmond & Snaith, 1983); Functional Assessment of Chronic Illness Fatigue Subscale (Yellen et al. 1997); Quality of Life: Short Form-36 vitality scale (no ref.)</p> <p><u>Objective measures</u> Cutaneous conductance (in microsiemens): Mind Lab Set used, sitting eyes open, 3 min pre & post^e Resting heart rate (beats/min): Tinké (bluetooth for Android), sitting eyes open, 1 min pre & post Peripheral capillary oxygen saturation (%): Tinké (bluetooth for Android), sitting eyes open, 1 min pre & post Breath rhythm (breaths/min): Tinké (bluetooth for Android), sitting eyes open, 1 min pre & 1 min post Heart rate variability (score of cardiac coherence reached during session): EmWave pro, sitting eyes open, 1.30 min pre & 1.30 min post Electroencephalogram (as a measure of 'mindfulness' /state of thoughtful awareness), phasic skin conductance (in microvolts; AF3, AF4, F7, F8): Emotiv Epop with Tech Bench for raw data and Emotiv 14 for analysis. Sitting eyes open 2 min pre & 2 min post. Citing ⁴⁸⁻⁶¹ collectively for the objective measures</p>	<p><u>Subjective measures</u> Short Form of the Profile of Mood States (Tension, anger, confusion, fatigue; citing Shacham⁶²); Hospital Anxiety and Depression Scale (citing Snaith⁶³); Pain type and location (questions and timing not reported); Pain level (rating on a scale from 1 "very slight discomfort" to 5 "extremely painful" (e.g. at its worst); Pain or sleep during the intervention</p> <p><u>Objective measures</u> None</p>
Timing of data collection	<p><u>Subjective measures</u> Day before first treatment session, and a week after final session</p> <p><u>Objective measures</u> At sessions 1 and 4</p>	<p><u>Subjective measures</u> Before and after directed relaxation</p> <p><u>Objective measures</u> Baseline blood pressure and heart rate collected before and after each session, and after the directed relaxation.</p>	<p><u>Subjective measures</u> Before the first and last sessions</p> <p><u>Objective measures</u> Before and after each session</p>	Before and after the intervention
Compliance	Not reported	5 did not return for second session (excluded from analysis)	Overall compliance 83% (83% attended at least 4 sessions, 50% attended all 6). Reasons of non-attendance: other appointments (n=4), worsening of clinical conditions (n=2)	Not applicable – only one session

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	Wepner et al.²⁹	Landry³³	Bidin et al.³⁴	Goldsby et al.¹⁷
Statistical methods used	Repeated measures analysis of variance 5% level of significance	Paired t-tests, two-way repeated measures analysis of variance, analysis of covariance Adjusted for age, sex and baseline values Fischer's least significant difference test for post hoc adjustment for multiple comparisons Compared: first measure (after singing bowl or silence) with baseline; second measure (after directed relaxation) with baseline; the change from baseline to first measure; the change from baseline to second measure 5% level of significance	Student t-test, two way for paired data (95% confidence interval) Wilcoxon signed rank test for non-normally distributed data 5% level of significance	2-way (group x time) repeated-measures analysis of variance Level of significance not reported. Assumed 5%. Stratified analyses (by age and whether bowl naïve or experienced) were only conducted for tension, anxiety and depression

