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Breathing exercises as part of osteopathic practice

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Abstract

Purpose: This study aims to investigate which breathing exercises should be integrated into osteopathic practice and how they are effective.

Method: This literature review includes four randomized controlled trials (RCT) and two clinical trials. Databases used were PubMed and ScienceDirect. Critical Appraisal Skills Programme (CASP) is a checklist that was used to verify the quality of the studies.

Results: The majority of the articles in this literature review indicate that breathing exercises are pain relieving but the mechanisms are unclear. Among the results, there was a decrease in pain and stress, an increase in breathing function and improvement of symptoms of dysfunctional breathing (DB) and quality of life. There were also articles with no significant results. The authors of these articles discussed that these results could have been due to short intervention time, no regular practice and low level of experience regarding the intervention among the participants.

Conclusion: The results of this study give an indication for osteopaths which breathing exercises are the most effective and for what purpose. Thus, more studies are warranted.

Key words: Deep breathing, Slow deep breathing, Deep breathing exercise, Slow paced breathing, Paced breathing, Breathing retraining, Dysfunctional breathing, Pain, Osteopathy

Declaration of conformity

We hereby confirm we have created this work independently, and to have used exclusively the sources and aids indicated. We have not submitted this thesis anywhere else. This work is not in any conflict of interest with any persons or institutions.

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List of Abbreviations

ADIM - Abdominal Draw-In Maneuver
ANS - Autonomic Nervous System
CASP - Critical Appraisal Skills Programme
CESD - Center for Epidemiological Studies - Depression Scale
DB - Dysfunctional Breathing
DSB - Deep Slow Breathing
ER - Emergency Room
FEV1 - Forced Expiratory Volume in one second
FVC - Forced Vital Capacity
HADS - Hospital Anxiety and Depression Scale
HRV - Heart Rate Variability
LBP - Low Back Pain
MVV - Maximum Voluntary Ventilation
NQ - Nijmegen Questionnaire
OA - Osteoarthritis
ODI-K - Oswestry Disability Index-Korean Version
OMT - Osteopathic Manual Therapy
PSS - Perceived Stress Scale
QVAS - Quadruple Visual Analogue Scale
RCT - Randomized Controlled Trial
SEBQ - Self Evaluation of Breathing Questionnaire
SF-36 - Medical Outcomes Survey Short Form 36 Questionnaire
SOC - Sense of Coherence
STAI - State and Trait Anxiety Index
VAS - Visual Analogue Scale
WOMAC - Western Ontario and McMaster Universities Osteoarthritis Index

1 Introduction

1.1 Background - Dysfunctional breathing

For functional breathing, coordination between the diaphragm, abdominal muscles and muscles of the rib cage are required. When there is a disturbance within this coordination, DB may occur, which is a term describing various breathing disorders. DB may be due to musculo-skeletal dysfunction, chronic psychological stress or to pathology. It is common within pathologies like asthma, chronic obstructive pulmonary disease, heart disease, neuromuscular disease and anxiety related disorders. To diagnose DB, pathologies must be ruled out (Boulding et al. 2016).

The primary muscle for breathing is the diaphragm and contraction of it is vital for respiration. Dyspnoea, intolerance to exercise, sleep disturbances and hypersomnia can occur if there is dysfunction of the diaphragm (Ricoy et al. 2019). When there is a dysfunction of the diaphragm other respiratory muscles often become overloaded (Courtney, 2009). To measure the diaphragm muscle by ultrasound, the thickness and contraction rate can be evaluated. This is a measure to assess the quality and function of the diaphragm muscle (Oh, Park and Lee, 2020).

Another measuring tool for dysfunctional breathing is respiratory rate. Respiratory rate is the number of breaths per minute. The definition of one breath is flow of air in and out of the lungs. For an adult, the respiratory rate is 12-20 breaths per minute but depending on age and medical condition it may vary. Respiratory rate is not only a measure for dysfunctional breathing, it can also give an indication that a patient is struggling to maintain homeostatic control and it can reveal conditions like hypoxia, hypercapnia, metabolic and respiratory acidosis (Rolfe, 2019).

Dysfunctional breathing can create symptoms that affect the quality of life and make it difficult for the body to maintain homeostasis (Courtney, 2009). There is no consensus regarding how to diagnose DB. Boulding et al. (2016) proposed a classification after

searching the literature in the field. In the classification that follows, DB can present as one of those or as a combination.

1) Hyperventilation syndrome: associated with symptoms both related to respiratory alkalosis and independent of hypocapnia.

2) Periodic deep sighing: frequent sighing with an irregular breathing pattern.

3) Thoracic dominant breathing: can often manifest in somatic disease, if occurring without disease it may be considered dysfunctional and results in dyspnoea.

4) Forced abdominal expiration: these patients utilize inappropriate and excessive abdominal muscle contraction to aid expiration.

5) Thoraco-abdominal asynchrony: where there is delay between rib cage and abdominal contraction resulting in ineffective breathing mechanics.

Nijmegen questionnaire (NQ), Self evaluation of breathing questionnaire (SEBQ), Manual assessment of respiratory motion and Optoelectronic plethysmography (a method of assessing three-dimensional lung volumes across the pulmonary ribcage, abdominal rib cage and abdomen using markers on the chest wall and abdomen) are tools to measure dysfunctional breathing (Boulding et al. 2016).

1.2 Background - Breathing therapy

Breathing therapy is often used to correct DB or enhance its functions. For example, breathing therapies have shown effectiveness in psychological conditions and chronic stress. Breathing is an autonomic function in the body that can be controlled voluntarily and through that influence physiological and psychological regulation (Courtney, 2009). Breathing can increase heart rate variability (HRV) through slow and breathing, nasal breathing and longer exhalation than inhalation and pause after exhalation (Ben-Tal et al. 2014; Courtney, 2009). HRV is the variance in time between heartbeats. Greater

variance indicates more activity in the parasympathetic nervous system and less variance indicates more activity in the sympathetic nervous system. Therefore, it is possible to evaluate the balance in the autonomic nervous system (ANS) through HRV (Malik et al. 1996).

Breathing exercises have been used for years to reduce pain in clinical settings, such as in labor and delivery (Lothian, 2011). Breathing and contemplation exercises like qigong, pranayama, Buteyko and meditation are widely used techniques that contain slow paced breathing (Wells et al. 2020). Several studies suggest that breathing exercises can reduce pain (Jafari et al. 2020; Wells et al. 2020; Busch et al. 2012; Chalaye et al. 2009) but the mechanisms are still unknown.

