Breathing exercises for dysfunctional breathing/hyperventilation syndrome in adults (Review)

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[Intervention Review]

Breathing exercises for dysfunctional breathing/hyperventilation syndrome in adults

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ABSTRACT

Background

Dysfunctional breathing/hyperventilation syndrome (DB/HVS) is a respiratory disorder, psychologically or physiologically based, involving breathing too deeply and/or too rapidly (hyperventilation) or erratic breathing interspersed with breath-holding or sighing (DB). DB/HVS can result in significant patient morbidity and an array of symptoms including breathlessness, chest tightness, dizziness, tremor and paraesthesia. DB/HVS has an estimated prevalence of 9.5% in the general adult population, however, there is little consensus regarding the most effective management of this patient group.

Objectives

1) To determine whether breathing exercises in patients with DB/HVS have beneficial effects as measured by quality of life indices

2) To determine whether there are any adverse effects of breathing exercises in patients with DB/HVS

Search methods

We identified trials for consideration using both electronic and manual search strategies. We searched CENTRAL, MEDLINE, EMBASE, and four other databases. The latest search was in February 2013.

Selection criteria

We planned to include randomised, quasi-randomised or cluster randomised controlled trials (RCTs) in which breathing exercises, or a combined intervention including breathing exercises as a key component, were compared with either no treatment or another therapy that did not include breathing exercises in patients with DB/HVS. Observational studies, case studies and studies utilising a cross-over design were not eligible for inclusion.

We considered any type of breathing exercise for inclusion in this review, such as breathing control, diaphragmatic breathing, yoga breathing, Buteyko breathing, biofeedback-guided breathing modification, yawn/sigh suppression. Programs where exercises were either supervised or unsupervised were eligible as were relaxation techniques and acute-episode management, as long as it was clear that breathing exercises were a key component of the intervention.

We excluded any intervention without breathing exercises or where breathing exercises were not key to the intervention.

Data collection and analysis

Two review authors independently checked search results for eligible studies, assessed all studies that appeared to meet the selection criteria and extracted data. We used standard procedures recommended by The Cochrane Collaboration.

Main results

We included a single RCT assessed at unclear risk of bias, which compared relaxation therapy (n = 15) versus relaxation therapy and breathing exercises (n = 15) and a no therapy control group (n = 15).

Quality of life was not an outcome measure in this RCT, and no numerical data or statistical analysis were presented in this paper. A significant reduction in the frequency and severity of hyperventilation attacks in the breathing exercise group compared with the control group was reported. In addition, a significant difference in frequency and severity of hyperventilation attacks between the breathing and relaxation group was reported. However, no information could be extracted from the paper regarding the size of the treatment effects.

Authors' conclusions

The results of this systematic review are unable to inform clinical practice, based on the inclusion of only one small, poorly reported RCT. There is no credible evidence regarding the effectiveness of breathing exercises for the clinical symptoms of DB/HVS. It is currently unknown whether these interventions offer any added value in this patient group or whether specific types of breathing exercise demonstrate superiority over others. Given that breathing exercises are frequently used to treat DB/HVS, there is an urgent need for further well designed clinical trials in this area. Future trials should conform to the CONSORT statement for standards of reporting and use appropriate, validated outcome measures. Trial reports should also ensure full disclosure of data for all important clinical outcomes.

PLAIN LANGUAGE SUMMARY

Breathing exercises for dysfunctional breathing/hyperventilation syndrome

Background

Dysfunctional breathing/hyperventilation syndrome (DB/HVS) is a breathing problem that involves breathing too deeply and/or too rapidly (hyperventilation). There are many possible causes of DB/HVS and if left untreated it can lead to a variety of unpleasant symptoms such as breathlessness, dizziness, pins and needles and chest pain.

Review question

The aim of this review was to investigate whether breathing exercises are useful in the treatment of dysfunctional breathing/hyperventilation syndrome. The overall aim of all breathing exercises is to teach the patient to breathe gently using the lower part of their chest, at a rate that matches their activity level.

Key results

Only one study met the criteria for inclusion in this review, in which participants also received relaxation therapy. This study had a small number of participants and provided very little detail as to how it was undertaken. Although the trial report suggested that breathing exercises may be beneficial in the treatment of this particular patient group no numerical data were presented so we could not be sure. No reliable conclusions can be drawn from this small, isolated study.

This Cochrane plain language summary is up to date as of February 2013.