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	Wepner et al. ²⁹	Landry ³³	Bidin et al. ³⁴	Goldsby et al. ¹⁷
Findings (only significant findings are reported)	<p><u>Subjective outcomes</u></p> <p>Significant time x group interactions for current pain (singing bowl group 59.82 v 43.72, placebo group 64.44 v 48.61, control group 43.67 v 55.72)</p> <p>Significant time x group interactions for pain over the last 4 weeks (singing bowl group 41.59 v 42.28, placebo group 60.28 v 47.50, control group 40.50 v 52.39)</p> <p>The authors did not report whether adverse events were reported or not.</p>	<p><u>Subjective outcomes</u></p> <p>Significant decrease in positive and negative affect from baseline to second measurement in both groups (singing bowl group 34.0 vs 30.5, control group 34.0 vs 31.2)</p> <p><u>Objective outcomes</u></p> <p>Significant decreases in systolic blood pressure from baseline to first measurement for singing bowl intervention (132.2 vs 124.2 mm Hg) and control group (133.9 vs 125.9 mm Hg), and from baseline to second measurement for singing bowl intervention (132.2 vs 122.5 mm Hg) and control group (133.9 vs 127.1 mm Hg). Significant intervention x time interaction for change from baseline to second measurement.</p> <p>Significant decreases in diastolic blood pressure from baseline to first measurement for singing bowl intervention (81.2 vs 78.6 mm Hg) and control group (83.5 vs 80.7 mm Hg), and from baseline to second measurement for singing bowl intervention (81.2 vs 79.2 mm Hg) and control group (83.5 vs 83.2 mm Hg).</p> <p>Significant decreases in heart rate from baseline to first measurement for singing bowl intervention (75.0 vs 71.4 beats/min) and the control group (72.8 vs 69.5 beats/min), and from baseline to second measurement for singing bowl intervention (75.0 vs 68.7 beats/min) and control group (72.8 vs 69.5 beats/min). There was also a significant intervention x time interaction for second measurement and the change from baseline to second measurement.</p> <p>The authors did not report whether adverse events were reported or not.</p>	<p><u>Subjective outcomes</u></p> <p>No significant change for distress when measured with Psychological Distress Inventory, but Significant change for Distress Thermometer scores (2.4 vs 5.3, p<0.001)</p> <p><u>Objective outcomes</u></p> <p>Significant decrease in tonic and phasic cutaneous conductance (3.03 v 1.64, p=0.009, and 0.87 vs 0.53, p=0.006, respectively), and resting heart rate (83.2 vs 75.7, p<0.001). Significant decrease in breath rate (14.4 vs 13.9), however p=0.063 [Not actually significant]. Significant increase in peripheral capillary oxygen saturation (96.7 vs 98, p<0.001).^d Significant increase in heart rate variability (19.7 vs 22.2, p=0.004).</p> <p><i>Note:</i> for the above objective measures it is unclear which time points were compared (e.g. before vs after a session, first vs last session).</p> <p>Reported a significant decrease in heart rate variability comparing pre-tests of the first and last sessions (7 vs 6, p=0.05), and for post-tests of the first and last sessions (11 vs 9, p=0.21), although p-values indicate no significant difference.</p> <p>Significant decrease in anterior-frontal alpha values from the electroencephalogram (85.5 v 75.9, p=0.046).</p> <p><i>Note:</i> for the above electroencephalogram measures it is unclear which time points were compared (e.g. before vs after a session, first vs last session).</p> <p>No adverse events were reported.</p>	<p>Significant changes in tension overall (1.26 vs 0.14, p<0.001), and for bowl naïve (1.61 vs 0.32, p<0.001) and bowl experienced participants (1.01 vs 0.15, p<0.001), and for those aged 20-39 years (1.56 vs 0.21, p<0.001), 40-59 years (1.29 vs 0.20, p<0.001), and 60-79 years (0.88 vs 0.26, p=0.038).</p> <p>Significant changes in anger overall (0.85 vs 0.05, p<0.001).</p> <p>Significant changes in confusion overall (1.01 vs 0.30, p<0.001).</p> <p>Significant changes in fatigue overall (1.65 vs 0.42, p<0.001).</p> <p>Significant changes in vigor overall (1.97 vs 1.48, p=0.002).</p> <p>Significant changes in anxiety overall (1.11 vs 0.44, <0.001), and for bowl naïve (1.30 vs 0.41, p<0.001) and bowl experienced participants (0.89 vs 0.47, p<0.001), and for those aged 20-39 years (1.43 vs 0.67, p<0.001), 40-59 years (1.03 vs 0.27, p<0.001), and 60-79 years (0.74 vs 0.29, p=0.019).</p> <p>Significant changes in depression overall (0.62 vs 0.42, p=0.002), and for bowl naïve (0.80 vs 0.41, p=0.003), and for those aged 40-59 years (0.66 vs 0.38, p=0.12).</p> <p>It is unclear whether the pain changes were significant.</p> <p>The authors did not report whether adverse events were reported or not.</p>

Notes:^aItem 1 is not included in the score. ^bIt is unclear what the measurements for the bowl size in Goldsby et al.'s¹⁷ study refer to (e.g. diameter). ^cThe references for Bidin et al.'s³⁴ subjective outcome measures were only reported in text, not in the reference list; hence we were unable to cite these references in the reference list of our review. ^dThe difference in the number of significant figures/ decimal places matches what was reported by Bidin et al.'s.³⁴ ^eit is unclear what the timings refer to (e.g. the duration of sitting or the time at which the measures were taken).

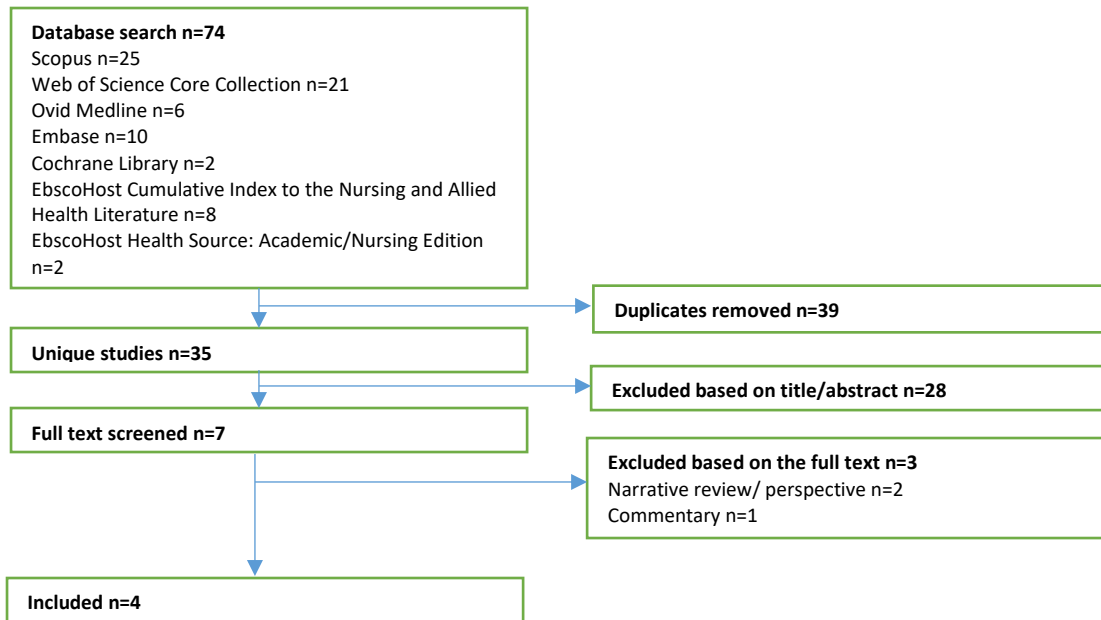


Figure 1: Flow chart of study inclusion/ exclusion