1.3 Background – Osteopathy

Osteopathy is a healthcare profession that utilizes manual therapy. The osteopath aims to approach the patient in a holistic manner, that includes taking into account both the physical and mental health.
During the anamnesis the osteopath for example considers general health, injuries, disorders, medication, stressors, sleep habits, nutrition and physical activity. In addition, a physical examination is done to set a diagnosis. The physical examination can include neurological tests (reflexes, sensory and strength), systemic tests (blood pressure and pulse) and orthopedic tests (function of joints, ligaments and other structures).
The aim for the treatment is to be individual and tailored to the patients needs and in consultation with the patient. The osteopath can choose from a number of treatments. Direct techniques such as articulation or manipulation of joints or indirect techniques such as positioning techniques and cranial osteopathy, to mention a few. The aim is for the patient to become independent.
The osteopath can treat patients with both acute and chronic pain. When pathology is suspected, the patient is referred to a physician. The osteopath can also refer to a

psychologist, nutritionist or other health care professionals if necessary (Svenska Osteopatförbundet 2022).

The World Health Organization has listed five different models that provide an overview of osteopathic approaches to assessment and treatment. These models are the biomechanical, the respiratory and circulatory, the neurological, the biopsychosocial and the bioenergetic. In an osteopathic treatment, these models are often applied in combination according to what is considered most suitable for the patient. These models are also part of the new standard for osteopathic practice in Europe (Svenska Osteopatförbundet 2018).

The biopsychosocial model includes biological, psychological and social factors as all of these can affect an individual's state of health (Svenska Osteopatförbundet 2022). For example, the osteopath takes into account that the social and emotional aspects have an impact on an individual's pain, not just the biological aspect (Thompson et al. 2013). Including these factors and in this way adapting the treatment to the individual is in line with the concept of person-centered care.

Person-centered care is an approach that aims to ensure that a care provider not only reduces a patient to their illness, but also takes into account the person behind. The caregiver should listen to the patient's subjective experiences and take his or her feelings, preferences and needs into account when a treatment plan is made. This is a way to make the patient active and reduce the caregiver's authority and this has been shown in better health effects and increased patient satisfaction (Ekman, 2011).

2 Problem statement

There seems to be a gap in the research when it comes to osteopathy and breathing. There is no consensus when it comes to defining and diagnosing DB in manual therapy. There is also a lack of research when it comes to the mechanisms behind the effects of breathing exercises. However, there is some research that suggests that breathing exercises are pain and stress relieving. Is it possible that these shortcomings in research make manual therapists less likely to use breathing exercises in their practice? Since breathing exercises seem to be pain and stress relieving, this literature review aims to investigate which breathing exercises osteopaths can integrate into their clinical practice and how they are effective.

2.1 Research question

Which breathing exercises should be integrated into osteopathic practice and how are they effective?

3 Method

3.1 Method for data collection

The databases used for this study were PubMed and ScienceDirect. The final search was made on 2021.10.03, and three search strings are presented below.

PubMed	deep breathing OR slow deep breathing OR deep breathing exercise OR slow paced breathing OR paced breathing
ScienceDirect	pain AND breathing retraining AND dysfunctional breathing
ScienceDirect	pain AND breathing retraining AND osteopathy

Table 1. Search strings

Keywords: deep breathing, slow deep breathing, deep breathing exercise, slow paced breathing, paced breathing, breathing retraining, dysfunctional breathing, pain, osteopathy

3.2 Inclusion and exclusion criteria

Inclusion criteria	**Exclusion criteria**
- Studies including humans - Studies with free access - Studies in English - RCTs and Clinical trials (PubMed) - Research articles (ScienceDirect) - Studies related to breathing and pain that are relevant for our research question	- Studies older than 10 years - Studies concerning pathologies - Studies with children/adolescents under the age of 19 - Studies on menopausal or pregnant woman

Table 2. Inclusion and exclusion criteria

3.3 Search results

	ScienceDirect	**PubMed**	**Total**
	n=419	n=8818	n=9237
Excluded by the database filters based on criteria	n=408	n=8682	n=9090
Included by the database filters based on criteria	n=11	n=136	n=147
Excluded manually based on criteria	n=9	n=132	n=141
Included manually based on criteria	n=2	n=4	n=6

Table 3. Search results based on inclusion and exclusion criteria. Studies included in this literature review n=6.

Critical Appraisal Skills Programme (CASP) is a checklist that was used to verify the quality of the studies. Two versions of CASP were used, one for the RCTs (CASP 1) and one for the qualitative studies (CASP 2).

4 Results

4.1 Article overview

Authors and publication year	**Art. 1 Oh, Park and Lee (2020)**	**Art. 2 Larsen et al. (2019)**	**Art. 3 Wells et al. (2020)**	**Art. 4 Smith and Norman (2017)**	**Art. 5 Hagman, Janson and Emtner (2011)**	**Art. 6 Benjamin et al. (2020)**
Study design	RCT	Clinical trial	RCT	RCT	Clinical trial	RCT
Blinding	Single-blinded	Not blinded	Cross-over double blinded	Not blinded	Not blinded	Not blinded
Population Female, Male Age (Years)	-44 P -44 F -40-49 Y	-20 P -14 F, 6 M -20-82 Y	-59 P -30 F, 30 M -18-65 Y	-63 P -39 F, 24 M -18-23 Y	-50 P -35 F, 10 M (at follow-up) -16-80 Y	-18 P -10 F, 8 M -19-45 Y
Intervention group Control group	-1 intervention group -1 control group	-1 intervention group -1 control group	-3 intervention groups -0 control group	-2 intervention groups -1 control group	-1 intervention group -1 control group	-2 intervention groups, whereas one served as a control group
Total duration Number of sessions Duration of sessions	-4 weeks -3 weekly sessions -50 min	-6 weeks -Weekly sessions -30 min + homework	-7 weeks -Weekly sessions -20-30 min	-1 day -1 session -10 min	-5 years -Daily exercises	-8 weeks -6 weekly sessions +4 OMT sessions
Pain or dysfunction	LBP	Osteoarthritis	Experimental pain by heat	Experimental pain by cold	DB	DB
Breathing exercises/other intervention	-Intervention group: Lumbar stabilization exercise, ADIM and respiratory resistance -Control group: Lumbar stabilization exercise, ADIM	-Intervention group: DSB -Control group: No intervention	-Intervention group 1: Mindfulness meditation -Intervention group 2: Sham-mindfulness meditation -Intervention group 3: Slow breathing exercise	-Intervention group 1: Deep breathing -Intervention group 2: Progressive muscle relaxation -Control group: No intervention	-Intervention group: Breathing retraining and education concerning breathing -Control group: No intervention	-Intervention groups: Breathing retraining and OMT intervention -Control group: No intervention during the delayed period
Measures of relevance	-Thickness of diaphragm -Lung capacity -ODI-K -QVAS	-Cardiac measures -Expiratory pause -WOMAC	-VAS -Respiration rate	-VAS -Cardiac measures -Demographics -STAI -PSS -CESD -UCLA loneliness scale -Body perception	-SF-36 -HADS -SOC -NQ -Influence on daily life	-Cardiac measures -NQ -SEBQ

Table 4. Summary of the six articles.

