Expertise
and insight
for the future

Olivia Eriksson

Breathing Pattern Disorders and Musculoskeletal Pain

Metropolia University of Applied Sciences

Bachelor of Healthcare

Osteopathy

Bachelor's Thesis

Author(s)	Olivia Eriksson
Title	Breathing Pattern Disorders and Musculoskeletal Pain
Number of Pages	40 pages + 1 appendices
Date	4 June 2021
Degree	Bachelor of Healthcare
Degree Programme	Osteopathy
Instructor	Gudrun Göransson, DO MSc, project supervisor

The purpose of this study is to investigate if breathing pattern disorder correlate with musculoskeletal pain and if the cause can be emotional distress and/or anxiety.

This literature review is based on searches preformed on three different databases, with the search strategy of finding sources for breathing pattern disorders and musculoskeletal pain.

Results shows that there is a correlation between musculoskeletal pain and breathing pattern disorders and that the disorder can be caused by psychological/emotional distress. Results also show that the respiratory function can benefit from osteopathic manual therapy techniques.

The conclusion for this study is that a person that suffers from a breathing pattern dysfunction with associated musculoskeletal pain can benefit from getting treated with manual techniques and physiotherapy. This study also shows that there needs to be more research done on this subject due to the fact that there are no clear ways of identifying and classify a breathing pattern disorder. New assessment tools are needed.

Keywords	Breathing pattern disorder, musculoskeletal pain, functional movement, osteopathic manual therapy techniques, diaphragm

Table of Contents

Table list

List of Abbreviations

BPD(s)	Breathing pattern disorder(s)
COPD	Chronic Obstructive Pulmonary Disease
FMS™	Functional Movement Screen™
OMT	Osteopathic Manual Therapy
UCB	Upper Chest Breathing

1. Introduction

Breathing pattern disorders (BPDs) and musculoskeletal pain is a bother for many people but this issue is currently not well investigated (Chapman, et al., 2016). Breathing is a key for a functional body. If a person cannot breathe, they are not alive (Stępnik, et al., 2020). It is involuntary to breath, but necessary. Despite that BPD is just a dysfunction (Chapman, et al., 2016), it can affect a person's whole life in a negative way. Musculoskeletal pain can be an outcome of BPDs. If the body has poor circulation, structures in the body have a tendency to start causing pain. The pattern of breathing plays an important role in how much oxygen we get into our body. Upper chest breathing (UCB) is one of many causes not to let enough oxygen in, which in turn leads to bad circulation (Bradley & Esformes, 2014); (Perri & Halford, 2004). Problems with correct breathing pattern and the musculoskeletal pain that arises therefrom is a real thing, even if it is not a disease (Chapman, et al., 2016).

A breathing pattern disorder (BPD) is when there is a dysfunction in the breathing pattern one use when they breath. It is an abnormal pattern that either causes a person to get to mush oxygen or to little oxygen in. It can occur either in absence of concurrent diseases or it can occur secondary to a cardiopulmonary disease and is characterized by an irregular breathing pattern. Dysfunctional breathing has been identified among all ages (Vidotto, et al., 2019). A BPD can cause a lot of stress, which could increase the BPD (Chapman, et al., 2016).

Studies show that dysfunctional breathing both can arise from and cause anxiety and depression (Chapman, et al., 2016). This is known to be a factor that goes hand in hand. A lot of people who suffer from an BPD are also fighting with their psychological health. It is relatable to a chain effect, the more the psychological health is affected, the more the BPD is affected and the other way around. Because of this, the body does not get enough oxygen flowing through the body and this increases musculoskeletal pain. The musculoskeletal pain can arise from different things, maybe it is just from the decrease of oxygen flow in the body, or it can be a combination between lack of oxygen and the change of breathing pattern that occurs from hyperventilation caused by anxiety.

This study investigates what causes BPD and how it can be correlated with musculoskeletal pain. The main factors for a functional breathing and what the criteria

for a dysfunctional breathing is and what factors in the functional movement one should have an eye on while examine and treating someone with a BPD.

2. Background

Breathing pattern disorder (BPD) is characterized by abnormal respiratory pattern, the respiration loses its normal and natural rhythm. Normally it is about over-breathing, which can be specified as quicker and deeper breaths then what our body needs (Vidotto, et al., 2019). What is important to bring up is the fact that a BPD is not a disease, it is a dysfunction (Chapman, et al., 2016). Abnormal breathing pattern is either in absence of an organic disease (that is due to psychogenic causes like anxiety) or secondary to another disease, like neurological/cardiopulmonary diseases (that is due to physiological/organic causes such as heart failure and asthma) (Vidotto, et al., 2019). There is different kind of causes for a person to develop a BPD, which will be addressed further in this study.