SUMMARY OF FINDINGS FOR THE MAIN COMPARISON *[Explanation]*

Breathing exercises compared with no intervention for dysfunctional breathing/hyperventilation syndrome

Patient or population: Participants with primary dysfunctional breathing/hyperventilation syndrome
Settings: Out patient setting
Intervention: Breathing exercises plus relaxation therapy
Comparison: Relaxation therapy alone

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk [control]	Corresponding risk [experimental]				
Quality of life	See comment	See comment	See comment	See comment	See comment	Not reported
Symptoms (approx 4 weeks follow-up)	See comment	See comment	See comment	41 (1 study)	⊕◯◯◯ **very low**[1,2]	The symptoms experienced by participants within each intervention group reduced but were described as non-significant

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: Confidence interval; **RR:** Risk Ratio; [other abbreviations, e.g. OR, etc]

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

1. (-1 limitations) The study was poorly reported so we were not able to determine its methodological quality
2. (-2 imprecision) There was only one very small study and data was not reported in a manner fit for meta-analysis

BACKGROUND

Description of the condition

Dysfunctional breathing/hyperventilation syndrome (DB/HVS) is a respiratory disorder, psychologically or physiologically based, involving breathing too deeply and/or too rapidly (hyperventilation) (Brashear 1983), or erratic breathing interspersed with breath-holding or sighing (DB) (Morgan 2002). Hyperventilation is defined as a state of alveolar ventilation in excess of metabolic requirements, leading to a decreased arterial partial pressure of carbon dioxide ($PaCO_2$) (Malmberg 2000) and respiratory alkalosis. If sustained, these physiological changes may result in a wide range of clinical symptoms which characterise DB/HVS (Hornsveld 1997). In many patients, DB/HVS is not a continuously symptomatic state but a syndrome of episodic symptoms which occur with or without recognisable provocation (Magarian 1982). However, where chronic hyperventilation ensues, it is suggested that the central respiratory control centres become more sensitive and trigger breathing at a lower level of $PaCO_2$, perpetuating a hypocapnic state (low $PaCO_2$) (Magarian 1982). Not all patients with DB/HVS present with hyperventilation and hypocapnia. As such, the term dysfunctional breathing encompasses a complex set of behaviour and symptoms with no obvious physiological explanation (Morgan 2002). Either way, DB/HVS can result in significant patient morbidity and an array of symptoms including breathlessness, chest tightness, dizziness, tremor and paraesthesia (Bott 2009). The presence of these symptoms can themselves result in anxiety, which can provoke further breathing irregularity.
DB/HVS has an estimated prevalence of 9.5% in the general adult population (Thomas 2005). However, as the mechanisms underpinning DB/HVS are poorly understood, the diagnosis of DB/HVS often occurs late with the patient having undergone a myriad of extensive negative investigations under various medical specialities (Gardner 2004). As the predominant symptoms are often unexplained breathlessness and 'air hunger' (50% to 90% of individuals with DB/HVS; Brashear 1983), these patients often present to the respiratory physician. However, the diversity of the clinical signs and symptoms make diagnosis extremely difficult. Because of these difficulties, there is a concern that diagnosed cases merely represent the tip of a 'clinical iceberg' with many patients' symptoms going unrecognised and consequently untreated. Furthermore, in cases where DB/HVS is suspected, there is little consensus regarding assessment and diagnostic criteria, or indeed validated management strategies/therapeutic interventions.

Description of the intervention

Whilst other treatment techniques including pharmacological interventions and education have also been advocated, breathing exercises are recommended as a first-line treatment for DB/HVS (Bott 2009). The overall aim of all breathing exercises is to reduce respiratory frequency and depth of breathing (tidal volume) to match alveolar ventilation to metabolic demand (Bott 2009). Breathing exercises include several different approaches. Most commonly, patients are taught breathing control (relaxed diaphragmatic breathing using the lower part of the chest) in either side lying, supine or sitting, with or without the use of visual and proprioceptive feedback. The Buteyko breathing technique also focuses on reducing the depth and frequency of respiration, and uses breath-holding exercises to measure the impact and progress of this training (Bowler 1998). In some Buteyko regimens, patients also tape their mouths closed at night to prevent mouth breathing (Cooper 2003). Yoga breathing exercises involve mental concentration to produce a reduction in breathing frequency, a normalised inspiratory:expiratory ratio with an end-inspiratory and end-expiratory pause (Cooper 2003).These techniques may be consolidated by an individualised home programme tailored for each individual patient's needs (Innocenti 2008).

How the intervention might work

Breathing exercises encourage patients to gradually alter their breathing pattern, with the ultimate goal to restore and maintain a normal breathing pattern and to re-programme the respiratory centre to trigger inspiration at a higher level of carbon dioxide (Innocenti 2008; Bott 2009).

Why it is important to do this review

We are aware of no systematic reviews which have specifically evaluated the effectiveness of breathing exercises on the clinical symptoms of DB/HVS in the absence of cardiorespiratory disease. Given that breathing exercises are frequently used to treat this condition, there is a need to rigorously appraise the existing evidence regarding the efficacy of these treatments.

OBJECTIVES

1. To determine whether breathing exercises in patients with DB/HVS have beneficial effects as measured by quality of life indices.

2. To determine whether there are any adverse effects of breathing exercises in patients with DB/HVS.

METHODS

Criteria for considering studies for this review

Types of studies

We planned to include randomised, quasi-randomised or cluster-randomised controlled trials in which breathing exercises, or a combined intervention including breathing exercises as a key component were compared with either no treatment or another therapy that did not include breathing exercises in patients with DB/HVS. Observational studies, case studies and studies utilising a cross-over design were not eligible for inclusion.