4.2 Article summaries

4.2.1 Article 1

Title: Comparison of effects of abdominal draw-in lumbar stabilization exercises with and without respiratory resistance on women with low back pain: a randomized controlled trial
Authors: Youn-Jung Oh, Sam-Ho Park and Myung-Mo Lee
Date: 2020.03.17
Ethical considerations: The participants were informed of the purpose and method of the study and all confirmed their voluntary participation. The study was approved by the Ethics Committee of Daejeon University and registered in the International clinical trials registry platform.
Financial support: The study was financed by the Department of Physical therapy at Daejeon University in Daejeon, South Korea.
Purpose: The purpose of the study was to evaluate the effects of abdominal draw-in lumbar stabilization exercises with respiratory resistance on women between 40-49 years with LBP.
Method: The study was a single-blinded randomized controlled trial. To calculate the sample size, G-power 3.19 software was used. Out of 60 women (40-49 years old), 44 matched the criteria for the study. They were divided into one control group (n=22) and one experimental group (n=22). The inclusion criteria for participation in the study was to have experienced low back pain (LBP) for at least 6 weeks, 3 or more positives on the Lumbar instability test, 3 or higher in the Quadruple visual analogue scale (QVAS) and no history of back surgery. QVAS assesses current level of pain, mean level of current pain, pain level at the mildest and pain level at the most severe. The scale is from 0-10 and the reliability is high. The exclusion criteria for participation in the study was to not have difficulties in motor performance due to pain, systemic or respiratory diseases and inability to attend at least 85% of the sessions. Both groups received abdominal draw-in lumbar stabilization exercises. In the experimental group they performed the exercises combined with respiratory resistance. Both groups performed

the exercises for 50 minutes per session, 3 times a week for 4 weeks. To assess the outcomes, QVAS and Oswestry disability index-Korean version (ODI-K) was used. Also, the thickness and contraction rate of the diaphragm and lung capacity were measured. The measures for lung capacity were forced vital capacity (FVC), forced expiratory volume in one second (FEV1) and maximum voluntary ventilation (MVV).
Results: In both groups, there were significant differences in QVAS, ODI-K, contraction thickness and contraction rate of the diaphragm before and after the intervention.
The experimental group showed significant differences in ODI-K, diaphragm thickness and in lung capacity (FVC, FEV1 and MVV) compared to the control group. There were also significant differences in MVV in the control group, but the experimental group had even greater differences at this measure.

4.2.2 Article 2

Title: Effect of deep slow breathing on pain-related variables in osteoarthritis
Authors: Kalee L. Larsen, Lorrie R. Brilla, Wren L. McLaughlin and Ying Li
Date: 2019.06.03
Ethical considerations: The University Human Subjects' Committee approved the study.
Financial support: Western Washington University contributed with funds for the purchase of The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) questionnaire.
Purpose: The purpose of this study was to evaluate if significant differences would be seen in joint pain perception and autonomic activity after a breathing exercise program for six weeks.
Method: Through informational posters at local senior centers and the university campus, the subjects in this study were recruited. Twenty subjects participated in the study and were divided into two groups, a training group (n=10) and a control group (n=10). There were 14 female, 6 male, 20-82 years old. The subjects included in this

study had been diagnosed with knee osteoarthritis (OA) by a physician and they had received a normative score of less than 50 on the American Academy of Orthopedic Surgeons Hip and Knee Questionnaire. They either had unilateral joint pain and no history of joint replacement or bilateral joint pain with joint replacement in one joint (in these cases the knee that had not been operated on was assessed). None of the subjects had undergone joint surgery within the last six weeks and all subjects got medical clearance to participate in the study by a physician. The subjects were not allowed to alter their diet or physical activity during the study. The breathing exercises were new to the subjects and consisted of deep slow breathing (DSB) with focus on prolonging the exhalation and to pause following exhalation. The breathing exercises consisted of weekly training sessions for 30 minutes and breathing exercises to do at home, during 6 weeks. The expiratory pauses were recorded, WOMAC was used to assess pain and physical function and HRV data were collected.

Results: This study shows no significant results that indicate that DSB is sufficient to reduce pain or improve physical function in subjects with lower extremity pain. However, both groups experienced less pain and better physical function during the course of the study and this is thought to be due to the social support that the subjects received during the study.

4.2.3 Article 3

Title: Attention to breath sensations does not engage endogenous opioids to reduce pain

Authors: Rebecca E. Wells, Jason Collier, Grace Posey, Fry Morgan, Timothy Auman, Brian Strittameter, Rossana Magalhaes, Adrienne Adler-Neal, John G. McHaffie, Fadel Zeidan

Date: 2020.03.09

Ethical considerations: All study procedures were approved by Wake Forest School of Medicine´s Institutional Review Board. All participants received written information

with explanations regarding all methods and they were free to withdraw from the study at any time.

Financial support: NIH's National Center for Complementary and Integrative Health, the Mind and Life Institute, and the Wake Forest Translational Science Institute supported this study and the authors declare no competing financial interests.

Purpose: This study seeks to investigate whether endogenous opioids can reduce pain during various interventions like mindfulness meditation, slow breathing and sham-mindfulness meditation.