If a person suffers from depression and anxiety, BPD will often be seen. In many cases there will be seen some type of difficulties with breathing. This gives a link between the psychological and the biomechanical aspect. Psychological distress causes a person to use accessory breathing muscles, which known as upper chest breathing (UCB); this often makes the breaths short and, in some cases, leads to hyperventilation (Bradley & Esformes, 2014); (Perri & Halford, 2004); (Courtney, 2009). Hyperventilation syndrome is the most known sort of breathing dysfunction. There are three different types of hyperventilation: chronic hyperventilation, acute hyperventilation and idiopathic hyperventilation. Chronic and acute hyperventilation syndrome are a type of breathing dysfunction and is most often caused by behavioral/psychological factors. Sometimes, but not as often as the previously mentioned reason hyperventilation is due to physiological/organic conditions. In the idiopathic hyperventilation syndrome people have chronic asymptomatic hyperventilation and respiratory alkalosis, that cannot be related to other underlying diseases. This form of hyperventilation is caused by psychological factors (Vidotto, et al., 2019). When hyperventilating (habitual chronic over-breathing) the amount of carbon dioxide increases which leads to respiratory alkalosis. Respiratory alkalosis can cause decrease in the threshold of peripheral nerve firing, muscle spasm, muscular tension, considerably increased perception of pain and emotional lability that produces anxiety (Perri & Halford, 2004).

Respiratory alkalosis is when the pH in the blood increases and this can be caused by a decrease of carbon dioxide in the blood. UCB can be a cause of the decrease of carbon dioxide. To measure this, it is possible to use Capnography. Capnography is a method to assess the biochemical aspect of the respiratory function. This method measures the average Carbon dioxide partial pressure at the end-tidal, this is the end of an exhalation and when this is compared to arterial Carbon dioxide measures (Bradley & Esformes, 2014). According to Bradley and Esformes, respiratory alkalosis can change the psychological, physiological and neuronal states in the body, and it affects health in a negative way. It is also possible that the respiratory alkalosis makes affected skeletal muscles prone to fatigue, trigger points and dysfunction due to decreased oxygenation in the tissue, altered electrolyte balance and constriction of smooth muscle. There is also a possibility that the muscle tone can be altered when in rest (Bradley & Esformes, 2014).

Upper chest breathing (UCB) is not a normal way of breathing and it is an inefficient way of breathing. This is accomplished by lifting up the sternum vertically by overuse of mm. Scaleni bilaterally. Also, a person with UCB overuses the muscles levator scapulae and trapezius. A good, normal and relaxed breathing occurs when widening the ribcage in the horizontal plane. UCB and the lift of sternum during respiration is an inefficient way of breathing and causes a lot of problems. Results of this can be that the inter-costal muscles can get decreased activity, chronic cervical overstrain and the rib function can be reduced. Muscles like trapezius, serratus anterior, latissimus dorsi and pectoralis major and minor is not the typical breathing muscles, but they take on a role as “ribcage lifters” during inhalation and contribute to the incorrect breathing pattern instead of practicing their purpose with the postural function. A result of this kind of incorrect breathing pattern, big groves over de clavicular bones appear as a side effect. People with UCB also shows signs of having a forward head posture and neck pain. People who were found to have of neck pain also showed signs of poor respiratory chemistry. When exhalation is passively done by elastic forces by lungs, costal cartilage and abdominal wall and the diaphragm is supposed to ascend in a relax state. During a correct exhalation the thorax and ribs are meant to be drawn down and in by the abdominal wall that should be drawn toward the spine. A faulty exhalation technique is when the breath is held in and not fully exhaled, the motion of the ribs is reduced. This

is what called paradoxical breathing, when both inhalation and exhalation is impaired (Perri & Halford, 2004). Pattern of UCB can be difficult to break, to go from UCB to diaphragmatic breathing due to the fact that the UCB makes the assessor breathing muscles hypertonic. This makes it difficult for the diaphragm to go back to an optimal resting position (Bradley & Esformes, 2014).

Paradoxical breathing is the most severe breathing dysfunction. It occurs when the breathing pattern is in the wrong direction. The abdomen is drawn in during inhalation and out during exhalation. This type of breathing pattern is related to chronic obstructive pulmonary disease (COPD) and stress or it can occur from the wish of having a flat stomach and holding in the abdomen is a way of achieving that (Perri & Halford, 2004); (Chapman, et al., 2016); (Courtney, 2009).