Types of participants

Adults (over 18 years old, but with no upper age limit) with a clinical diagnosis of DB/HVS in-line with the study author's own definition. Studies involving participants with symptoms of DB/HVS secondary to identifiable respiratory, cardiac or metabolic disease were not eligible for inclusion.

Types of interventions

We considered any type of breathing exercise for inclusion in this review, such as breathing control, diaphragmatic breathing, yoga breathing, Buteyko breathing, biofeedback-guided breathing modification, yawn/sigh suppression. Programs where exercises were either supervised or unsupervised were eligible as were relaxation techniques and acute-episode management, as long as it was clear that breathing exercises were a key component of the intervention.

We excluded any intervention without breathing exercises or where breathing exercises were not key to the intervention.

We planned to include trials with the following comparisons.

1. Breathing exercises versus no intervention.
2. Breathing exercises versus another intervention.
3. Breathing exercises in addition to a control intervention versus the control intervention alone.

Types of outcome measures

Primary outcomes

Quality of life (QOL) measured by any respiratory disease specific or generic instrument.

Secondary outcomes

Secondary outcomes included the Nijmegen questionnaire, which is a validated screening tool for the detection of DB/HVS. The scale provides a score between zero and 64 with higher scores indicating more severe hyperventilation symptoms (van Dixhoorn 1985). Secondary outcomes that were also extracted where available included: ventilation (measured by minute volume, tidal volume, respiratory frequency, end tidal CO_2 or transcutaneous CO_2), functional exercise capacity (e.g. measured by shuttle walking test, six-minute walk. All exercise capacity tools were considered), and DB/HVS specific tests (e.g. breath-hold test or hyperventilation provocation test (HVPT)).

Search methods for identification of studies

We identified trials for consideration using both electronic and manual search strategies. For the OVID MEDLINE search, the subject search was run with the Cochrane Highly Sensitive Search Strategy (CHSSS) for identifying randomised trials in MEDLINE: sensitivity maximising version (2008 revision) as referenced in Chapter six and detailed in box 6.4c of the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2008). The search strategy and filter for MEDLINE is presented in Appendix 1 and included a combination of controlled vocabulary (MeSH) and free text terms. All searches were based on this strategy but were appropriately revised to suit each database (see Appendix 2; Appendix 3; Appendix 4; Appendix 5; Appendix 6; Appendix 7).

Electronic searches

To identify studies for inclusion in this review the following electronic databases were searched.

- OVID MEDLINE (1948 to Feb week 2 2013)
- OVID EMBASE (1980 to week 08 2013)
- CENTRAL (2013, Issue 1)
- AMED (all years to Feb 2013)
- Psychinfo (1806 to Feb week 3 2013)
- CINAHL (1981 to Feb 2013)
- LILACS (all years to Feb 2013)

Searching other resources

Reference lists of all eligible primary trials, key textbooks, narrative and systematic reviews were searched to identify additional relevant articles. Abstracts from scientific meetings and respiratory journals were also handsearched.

Unpublished data

The National Research Register (NRR) Archive, Health Services Research Projects in Progress (HSRProj), Current Controlled Trials register (incorporating the meta-register of controlled trials and the International Standard Randomised Controlled Trial Number (ISRCTN)) were searched to identify research in progress and unpublished research.

We attempted to identify all relevant studies irrespective of language. Non-English papers were assessed and where necessary, were translated with the assistance of a native speaker. We sent a final list of included articles to two experts in the field of DB/HVS and requested that they reviewed the list for possible omissions.

Data collection and analysis

Selection of studies

Two review authors (MOJ, AH) independently checked search results for eligible studies. Initially, two of us screened the titles, abstracts or both of identified studies. Where it was clear from the study title or abstract that the study was not relevant or did not meet the selection criteria, it was excluded. Where unclear, the full paper was retrieved and assessed, as were all studies that appeared to meet the selection criteria. We resolved disagreements between review authors through discussion and consensus. Where resolution was not achieved, the papers in question were considered by a third review author (NOC). A full record of decisions and their rationale was kept.

Data extraction and management

Two review authors (MOJ, AH) extracted data independently using a standardised form. Discrepancies were resolved by consensus. Where agreement could not be reached a third review author (NOC) considered the paper.

The form included the following items.

- Risk of bias assessment results.
- Country of origin.
- Study design.
- Study population (age; gender; prior management; comorbidities).
- Sample size (intervention and control groups).
- Intervention (breathing exercise type/approach).
- Outcomes (QOL indices, Nijmegen, measures of ventilation, exercise capacity and DB/HVS specific tests (measured by breath-hold test or hyperventilation provocation test (HVPT)).
- Results (short-term, intermediate- and long-term follow-up for each outcome).
- Adverse effects (nature and frequency).

Assessment of risk of bias in included studies

Risk of bias was assessed using the Cochrane 'Risk of bias' assessment tool outlined in Chapter 8 of the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2008). We planned to give studies an overall rating of high, low or unclear risk of bias based on the Cochrane criteria. Specifically, if a study was judged as being at high risk of bias on one or more criteria then that study would achieve an overall assessment of high risk of bias. Where a study was judged as having unclear risk of bias on one or more criteria then that study would achieve an overall assessment of unclear risk of bias.