Method: This is a randomized, crossover double-blinded study. The participants were recruited via flyers, social media and the Wake Forest clinical trial registry. To calculate the sample size, the G-power software 3.0.1 was used and the sample size was calculated to provide ≥90% power. There were 59 participants (30 female and 30 male) divided into three groups (n=19), (n=20) and (n=20). Inclusion criterias were age between 18-65, no previous experience of meditation and pain-free. Exclusion criteria were usage of opioids, pregnancy, history of syncope and fear of needles and blood. The three groups received three different interventions consisting of mindfulness meditation training, sham-mindfulness meditation training and slow breathing exercise training. These interventions were performed during four sessions (2-5) for 20 minutes each. The subjects were also exposed to heat stimuli during session 1 and during session 6-7. During the last two sessions (6-7) the three different interventions were examined with naloxone and saline infusion. For each group, pain intensity and pain unpleasantness were measured and visual analogue scale (VAS) was used. In addition to this, the respiration rate was also measured. The outcomes were analyzed with ANOVA and SPSS 26.0 software.

Results: Slow breathing and mindfulness meditation appear to reduce pain, but this effect is not due to the endogenous opioids. In the mindfulness meditation group, there was a significant reduction in pain unpleasantness during naloxone and saline but not in pain intensity. In the slow breathing group, the pain intensity and pain unpleasantness significantly decreased with naloxone but not saline. In the sham-mindfulness meditation group there was no significant reduction of pain unpleasantness during naloxone or saline. There was increased pain intensity during naloxone and saline, but

not significant. Individuals in all three groups that self-reported focusing on the breath exhibited a greater percent decrease in pain intensity during naloxone and saline infusion.

4.2.4 Article 4

Title: Brief relaxation training is not sufficient to alter tolerance to experimental pain in novices
Authors: Karen E. Smith and Greg J. Norman
Date: 2017.05.11
Ethical considerations: The authors state that there are no competing interests. The participants in the study were provided compensation, either monetary or course credit, all participants also gave their written informed consent. University of Chicago's Institutional Review Board approved the study and it was conducted in accordance with the Declaration of Helsinki.
Financial support: No specific funding.
Purpose: The purpose of this study is to examine how the experience of pain in healthy individuals is influenced by different components of mindfulness practice (deep breathing and muscle relaxation).
Method: In this RCT, 63 university of Chicago undergraduates (24 male and 39 female), ages 18-23 participated. They were divided into three groups, they either performed 10 minutes of deep breathing, progressive muscle relaxation or a control condition. Afterwards they performed a cold pain task, where the participants placed their foot in 0℃ water. Every 30 seconds they rated their pain using VAS. The instructions were to remove their feet when the pain was out of tolerance, otherwise the task ended after 5 minutes. At the baseline of the study all participants completed six questionnaires assessing demographics and their current psychological state. The questionnaires used were State and Trait Anxiety Index (STAI), Perceived Stress Scale (PSS), Center for Epidemiological Studies - Depression Scale (CESD), UCLA

Loneliness Scale and Body Perceptions Questionnaire. Through different cardiovascular measures, ANS activity was evaluated during the experiment.
Results: It is not sufficient to affect the experience of pain through focused breathing or short-term relaxation. The authors discuss that a possible explanation is that the intervention time was too short or that relaxation tasks alone may not be sufficient to influence pain tolerance.

4.2.5 Article 5

Title: Breathing retraining - A five-year follow-up of patients with dysfunctional breathing
Authors: Carina Hagman, Christer Janson and Margareta Emtner
Date: 2011.03.31
Ethical considerations: The authors state that none of them has a conflict of interest regarding this study. Before inclusion in this study, the participants gave their informed consent. The Ethics Committee of the Medical Faculty of Uppsala University approved the study.
Financial support: The Center for Clinical Research Dalarna and the Bror Hjerpstedt Foundation in Uppsala financially supported this study.
Purpose: To describe and evaluate patients with DB after breathing retraining during five years.
Method: This qualitative study followed up 22 of 25 patients with DB and 23 of 25 patients with asthma after five years. The criteria for the patients to participate in the study were age 16-80, forced expiratory volume in 1 s and vital capacity ≥ 80% of predicted value, resting oxygen saturation ≥ 95%, no other disease and non-smoker for a minimum of one year before the start of study. The groups were sex-matched. The study used five self-report questionnaires regarding quality of life. Medical Outcomes Survey Short Form 36 Questionnaire (SF-36) measured general health, Hospital Anxiety and Depression Scale (HADS) measured anxiety and depression, Sense of Coherence (SOC) measured sense of coherence, NQ measured dysfunctional breathing and the

questionnaire Influence on daily life was also used. Emergency room (ER) visits and symptoms associated with DB were also measured. Breathing retraining was only received by patients with DB, it included information, advice and instructions of diaphragmatic breathing. The patients with asthma served as a control group. The diagnosis of asthma and DB were set by a physician who also examined the patients. Various tests were used to evaluate statistically significant differences and differences within groups over time. SPSS version 18.0 was used for analysis.
Results: This five-year follow-up study gives an indication that breathing retraining and to learn about the condition is beneficial for patients with DB. Significant outcomes were that symptoms that are associated with DB decreased, quality of life improved, the number of ER visits decreased and the patients were less affected by their DB, both in their daily life and during exercise. The only significant difference for the patients with asthma in the control group concerned quality of health, namely less pain.

4.2.6 Article 6

Title: The effect of osteopathic manual therapy with breathing retraining on cardiac autonomic measures and breathing symptoms scores: A randomized wait-list controlled trial
Authors: J.G. Benjamin, R.W. Moran, D.J. Plews, A.E. Kilding, L.E. Barnett, W.J. Verhoeff, C.J. Bacon
Date: 2020.02.17
Ethical considerations: Written informed consent was given by all participants prior to the study. The study was registered with the Australian New Zealand Clinical Trials Registry and approved by the institutional ethics committee. There were no declarations of interest.
Financial support: No information. This was a sub-study embedded within a primary study.

Purpose: The purpose of this study was to evaluate the effects of breathing retraining and osteopathic manual therapy (OMT) on cardiac autonomic measures and breathing symptoms during spontaneous breathing in healthy active adults.

Method: In this randomized wait-list controlled trial, 18 participants (10 females and 8 males) were recruited through online advertising in the area of Auckland. The inclusion criteria are the following; age 19-45, no known cardiac, autonomic or affective disorders, no respiratory-related hospital stay or hospital stay due to smoking in the last six months, participation of at least four hours of weekly exercise and experience that breathing is limiting their performance when exercising. They were assigned to breathing retraining and OMT intervention and were divided into two separate groups. The first group started immediately and the second group started after 6 weeks, to use the second group as a control group. There were 6 breathing retraining sessions and they included awareness and education concerning diaphragmatic breathing, nasal breathing, longer exhalation than inhalation, pause following exhalation and evenness of airflow. The OMT sessions evaluated the presence of either a change in asymmetry, range of motion or tenderness. The treatment consisted of soft tissue massage, mobilization, manipulation and/or functional osteopathic techniques. The participants received OMT 4 times. To evaluate the outcomes, dysfunctional breathing questionnaires (NQ and SEBQ), heart-rate, HRV and heart rate-recovery were measured.