The primary respiration muscles are the diaphragm, scalenes, transverse abdominus, inter-costals, deep intrinsic muscles of the spine and muscles of the pelvic floor. These muscles are also used for core stability. UCB is the most common BPD. Instead of widening in the horizontal plane, UCB is when the sternum lifts up vertically during inspiration (Perri & Halford, 2004). A normal breathing pattern is when the diaphragm is used and works together with the abdomen, lower rib cage and the upper rib cage. A dysfunctional breathing is when only the upper chest is used, and this can be a cause of a BPD. If a BPD is developed, there is a chance that a musculoskeletal dysfunction will develop as well. One dysfunction increases the other and the chain goes on. People with a dysfunctional breathing is also prone to have a bad posture, low back pain, scapular dyskinesis, neck pain and temporomandibular joint pain. According to Chapman, et al., it is important when you look at a person's posture to note how they are holding up their body, a hunched or slumped position can possibly limit the ability for the diaphragm to expand properly (Chapman, et al., 2016). UCB is when the accessory muscles (upper trapezius, sternocleidomastoid and scalene muscles) do most of the breathing instead of the diaphragm that is supposed to do most of the work. When the accessory muscles are the main muscles for breathing, trigger point formation, scapular dyskinesis and neck pain is often connected to this (Bradley & Esformes, 2014). When it has been validated that the UCB is the dominating breathing pattern, it is clear to say that there is reduced diaphragm action. The diaphragm also has a postural function and when one function of

the diaphragm is interfered, it can also affect the other functions in a negative way (Bradley & Esformes, 2014).

The most important muscle for breathing is the diaphragm and it accounts for 70-80 % of the inhalation force (Chapman, et al., 2016). Therefore, it is important that this muscle works properly and is in good function for the breathing to work properly. It is important in both inhaling and exhaling, but as well as for the mobility of the ribcage (Stępnik, et al., 2020). If there is a dysfunction of the diaphragm, it will affect the respiratory function (Bordoni, et al., 2016). The diaphragm contributes to several other functions like urination, vomiting, swallowing, expectoration, defecation and venous and lymphatic return. According to Bordoni, et al., the diaphragm also has an important role for the posture, and the body position and it can affect the pain perception. Chemoreceptors provides stimuli to the respiratory act and is the most important stimuli, their job is to help the body to maintain biochemical balance. One more strong stimulus is the emotional aspect, such as feelings, anxiety, and depression (Bordoni, et al., 2016); (Courtney, et al., 2011). Anxiety and depression can be a cause of BPD, which can lead to UCB and this in turn can lead to a chain reaction (Bradley & Esformes, 2014). The BPD is going to give the person more anxiety, since lack of oxygen is stress inducting and with this the BPD is reinforced and the chain reaction is enhanced. The deeper the BPD goes, the less circulation the body gets and the more musculoskeletal pain there will be.

Physiotherapy can be of use for the diaphragms function. The diaphragm is adaptable, and thanks to this adaptive ability, there is a good chance to affect people with respiratory diseases with anaerobic resistance training and aerobic training to increase the diaphragms performance. It can be beneficial for a person to combine manual treatment and physiotherapy, in order to improve the respiratory function (Bordoni, et al., 2016).

If there is trouble getting enough oxygen in to the body, there will be lack of circulation. Muscles that do not get enough circulation will hurt, which leads to musculoskeletal pain. Therefore, musculoskeletal pain can occur if a person has BPD. The autonomic nervous system and the central nervous system get influenced and mediated by neuromusculoskeletal responses. One’s breathing can get affected by a lot of different

things, some examples are physiological, psychological, biochemical and biomechanical (Chapman, et al., 2016); (Hansen-Honeycutt, et al., 2016). If a person shows signs of hypersensitivity to light palpation, there is a chance that the autonomic nervous system may have difficulties balancing the body's involuntary systems, the sympathetic and parasympathetic nervous systems. If the body always is in a protective state through activity in the sympathetic nervous system, there is a chance that the body will show a withdrawal reflex during palpation due to the fact that the body is in an up-regulation (when the sympathetic nervous system makes the body stay in a protective state) state. To get the body to down-regulate, it is possible to use manual therapy on the affected areas to help with this and hopefully take the pain away. Since the areas where the withdrawal reflex is tender to palpation, it is good to assess these areas due to the fact that there may be a chance that musculoskeletal pain and BPD can be caused by an up-regulation in the autonomic nervous system (Chapman, et al., 2016); (Hansen-Honeycutt, et al., 2016).