We used the following criteria to assess the included study (using yes/no/unclear judgments).

- Adequate sequence generation?
- Adequate allocation concealment?
- Adequate blinding of assessors?
- Incomplete outcome data adequately assessed?
- Free of suggestion of selective outcome reporting?
- Free of other bias?

Since it is not possible to blind therapists or clinicians in studies of this kind of intervention these criteria were not assessed but the potential impact of incomplete blinding is reflected in the discussion of the results. Two review authors (MOJ, AH) independently checked risk of bias. Disagreement between review authors was resolved through discussion. Where resolution was not achieved, the article was considered by a third review author (NOC). As the quality of the included study was unclear, we attempted to contact the authors for clarification.

Measures of treatment effect

For continuous variables, we planned to enter the mean (and standard deviation) post-intervention difference between groups into the meta-analysis. Where this data were unavailable from authors, we planned to record the mean (and standard deviation) change from baseline for each group. For continuous outcomes, we planned to enter mean difference as the measure of effect size where different studies utilised a common outcome measure. Where a variety of measures were employed across studies, we planned to use the standardised mean difference to pool results. For dichotomous outcome measures, we planned to use the risk ratio.

Unit of analysis issues

In addition to short-term (at completion of the intervention) results, we planned to report data at mid-term follow-up (six months post intervention) and long-term (one year post-intervention) follow-up where reported. Where studies recorded multiple measures, data taken at the time point closest to these thresholds would be used.

Dealing with missing data

Where insufficient data were presented to enter a study into the meta-analysis, we planned to contact study authors to request access to the missing data.

Assessment of heterogeneity

We planned to assess heterogeneity and its impact using the Chi^2 test and the I^2 test.

Assessment of reporting biases

We planned to explore possible publication bias/small study effects using funnel plots and statistically assessed with Egger's test.

Data synthesis

Where adequate data existed, we planned to pool results using Review Manager 5 using a random-effects model.

Where inadequate data were found to support statistical pooling, we planned to report a narrative synthesis of the evidence using the GRADE system (Guyatt 2008).

Subgroup analysis and investigation of heterogeneity

Where there was evidence of heterogeneity, we planned to explore subgroup analysis. Where adequate data allowed, we planned to perform the following preplanned subgroup analyses:

1. type of breathing exercise intervention (subgroups: yoga-based versus conventional breathing control versus Buteyko breathing);
2. amount of treatment provided (multiple treatment versus single treatment studies).

Sensitivity analysis

When sufficient data were available, we planned to conduct sensitivity analyses on the basis of risk of bias, specifically the effect of excluding studies at high risk of bias.