HRV was assessed as an average of seven days of 6-min electrocardiograms in awake state, using time (logarithm of root-mean-square of successive differences; LnRMSSD) and frequency domain (logarithm of high-frequency; LnHF) measures.

Results: Breathing retraining and OMT during six weeks have an increasing effect of HRV compared to no treatment. It may also induce favorable autonomic modulation. There was a significant increase in HRV indices, LnRMSSD and LnHF. There was also a significant improvement in NQ.

4.3 Critical Appraisal Skills Programme (CASP)

CASP 1 was used for the randomized controlled trials. Four areas were analyzed; study design (A), methodology (B), results (C) and application (D).
CASP 2 was used for the qualitative studies. Three areas were analyzed; validity of results (A), results (B) and applicability of results (C).

4.3.1 Article 1

Title: Comparison of effects of abdominal draw-in lumbar stabilization exercises with and without respiratory resistance on women with low back pain: a randomized controlled trial	
Authors: Oh, Park and Lee, 2020	
A	The basic study design is valid for an RCT
B	The investigators were not blinded, only the participants
C	No confidence interval reported
D	Narrow range of population age and only women included. Further studies are needed, also studies comparing this intervention to existing osteopathic interventions.
Summary: Proposal for further studies; two additional intervention groups performing abdominal draw-in maneuver (ADIM) and respiratory resistance without stabilization exercises. This to evaluate the effects of ADIM and respiratory resistance alone.	

Table 5. CASP 1, RCT

4.3.2 Article 2

Title: Effect of deep slow breathing on pain-related variables in osteoarthritis	
Authors: Larsen et al. 2019	
A	No power calculation. The sample size was small and not calculated. The participants' availability decided what group they were assigned to. Too few questionnaires.
B	This was not a blinded study. No significant results between groups in this study, but significant results over time which the authors explain may be due to social support and not the interventions. No confidence interval reported.
C	Previous studies indicate that breathing retraining decreases pain. Further studies are needed, also studies comparing this intervention to existing osteopathic interventions.
Summary: Although no significant results between groups, the pain decreased and the physical function improved over time in both groups. This study cannot explain these positive effects.	

Table 6. CASP 2, Clinical trial

4.3.3 Article 3

Title: Attention to breath sensations does not engage endogenous opioids to reduce pain	
Authors: Wells et al. 2020	
A	The basic study design is valid for an RCT
B	This was a crossover double-blinded study and there is nothing to comment on the methods
C	The results were clearly reported
D	This population may not be comparable to our patients, due to inclusion criteria of being pain free. Further studies are needed, also studies comparing this intervention to existing osteopathic interventions.
Summary: The article states that the mechanism behind pain relief by breathing is not due to endogenous opioids. The results indicate that focus on breathing can reduce the subjective experience of pain.	

Table 7. CASP 1, RCT

4.3.4 Article 4

Title: Brief relaxation training is not sufficient to alter tolerance to experimental pain in novices	
Authors: Smith and Norman, 2017	
A	Sample size was calculated, but the number was unclear. 11 of 63 participants were excluded during the study, this may have affected the results.
B	This was not a blinded study
C	Confidence interval is not reported
D	Narrow range of population age and short intervention time. Further studies are needed, also studies comparing this intervention to existing osteopathic interventions.
Summary: Short intervention time may not be comparable to patients experiencing long term pain.	

Table 8. CASP 1, RCT

4.3.5 Article 5

Title: Breathing retraining - A five-year follow-up of patients with dysfunctional breathing	
Authors: Hagman, Janson and Emtner, 2011	
A	No calculation of sample size. The authors don't mention any follow up or support during the five years, this could be a limitation in the study design. Groups were sex-matched, more females than males. In the control group all had asthma.
B	This was not a blinded study. There were significant results, but unclear what factors that contributed to them. Confidence interval is not reported.
C	For the results to be relevant in osteopathic practice, the correct diagnosis must be set.
Summary: The results are relevant for osteopaths but should be confirmed by RCTs.	

Table 9. CASP 2, Clinical trial

4.3.6 Article 6

Title: The effect of osteopathic manual therapy with breathing retraining on cardiac autonomic measures and breathing symptoms scores: A randomized wait-list controlled trial	
Authors: Benjamin et al. 2020	
A	Small sample size
B	This was not a blinded study
C	The results were clearly reported
D	Further studies are needed, also studies comparing this intervention to existing osteopathic interventions.
Summary: The results indicate that breathing retraining and manual therapy as a combination can be helpful to sustain a balanced autonomic state.	

Table 10. CASP 1, RCT

5 Discussion

5.1 Discussion of method for this literature review

This literature review includes four RCTs and two clinical trials. RCTs are considered to be the highest ranked of research methods in the field of science. The value of clinical trials is increasing, since they are effectively used to evaluate the subjectivity in the humans studied. This is especially useful in the field of manual therapy.

The use of other search engines in this literature review might have provided a more accurate view over the state of knowledge within the field. With an even deeper preparatory work the chosen words for the search strings might have been more on point for the research question. It could also have been the result of less search strings. On the search engines used, not all studies were available for free, hence some studies of importance may have been lost.

This literature review contains studies not older than ten years to ensure the most current knowledge but this could also result in loss of articles of interest. Due to the manual selection of the studies to answer the research question, there is a risk for bias.

In order to focus on the field of osteopathy in this literature review, studies concerning pathologies were excluded. The study of Larsen et al. (2019) was included since osteoarthritis is common among patients for osteopaths. Adolescents, menopausal and pregnant women were also excluded since these groups do not represent the general patientgroup within osteopathy. Children under the age of 8 were excluded too, since it is not legal to treat this patient group in Sweden.

CASP is a recognized tool to evaluate studies. The questions in these forms are designed to help the researcher evaluate the quality of the study systematically. This tool was used in an attempt to maintain objectivity but bias may still have occurred.