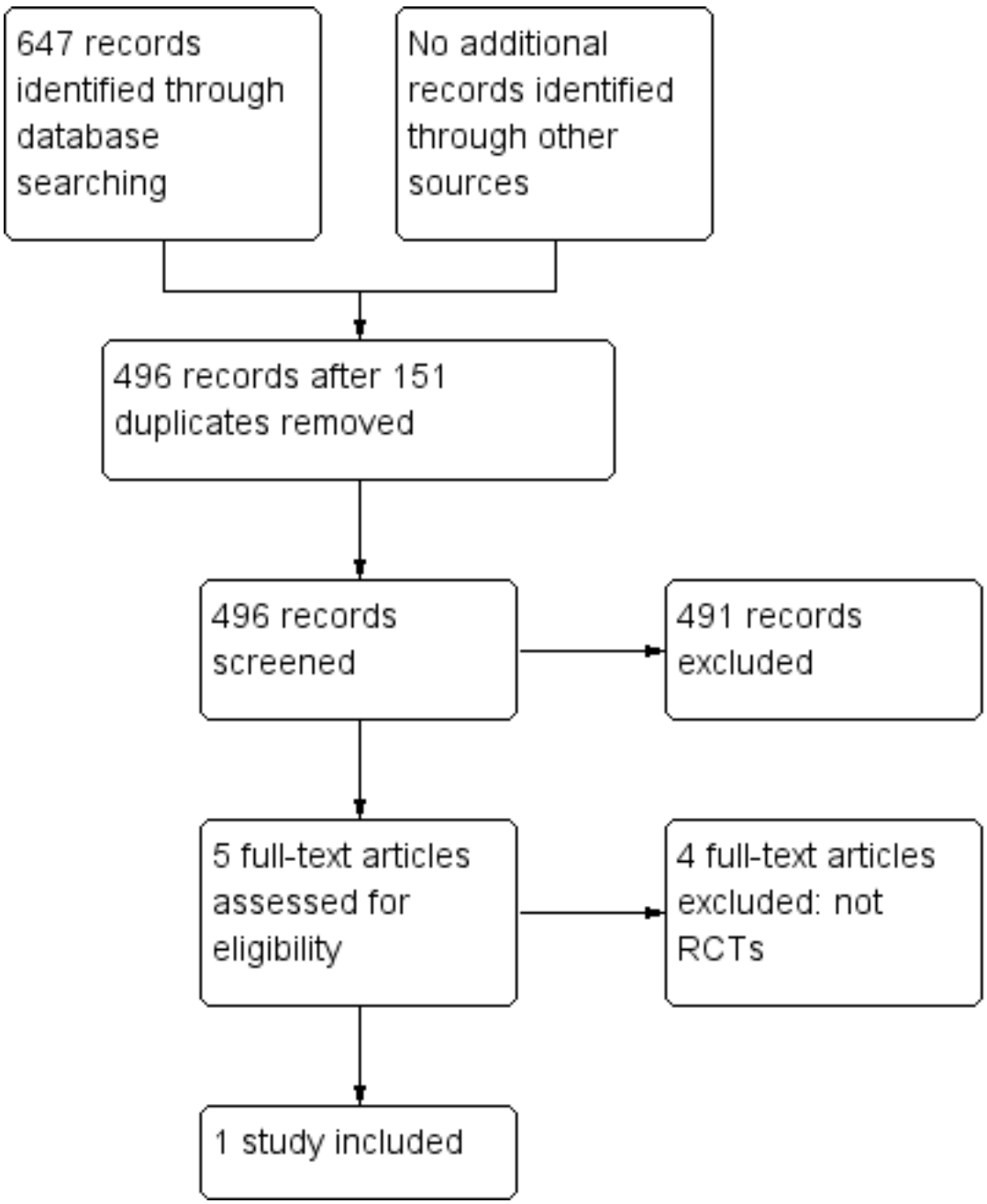
RESULTS

Description of studies

Results of the search

Electronic and manual searches were undertaken through March 2011; these identified 554 potential trials and reviews, which included 126 duplicate papers. Based on title and abstract screening, review author MOJ identified six trials; two for immediate inclusion and four that were unclear and required discussion. Review author AH identified 12 trials for which inclusion was unclear and required discussion. Following discussion between the two review authors (MOJ, AH), nine trials were considered to be not relevant from the review as they did not meet the inclusion criteria. Five full text papers were retrieved and evaluated for inclusion in the review. Four of these full text papers did not meet the inclusion criteria (Weimann 1970; Beumer 1971; Van Doorn 1982; Monday 1995) as they were not randomised controlled trials (RCTs). Monday 1995 was excluded on this basis following further discussion with the third review author (NOC). A repeat search undertaken on 19th April 2012 identified an additional 48 titles (29 after removing duplicates), but none met the inclusion criteria for our review. A second update search undertaken on the 26 February 2013 returned 45 references (39 after removing duplicates), none of which met the inclusion criteria. Therefore, this review is based on a single RCT (Lindeboom 1980). Figure 1 shows a flow chart of the search screening process.

Figure 1. Study flow diagram.



Included studies

The Dutch RCT (Lindeboom 1980) studied 45 participants with hyperventilation syndrome. The study had two intervention groups; relaxation therapy (n = 15) versus relaxation therapy and breathing exercises (n = 15), The control group (n = 15) received no therapy. Participants in both intervention groups underwent an assessment, followed by eight one-hour training sessions twice weekly. The relaxation therapy was a variation of the Jacobson method (Jacobson 1938) plus attention to body posture based on yoga principles. The Jacobson method is a progressive muscle relaxation technique used to reduce anxiety by alternately tensing (10 seconds) and relaxing (20 seconds) muscle groups in upper and lower limbs, the trunk and face. Breathing exercises focused on reducing respiratory frequency and diaphragmatic breathing. All groups received additional written information. The breathing exercises and relaxation therapy was led by a physiotherapist. In addition, participants received one introductory and one debrief talk lasting a minimum of 1.5 hours from a psychologist. The study's primary outcome measures were 1) the number and intensity of hyperventilation attacks and 2) the symptoms experienced, although it was not specified how these were measured. In addition, muscle tone/tension was measured using EMG apparatus. It was not stated which specific muscles were measured. Outcomes were measured at baseline and on completion of the 10 treatment sessions. In addition, a follow-up survey was conducted after one year (65% response rate) but no details of the survey content or data collection were provided. Review authors MOJ and AH attempted to contact the authors for clarification of methods and results but did not receive a response. The incidence of participant drop-out was not disclosed or discussed in this paper.

Excluded studies

Four full text papers were retrieved, evaluated and subsequently excluded from this review. Beumer 1971 was a narrative editorial and Weimann 1970 was an observational study. Monday 1995 was a RCT with 18 participants randomised to three groups; Group 1 (control), Group 2 (breathing retraining sessions) and Group 3 (breathing exercise sessions plus progressive relaxation techniques) (Characteristics of excluded studies). However, the control group received verbal education on breathing techniques and therefore could not be classed as a no-breathing exercises control group. Van Doorn 1982 randomised 20 participants with chronic hyperventilation syndrome between two intervention groups; Group 1 (biofeedback training) and Group 2 (breathing exercises). However, no control group was used in this study.