5.2 Discussion of the methodology of the six studies

5.2.1 Introduction

What these six studies have in common is how breathing can affect pain and quality of life. Oh, Park and Lee (2020) and Larsen et al. (2019) evaluate low back pain and osteoarthritis respectively. Wells et al. (2020) evaluate experimental pain in the form of heat and Smith and Norman (2017) in the form of cold. Hagman, Janson and Emtner (2011) and Benjamin et al. (2020) does not focus on pain specifically but more on how DB affects quality of life. Benjamin et al. (2020) also combines breathing retraining with osteopathic treatment.

5.2.2 Intervention

Except for Smith and Norman (2017) and Hagman, Janson and Emtner (2011) who had their intervention time for one day and five years respectively, the intervention time and study design for the remaining articles were similar. The total duration was 4-8 weeks and all contained weekly sessions with breathing exercises. Benjamin et al. (2020) also included OMT.

Hagman, Janson and Emtner (2011) do not mention any follow up or support during the five years, this could be a limitation in the study design. The participants were told to do breathing exercises and to be aware of their breathing pattern several times a day. It is hard to know whether the participants have performed the tasks with the same quantity and quality for such a long period of time. There were significant results, but it is unclear whether it was the information or the breathing retraining that contributed to the improvements.
There is also a lack of data regarding DB and its natural course, therefore it is hard to know if the improvements of symptoms in the DB group may have been spontaneous.

Smith and Norman (2017) had a short intervention time of 10 minutes at one occasion which might have affected the results. Compared to the other studies that lasted for 4-8 weeks, the participants in this study did not have time to practice deep breathing or muscle relaxation to make it automatic. Therefore, this study may not be comparable to the rest.

All studies had two or more intervention groups and one control group, except Wells et al. (2020), who had no control group. Instead, they had three intervention groups; mindfulness meditation, sham-mindfulness meditation and slow breathing exercise. The sham-mindfulness group were instructed to believe that they were performing meditation to see if there is a placebo-induced analgesia by endogenous opioids.

The participants of the intervention group of Larsen et al. (2019) were selected by their availability to attend and perform the exercise. This may have led to the intervention group differing from the control group in energy level and physical shape at baseline.

5.2.3 Measures

In addition to objective measuring tools (physiological measures), all studies contained subjective measures (questionnaires), which are effectively used to evaluate the experience of pain, dysfunctional breathing and how that affects daily life. Larsen et al. (2019) had few questionnaires, if they had included several the results may have explained the positive effects over time. Larsen et al. (2019), Smith and Norman (2017) and Benjamin et al. (2020) all measured HRV to evaluate how breathing affects the ANS. HRV provides indications of ANS activity and it may be used to estimate the balance between parasympathetic and sympathetic activity (Larsen et al. 2019).

5.2.4 Population

The sample size of four studies varies from 44 to 63. Benjamin et al. (2020) and Larsen et al. (2019) differ with populations of 18 to 20 participants respectively. It is not clear whether or not Larsen et al. (2019) calculated the sample size. Benjamin et al. (2020) discusses that due to the low level of participants that were analyzed, the calculated sample size of 15 was not reached. These smaller populations may have affected the results.

Breathing dysfunction and pain is the focus of the six studies, this can also be found in all ages of the human population. Oh, Park and Lee (2020) and Smith and Norman (2017) had a narrow span of age of their population studied, 40-49 and 18-23 years respectively. Therefore, these studies may not be representative on their own but contribute along with the other studies. The rest of the studies had wider age spans, from 16-82 years.
Oh, Park and Lee (2020) only had women in their study. The rest of the studies had more females than men in their populations, except Wells et al. (2020) who had equal numbers of the sexes. Whether or not this affects the results is unclear, the authors themselves have not mentioned it as a limitation.

5.2.5 Blinding

The studies of Larsen et al. (2019), Smith and Norman (2017), Hagman, Janson and Emtner (2011) and Benjamin et al. (2020) were not blinded, but this low level of blinding may not be relevant for the results. The studies involve the participants through assignments and questionnaires that complicate the procedure of blinding. For most of the studies in this literature review and in order to answer the research question, blinding may not be considered decisive.

5.2.6 Confidence intervals

Wells et al. (2020) and Benjamin et al. (2020) both reported confidence intervals, the remaining four studies did not, this may have affected the results.

5.2.7 Ethics

The participants of all studies were informed about the interventions and the studies were approved by the university ethics committee in each country that they were conducted. Smith and Norman (2017) were also conducted in accordance with the Declaration of Helsinki.

5.3 Discussion of the results and relevance for osteopathy

This section is an exploration of how breathing exercises may affect DB and how it can be applied into an osteopathic practice.

5.3.1 Outcome measures - Increased quality of life

Quality of life includes both physical and mental health. Some of the articles in this literature review have specifically measured the quality of life and some have not. The outcome measures below in the discussion all indirectly affect quality of life.

Larsen et al. (2019), Wells et al. (2020) and Benjamin et. al. (2020) did not measure quality of life directly.
Smith and Norman (2017) did not specifically measure quality of life, they used five different questionnaires evaluating current psychological state at baseline. Only stress and anxiety were measured after the intervention. There was a significant increase in anxiety but significant decrease in stress after the deep breathing, progressive muscle

relaxation and control condition. There was no significant improvement after the cold pain task. Due to the short duration of this study, it is not possible to draw any conclusions about quality of life.

Oh, Park and Lee (2020) and Hagman, Janson and Emtner (2011) have specifically measured quality of life through questionnaires.
Oh, Park and Lee (2020) used ODI-K to evaluate the level of dysfunction in patients with LBP. This questionnaire includes pain level, personal hygiene, lifting objects, walking, sitting, standing, sleeping, social participation, travel, and mobility. Both the intervention group and control group got significant improvements in ODI-K, but the intervention group showed significantly better improvement.
Hagman, Janson and Emtner (2011) measured quality of life through two questionnaires. SF-36 measured physical function, bodily pain, general health, vitality, social function, emotional and mental health. The second questionnaire, Influence on daily life, evaluates breathing difficulties, effects of stress, impact on daily life and on exercise. The only significant improvement from the SF-36 questionnaire was the physical component for the group with DB. The questionnaire concerning influence on daily life showed that there was a decrease in breathing problems at the end of the study for the patients with DB. They were also less affected by their DB in their daily life and when exercising, less often off work, and their breathing problems were less affected by stress.

5.3.2 Outcome measures - Stress decrease

There are different procedures to measure stress. For example, perceived stress can be evaluated through questionnaires and physiological stress can be measured through HRV.