Risk of bias in included studies

The included study was judged as being at unclear risk of bias across all criteria, principally due to insufficient methodological reporting.

Allocation

Unclear risk of bias due to insufficient methodological reporting.

Blinding

Unclear risk of bias due to insufficient methodological reporting.

Incomplete outcome data

Unclear risk of bias due to insufficient methodological reporting.

Selective reporting

Unclear risk of bias due to insufficient methodological reporting.

Other potential sources of bias

Unclear risk of bias due to insufficient methodological reporting.

Effects of interventions

See: **Summary of findings for the main comparison**

No numerical data or statistical analysis were presented in this paper. The results describe a significant reduction in frequency and severity of hyperventilation attacks in the breathing exercise group compared with the control group, which demonstrated an increase in the frequency and severity of attacks. In addition, a significant difference in frequency and severity of hyperventilation attacks between the breathing and relaxation group was reported. No information could be extracted from the paper regarding the size of the treatment effect or the threshold applied for establishing statistical significance across any comparisons.

The symptoms experienced by participants within each intervention group reduced but were described as non-significant.

There was no effect on muscle tone/tension in either intervention group compared with the control group. It was not stated which specific muscles were measured by EMG.

The occurrence of adverse events was not reported in this trial.

DISCUSSION

Summary of main results

Only one RCT met the inclusion criteria for this review. Lindeboom 1980 compared relaxation therapy to relaxation therapy and breathing exercises and to a control group who received no therapy. While the authors of this study report a statistically significant effect of breathing exercises, the absence of numerical data on any of the outcomes impedes interpretation of these results

Overall completeness and applicability of evidence

We used a systematic search strategy in an attempt to identify both published and unpublished studies and consulted experts in the field. As such we minimised the risk that we may have missed any trials that met our inclusion criteria.The applicability of the results of this review are limited, as we only reviewed one small RCT (Lindeboom 1980) that was judged to be at unclear risk of bias.

Quality of the evidence

The included RCT (Lindeboom 1980) contained insufficient methodological detail for all key domains in the risk of bias assessment. Participant numbers were small, no numerical data were presented and the description of results was incomplete. Given the multiple potential sources of bias and the lack of information we would conclude that this trial does not provide credible evidence either for or against the effectiveness of breathing exercises.

Potential biases in the review process

Given the paucity of data we were unable to implement much of the proposed approach to data synthesis and analysis. As such our methodological choices have had little influence on the conclusions of this study.

Agreements and disagreements with other studies or reviews

To the authors' knowledge there are no other systematic or narrative reviews evaluating the effectiveness of breathing exercises on the clinical symptoms of DB/HVS, with which to compare our findings.

AUTHORS' CONCLUSIONS

Implications for practice

The results of this systematic review are unable to inform clinical practice, based on the inclusion of only 1 small poorly reported RCT Lindeboom 1980. We found no credible evidence regarding the effectiveness of breathing exercises for the clinical symptoms of DB/HVS .Therefore, no recommendations for clinical practice can be made.

Implications for research

It is currently unknown whether these interventions offer any added value in this patient group or whether specific types of breathing exercise demonstrate superiority over others. Given that breathing exercises are frequently used to treat DB/HVS, there is an urgent need for further well designed clinical trials in this area. Future trials should conform to the CONSORT statement for standards of reporting and use appropriate, validated outcome measures. Trial reports should also ensure full disclosure of data for all important clinical outcomes.

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* *Indicates the major publication for the study*

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Lindeboom 1980

Methods	Randomised controlled trial
Participants	Hyperventilation syndrome (n = 45). Co-morbidities not reported Inclusion/exclusion criteria, age and gender split not reported
Interventions	Breathing exercises plus relaxation therapy (n = 15) versus relaxation therapy alone (n = 15) compared with a control group (n = 15) Participants in both intervention groups underwent an assessment, followed by 8 x 1 hour training sessions twice weekly The breathing exercises and relaxation therapy was led by a physiotherapist. In addition, participants received one introductory and one debrief talk lasting a minimum of 1.5 hours from a psychologist Breathing exercises focused on reducing respiratory frequency and diaphragmatic breathing Relaxation therapy was a variation of the Jacobson method plus attention to body posture based on yoga principles All groups received additional written information. Further details of the interventions were not reported.
Outcomes	Primary outcome measures were 1) the number and intensity of hyperventilation attacks and 2) the symptoms experienced. It was not specified how these were measured. 3) Muscle tone/tension was measured using EMG apparatus Outcomes were measured at baseline and on completion of the 10 treatment sessions A follow-up survey was conducted after 1 year (65% response rate) but no detail of the survey content or data collection was provided
Notes	Methodological detail inadequately described for data extraction

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Insufficient methodological detail
Allocation concealment (selection bias)	Unclear risk	Insufficient methodological detail
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	No numerical data presented
Selective reporting (reporting bias)	Unclear risk	Insufficient detail provided
Other bias	Unclear risk	Insufficient detail provided

Lindeboom 1980 (*Continued*)

Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient detail provided

EMG - electromyography

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Beumer 1971	Narrative editorial
Monday 1995	Control group could not be classed as a no-breathing exercises control group
Van Doorn 1982	No control group
Weimann 1970	Observational study

DATA AND ANALYSES

This review has no analyses.

APPENDICES

Appendix 1. MEDLINE search strategy

1. exp Hyperventilation/
2. hyperventilat$.ti,ab.
3. ((breath$ or respirat$) adj5 dysregul$).ti,ab.
4. over$breath$.ti,ab.
5. (air adj3 hunger).ti,ab.
6. Panic Disorder/
7. (panic adj3 (attack$ or disorder$)).ti,ab.
8. or/1-7
9. Breathing Exercises/
10. (breath$ adj3 (exercis$ or retrain$)).ti,ab.
11. buteyko.ti,ab.
12. (diaphragm$ adj3 breath$).ti,ab.
13. (breath$ adj3 control$).ti,ab.
14. (relax$ adj3 breath$).ti,ab.
15. tidal breath$.ti,ab.
16. Respiratory therapy/
17. physiotherap$.ti,ab.
18. physical therapy.ti,ab.
19. yawn.ti,ab.
20. sigh.ti,ab.
21. or/9-20
22. 21 and 8

Modified Adapted Cochrane Highly Sensitive Search Strategy for MEDLINE (CHSSS 2008) designed to identify RCTs and other trials which may be suitable for inclusion in the review.

23. randomised controlled trial.pt.
24. controlled clinical trial.pt.
25. randomized.ab.
26. randomly.ab.
27. trial.ab.
28. groups.ab.
29. or/23-28
30. exp animals/ not humans.sh.
31. (28 not 29)
32. (8 and 21 and 30)

Appendix 2. EMBASE search strategy

1. exp hyperventilation/
2. hyperventilat$.ti,ab.
3. ((breath$ or respirat$) adj5 dysregul$).ti,ab.
4. over$breath$.ti,ab.
5. (air adj3 hunger).ti,ab.
6. panic/
7. (panic adj3 (attack$ or disorder$)).ti,ab.
8. or/1-7
9. breathing exercise/
10. (breath$ adj3 (exercis$ or retrain$)).ti,ab.
11. buteyko.ti,ab.
12. (diaphragm$ adj3 breath$).ti,ab.
13. (breath$ adj3 control$).ti,ab.
14. (relax$ adj3 breath$).ti,ab.
15. tidal breath$.ti,ab.
16. physiotherap$.ti,ab.
17. physical therapy.ti,ab.
18. yawn.ti,ab.
19. sigh.ti,ab.
20. or/9-19
21. 8 and 20
22. Randomized Controlled Trial/
23. randomisation/
24. Controlled Study/
25. Clinical Trial/
26. controlled clinical trial/
27. Double Blind Procedure/
28. Single Blind Procedure/
29. Crossover Procedure/
30. or/22-29
31. (clinica$ adj3 trial$).mp.
32. ((singl$ or doubl$ or trebl$ or tripl$) adj3 (mask$ or blind$ or method$)).mp.
33. exp Placebo/
34. placebo$.mp.
35. random$.mp.
36. ((control$ or prospectiv$) adj3 (trial$ or method$ or stud$)).mp.
37. (crossover$ or cross-over$).mp.
38. or/31-37
39. 30 or 38
40. exp ANIMAL/
41. Nonhuman/
42. Human/
43. 40 or 41
44. 43 not 42
45. 39 not 44
46. 21 and 45

Appendix 3. CENTRAL search strategy

#1 MeSH descriptor Hyperventilation explode all trees
#2 hyperventilat*
#3 (breath* or respirat*) near5 dysregul*
#4 over-breath* or overbreath* or "over breath*"
#5 air* near3 hunger*
#6 MeSH descriptor Panic Disorder explode all trees
#7 panic near3 (attack* or disorder*)
#8 (#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7)
#9 MeSH descriptor Breathing Exercises, this term only
#10 breath* near3 (exercis* or retrain* or train*)
#11 buteyko
#12 diaphragm* near3 breath*
#13 breath* near3 control*
#14 relax* near3 breath*
#15 tidal* near3 breath*
#16 MeSH descriptor Respiratory Therapy explode all trees
#17 physiotherap*
#18 "physical therapy"
#19 yawn
#20 sigh
#21 (#9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20)
#22 (#8 AND #21)

Appendix 4. CINAHL search strategy

S35 S34 [Limiters - Exclude MEDLINE records]
S34 S26 and S33
S33 S27 or S28 or S29 or S30 or S31 or S32
S32 (single* or double* or triple*) and blind*
S31 clinical* and (trial* or study or studies)
S30 randomly
S29 placebo
S28 randomised or randomised
S27 (MH "Clinical Trials+")
S26 S9 and S25
S25 S10 or S11 or S12 or S13 or S14 or S15 or S16 or S17 or S18 or S19 or S20 or S21 or S22 or S23 or S24
S24 sigh*
S23 yawn
S22 physical therapy
S21 (MH "Physical Therapy+")
S20 "physiotherap*"
S19 (MH "Respiratory Therapy+")
S18 tidal* N3 breath*
S17 relax* N3 breath*
S16 breath* N3 control*
S15 diaphragm* N3 breath*
S14 buteyko*
S13 breath* N3 train*
S12 breath* N3 retrain*
S11 breath* N3 exercise*
S10 (MH "Breathing Exercises")