Only Smith and Norman (2017) measured perceived stress, through the PSS. The perceived stress among the participants significantly decreased, but there was no

significant difference in scores of the PSS between the different intervention groups over time.
Larsen et al. (2019), Smith and Norman (2017) and Benjamin et al. (2020) included cardiac measures in their studies. Only Benjamin et al. (2020) showed significant increase in HRV.
Hagman, Janson and Emtner (2011) measured influence on daily life, where questions about stress were included. Participants perceived that their DB symptoms were less affected by stress after the course of the study.
Oh, Park and Lee (2020) and Wells et al. (2020) did not include stress as a measure.

Benjamin et al. (2020) present that six weeks of breathing retraining and OMT have an increasing effect of HRV compared to no treatment, and it may also induce favourable autonomic modulation. Balance in ANS is important because the consequences of chronic sympathetic activity can lead to health risks such as renal and cardiac failure (Joles and Koomans, 2004).
The breathing retraining sessions in the study of Benjamin et al. (2020) included diaphragmatic breathing, awareness and education, nasal breathing, longer duration of exhalation than inhalation, pause after exhalation and evenness of airflow.
Osteopathic practitioners have knowledge about function and movement of breathing and therefore can identify dysfunction. In addition to the manual therapy that osteopaths can contribute with, breathing exercises like those that Benjamin et al. (2020) describes can serve as a tool in the clinical practice and for the patient to work with on their own.

5.3.3 Outcome measures - Aspects of improved breathing function

Dysfunctional breathing can among others be measured through evaluation of the diaphragm muscle (contraction rate and thickness), respiration measures (FVC, FEV1, MVV, expiratory pause and respiration rate) and questionnaires.

Smith and Norman (2017) did not specifically measure symptoms related to DB.

Oh, Park and Lee (2020), measured DB by measuring thickness and contraction rate of the diaphragm and lung capacity. Both groups in this study showed significant differences in MVV, and thickness and contraction rate of the diaphragm before and after the intervention. In the group with the respiratory resistance, respiration measures (FVC, FEV1, MVV), thickness and contraction rate of the diaphragm showed significantly better improvement than the control group.

Larsen et al. (2019) measured the expiratory pause as an indicator of breathing retraining efficacy and there were no significant results.

Wells et al. (2020) measured respiration rate and there was a significant decrease in all intervention groups.

Benjamin et al. (2020) used NQ and SEBQ to evaluate dysfunctional breathing. There was only a significant improvement in NQ.

Hagman, Janson and Emtner (2011) used NQ to evaluate symptoms associated with DB. They also used Influence on daily life, a questionnaire evaluating breathing problems and effects of stress and impact on daily life and on exercise. The experimental group showed significant improvements in both of these questionnaires.

The five-year follow-up study by Hagman, Janson and Emtner (2011) indicates that patients with DB benefit from breathing retraining and education concerning breathing and their condition. Significant outcomes were that symptoms associated with DB decreased, quality of life improved, the number of ER visits decreased and the patients were less affected by their DB, in daily life and when exercising.

The authors discuss that it is hard to pinpoint the cause of DB, it is rarely just one factor. In addition to breathing exercises, the receiving of information and explanation about the condition for the patients with DB may have contributed to the improvements in their physical activity.

It is of importance to set the correct diagnosis, to not mistake asthma for DB, which often is the case according to Hagman, Janson and Emtner (2011). Unexplained symptoms can lead to fear of illness for the patient and this may be prevented by correct diagnosis.

Maybe osteopaths can help to evaluate DB. The role of the osteopath is, among others, to inform the patient about their diagnosis. One aim with this knowledge is to empower the patient and thereby make them autonomous in their healing process.
There is no consensus when it comes to diagnosing DB and there is no data on the natural course of it. Therefore, the DB classification proposal of Boulding et al. (2016) could be a tool in osteopathic practice in addition to the anamnesis and the physical examination. The results of Hagman, Janson and Emtner (2011) are relevant for the osteopathic practice. In order to know whether it was the information about the condition or the breathing retraining that were the most efficient further studies are needed.

5.3.4 Outcome measures - Pain relief

Four of six studies specifically measured pain. Hagman, Janson and Emtner (2011) and Benjamin et al. (2020) does not focus on pain specifically but more on how DB affects quality of life.

Slow paced breathing seems to reduce pain and is a widely used technique to promote well-being (Zunhammer, Eichhammer and Busch, 2013; Arsenault, et al. 2013; Busch et al. 2012) but the mechanism behind pain reduction is still unknown.
The results of Wells et al. (2020) indicate that focus on breathing can reduce the subjective experience of pain. The participants in this study that self-reported focusing on the breath got a greater percent decrease in pain intensity during naloxone and saline infusion. Is it possible that this self-reported focus of the breath corresponds to mindfulness meditation?
The majority of previous mindfulness and pain studies that Wells et. al (2020) refers to, has shown greater reduction in the subjective experience of pain and less in pain intensity. These studies have used a Vipassana (choice-less awareness) meditation but Wells et al. (2020) used Shamantha (focused attention) meditation. The authors discuss

that the difference in focus during meditation may be the reason for the reduction of pain unpleasantness and not in pain intensity.
It is less cognitive demanding to focus on DSB than mindfulness meditation, thus both can reduce the subjective experience of pain. Therefore, DSB could be beneficial for patients with conditions like fibromyalgia, chronic fatigue syndrome and multiple sclerosis, and it is not uncommon for these patients to see an osteopath. On the other hand, mindfulness meditation seems to be more effective and longer lasting than DSB (Wells et al. 2020).
According to the results of Wells et al. (2020), DSB might be a tool for osteopaths to work with. Could the ultimate be to combine DSB and meditation as a tool for patients to cope with their pain?

The results of Larsen et al. (2019) showed that there were no significant results that indicated that DSB can relieve pain or to improve physical function for patients with lower extremity pain. Despite the non-significant results, both the experimental and control group experienced less pain and better physical function during the study and shifted toward a more parasympathetic state. Larsen et al. (2019) discuss that this might be due to the social support the participants received during the study. These thoughts and results are in line with the biopsychosocial model of pain, which also is one of the five treatment models of osteopathy. Ferreira and Sherman (2007) mention that social support and optimism may be important factors to affect OA pain. Osteopaths can support persons with OA, through empowerment and knowledge about their diagnosis and social support via the biopsychosocial model and the person-centered care approach.
The results of Larsen et al. (2019) contrast to previous studies indicating that DSB can decrease sympathetic activity and increase parasympathetic activity. There are also studies that show that pain is affected by ANS activity and these studies have measured perceived pain through heat pain threshold and tolerance (Busch et al. 2012; Chalaye et al. 2009; Jerath et al. 2006).
Even though the study has no significant results, it may have clinical relevance in osteopathic practice. In contrast to the study of Larsen et al. (2019), during the meeting

between the patient and the osteopath, there is time for supporting the patient and contributing with education concerning breathing and breathing exercises. These factors could be of importance to reach significant results, but more studies are needed.