S9 S1 or S2 or S3 or S4 or S5 or S6 or S7 or S8
S8 panic N3 disorder*
S7 panic N3 attack*
S6 (MH "Panic Disorder")
S5 air* N3 hunger*
S4 over-breath* or overbreath* or "over breath*"
S3 breath* N3 dysregul*
S2 hyperventilat*
S1 (MH "Hyperventilation+")

Appendix 5. PSYCInfo search strategy

1. exp hyperventilation/
2. hyperventilat$.ti,ab.
3. ((breath$ or respirat$) adj5 dysregul$).ti,ab.
4. over$breath$.ti,ab.
5. (air adj3 hunger).ti,ab.
6. panic disorder/ or panic attack/
7. (panic adj3 (attack$ or disorder$)).ti,ab.
8. or/1-7
9. respiration/
10. (breath$ adj3 (exercis$ or retrain$)).ti,ab.
11. buteyko.ti,ab.
12. (diaphragm$ adj3 breath$).ti,ab.
13. (breath$ adj3 control$).ti,ab.
14. (relax$ adj3 breath$).ti,ab.
15. tidal breath$.ti,ab.
16. physiotherap$.ti,ab.
17. physical therapy.ti,ab.
18. yawning/
19. yawn.ti,ab.
20. sigh.ti,ab.
21. or/9-20
22. 8 and 21
23. random$.mp.
24. (clinical adj5 trial$).mp.
25. (control$ adj5 trial$).mp.
26. ((clinical or control$ or comparativ$) adj5 (study or studies)).mp.
27. placebo$.mp.
28. (single blind$ or single-blind$).mp.
29. (double blind$ or double-blind$).mp.
30. (triple blind$ or triple-blind$).mp.
31. 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30
32. 22 and 31

Appendix 6. AMED search strategy

S31 S22 and S30
S30 S23 or S24 or S25 or S26 or S27 or S28 or S29
S29 (single* or double* or triple*) and blind*
S28 clinical* and (trial* or study or studies)
S27 randomly
S26 placebo
S25 randomised or randomised
S24 (DE "RANDOMIZED CONTROLLED TRIALS")
S23 (DE "CLINICAL TRIALS")
S22 S8 and S21
S21 S9 or S10 or S11 or S12 or S13 or S14 or S15 or S16 or S17 or S18 or S19 or S20
S20 sigh*
S19 yawn
S18 (DE "PHYSIOTHERAPY")
S17 "physical therapy"
S16 physiotherap*
S15 tidal* N3 breath*
S14 relax* N3 breath*
S13 breath* N3 control*
S12 diaphragm* N3 breath*
S11 buteyko*
S10 breath* and (exercis* or retrain* or train*)
S9 (DE "BREATHING EXERCISES") OR (DE "BREATHING THERAPIES")
S8 S1 or S2 or S3 or S4 or S5 or S6 or S7
S7 panic* N3 attack*
S6 panic* N3 disorder*
S5 air* N3 hunger*
S4 over-breath* or overbreath* or "over breath*"
S3 breath* N3 dysregul*
S2 hyperventilat*
S1 (DE "HYPERVENTILATION")

Appendix 7. LILACS search strategy

hyperventil$ or hiperventil$ or dysregulat$ or desregul$ or panic$ or panico$ [Words]
and
breath$ or respir$ or aliento or physiotherap$ or fisioterap$ or relax$ or relaj$ or diaphragm or diafragma or buteyko [Words]
and
random$ or placebo$ or trial$ or azar$ or aleator$ or julgamento or jucio or estudio or estudo [Words]

CONTRIBUTIONS OF AUTHORS

MOJ: led the design of the review protocol as primary author, implemented the search strategy with the Ariways group's trials search coordinator, applied eligibility criteria, assessed studies and extracted and analysed data, lead the write up and will update the review.

AH: closely informed the protocol design, helped to implement the search strategy, applied eligibility criteria, assessed studies, extracted and analysed data and assisted the write up and will update the review.

NOC: closely informed the protocol design, acted as a third review author for conflicts in applying eligibility

criteria and assessed included studies and assisted in the analysis of data, the write up and will update the review.

LM: provided statistical advice and support in the protocol and advised on the data analysis process. LM also contributed to the writing of the protocol and final review.

DECLARATIONS OF INTEREST

MJ is the primary author of a manuscript investigating the therapeutic benefit of manual therapy in patients with primary dysfunctional breathing which did not meet our inclusion criteria for this review. MJ received an honorarium to present the RCT at a physiotherapy special interest conference.

AH, LM, NOC none known.

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