Smith and Norman (2017) show that short term relaxation or focused breathing is not sufficient to affect the participants experiences of pain. The authors discuss that a likely explanation might be that the intervention was too short to have an effect. It is also possible that relaxation tasks alone are not sufficient to affect pain tolerance.
The authors point out that there is a difference between beginners and experienced practitioners of contemplating practices when it comes to affecting the experiences of pain. The theory that breathing is the key mechanism to influence individuals' experiences of pain was not supported in the study of Smith and Norman (2017). The positive effects of contemplative techniques do not seem to depend solely on focusing on breathing or muscle relaxation, the mechanisms behind the perception of pain seem to be more complex.
Smith and Norman (2017) argue that previous studies indicate that relaxation interventions are efficient when treating pain symptoms in patients suffering from chronic pain and from clinical disorders like anxiety and depression. More research is needed when it comes to understanding how mindfulness, meditation and relaxation interventions affect acute pain.
The artificial pain in this study may not be comparable to individuals with long term pain, which is a common patient group seeing an osteopath. In order for osteopaths to take any of these interventions into their clinical practice, it is necessary to know for how long and how much practice is needed to achieve effects. Most likely, these interventions require continuity to have an effect. To maintain this continuity, osteopaths can contribute with support through revisits.

For patients with LBP, it seems that breathing exercises are equally important as accurate physical exercise according to Oh, Park and Lee (2020). Both groups in this study performed ADIM with a lumbar stabilization exercise program. In addition, the experimental group was breathing with resistance. Both groups got a statistically

significant decrease in pain. Compared to the control group, the experimental group also showed significantly better improvements in ODI-K, lung capacity, diaphragm thickness and contraction rate.
The decrease in pain is believed to be due to stronger contraction of the diaphragm and abdominal deep muscles, which increases the intra-abdominal pressure and in turn decreases the pressure on the lumbar spine. This indicates that breathing with resistance might be something for osteopaths to consider when treating patients with LBP. To evaluate the effects of ADIM and respiratory resistance alone, further studies should include two additional intervention groups performing ADIM and respiratory resistance respectively without stabilization exercises.

5.3.5 Further exploration of breathing exercises in osteopathic practice

According to this literature review and to the four outcome measures, there is an indication that breathing exercises have different effects and can affect different conditions.

It seems possible to be able to address pain experiences through breathing exercises. According to Wells et al. (2020), DSB with focus on the breath can reduce the subjective experience of pain and Oh, Park and Lee (2020) show that breathing with resistance has a good effect on LBP.

Breathing with resistance has also been shown to improve breathing function (Oh, Park and Lee, 2020), as does slow breathing according to Wells et al. (2020).
The study of Benjamin et al. (2020) also showed increased breathing function. The techniques used were diaphragmatic breathing, nasal breathing, longer duration of exhalation than inhalation, pause after exhalation and evenness of airflow, awareness and education concerning breathing. Daily practice of breathing exercises was also part of the study. The results of Hagman, Janson and Emtner (2011) also indicate that

education concerning breathing and daily practice of breathing exercises improved breathing function.

To receive education concerning breathing and to perform daily practice of breathing exercises has also been shown to reduce stress (Benjamin et al. 2020; Hagman, Janson and Emtner, 2011). The study of Smith and Norman (2017) also showed a reduction in stress by deep breathing, but only short term effect.

Increased quality of life has also been shown to be an effect of receiving education concerning breathing and to perform daily practice (Hagman, Janson and Emtner, 2011). Oh, Park and Lee (2020) could also show increased quality of life through breathing with resistance. Most often, all outcome measures in this literature review indirectly affect quality of life.

All of these mentioned breathing exercises could be possible tools for an osteopath to use to influence any of the outcome measures in this study. It is difficult to say that one breathing exercise only addresses one single outcome measure, it usually affects several.

The osteopath can contribute with education regarding breathing and breathing exercise. They also have the possibility to support the implementation of daily practice of breathing exercises for the patient if necessary. Through this, breathing exercises can be a tool for the patient to independently work with.

Since osteopathy in Sweden is not part of the primary healthcare system, it is not accessible for everyone. Thus, the profession is not well established and it is also a socio-economic issue. Being able to work with breathing exercises independently of a therapist could save both time and money. In this way, breathing exercises could be easily accessible and revisits minimized.

6 Limitations

The authors had limited experience of writing a literature review nor in the field of the subject investigated. With experience, the research question may have been more specific and thereby the articles more accurate in trying to answer the research question. More experience considering CASP would have been eligible in order to determine the reliability of the articles. In addition to this, several databases might have been preferable and articles of value may have been omitted due to no free access.

7 Proposal for further studies

Consensus regarding DB and breathing exercises is needed for further studies. More studies are warranted to distinguish the effectiveness of different contemplation and breathing techniques and also details about how much practice is needed to achieve the best effect. Further studies are needed to explore the mechanisms behind breathing exercises and also studies that investigate this in an osteopathic context.

8 Conclusion

The majority of the articles in this literature review indicate that breathing exercises are pain relieving but the mechanisms are unclear. Among the results, there was a decrease in pain and stress, an increase in physical function and improvement of symptoms of DB and quality of life.

However, there were also articles with no significant results. The authors of these articles discussed that these results could have been due to short intervention time, no regular practice and low level of experience regarding the intervention among the participants. In the osteopathic practice it is possible to meet these shortcomings. Osteopaths can contribute with education concerning breathing and breathing exercises, support and continuity. Breathing exercises can serve as a tool in the clinical practice and for the patient to work with on their own.

In order for osteopaths to take any breathing exercises into their clinical practice, it is of importance for the osteopath to be updated when it comes to the most effective techniques.
According to the studies in this literature review, breathing with resistance, awareness of breathing, diaphragmatic breathing, nasal breathing, longer exhalation than inhalation, pause after exhalation and evenness of airflow are the most effective techniques.
The four outcome measures evaluated in this literature review were; pain, stress, breathing function and quality of life. The results indicate that breathing exercises have different effects on the different outcome measures. More studies are warranted.

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