It is important to be able to breath with a normal breathing pattern and it influences the spinal stabilization and posture. The breathing mechanisms plays an important role in the neuro-musculoskeletal system. There must be a normal motor program set by the nervous system for respiration. The breathing mechanisms are also affected by bio-mechanical, biochemical and psychosocial factors. There is an important connection between a person's health and their respiratory function, and this is connected through the autonomic nervous system. The fundamental function that carbon dioxide has to maintain the acid-base balance in the body is one explanation, it can have enormous effects on the immune and endocrine systems, pain perception, muscle function, emotional lability just by one subtle change (Perri & Halford, 2004); (Courtney, et al., 2011).

Breathing pattern disorder (BPD) can have an influence on the motor control of scapula, lumbar and the cervical regions and by this there is a chance that it has a detrimental effect on the functional movement of this region of the body. To assess this and the kinetic chain of the body it is possible to use a tool that is a screening tool called "Functional Movement Screen™" (FMS™) (Bradley & Esformes, 2014). This tool gives the opportunity to evaluate the kinetic chain that links the body together with segments that rely on one another. With this tool it is possible to see the correlation

between BPD and the functional movement of the body and by this be more aware of how the BPD is related with musculoskeletal pain. When breathing pattern is evaluated, usually there is a clinical observation to compare persons with no BPD with person how has a BPD to evaluate different types of breathing patterns and by this it is possible to do a biomechanical diagnosis of the BPD. To be able to use this kind of assessment, the chest and abdomen motion is observed in a seated position in rest. This way it is possible to notice various types of stimulated breathing patterns (Bradley & Esformes, 2014).

A breathing pattern disorder (BPD) can also be a response to emotions arising from a traumatic situation. Secondary symptoms of BPD can be trouble taking a deep breath, frequent yawning, panic attacks and fatigue (Chapman, et al., 2016). BPD is a problem for a lot of people. Within conventional medicine, it is common to think that a breathing dysfunction is some sort of cardiopulmonary disease, such as asthma or COPD (Vidotto, et al., 2019). Since looking at BPDs from many different angles, including psychological and biomechanical angles is quite new, conventional medicine might not yet understand the implications of this and it gets misdiagnosed or misunderstood. This is possibly also why it is underdiagnosed (Vidotto, et al., 2019). According to Vidotto, et al., the reasons for misdiagnosing can be a lack of understanding and studies done on pathophysiology, classification, and symptoms on the subject. It can be difficult to differentiate different kind of dysfunctional breathing and cardiopulmonary diseases since the symptoms can be quite similar (e.g., tachycardia, dyspnea, dizziness and paresthesia). The authors also mention that there might be some misunderstandings about the causes, diagnosis and treatment for dysfunctional breathing which may be a reason that people do not get the appropriate treatment (Vidotto, et al., 2019).

3. Aim

The aim of this study is to build a better understanding and get more knowledge about breathing pattern disorders (BPDs) and the symptoms of the associated musculoskeletal pain. It is to find out if there is any correlation between BPDs and the functional movement of the body and if musculoskeletal pain gained from the BPDs can affect that (Bradley & Esformes, 2014), what the causes of the BPDs is and if there are

biomechanical changes that occur while the BPD develops. It is also important to keep the psychologic aspect, due to the fact that it can be quite stressful not be able to breath properly.

Since there is some misunderstandings and misdiagnosis regarding BPD this study will attempt to achieve a better understanding of the issue at hand and find out if there is evidence that alternative medicine can help persons that suffers from a BPD. The aim of this study is to build knowledge about the BPDs and to learn if alternative to conventional medicine do exist and that if it can be a tool to help for those who need it (Vidotto, et al., 2019).

3.1 Research Question

The question that should be answered by this research is if the breathing pattern disorders (BPDs) is correlated to musculoskeletal pain and if it can occur from emotional distress/anxiety.

4. Method

Before the research started, two books were read to build a good understanding and wide knowledge about the subject. The first book is written by Leon Chaitow, Dinah Bradley and Christopher Gilbert (2014) with the name ”Recognizing And Treating Breathing Disorders”. The second book read for background was “Seeley’s Anatomy & Physiology” by Cinnamon VanPutte, Jennifer Regan, Andrew Russo, Rod Seeley, Trent Stephens and Philip Tate (2017).

4.1 Study design

The method of this study is a literature review. This means that there has been a deep and thorough background reading, searching for resources of articles, building a knowledge and to find the most recent and appropriate studies made on the subject.

During the research for this study, it became quite clear that this is a relatively unexplored area, the information available about this is fairly new and it is only in recent years that one has begun to get clarity on what BPD is. There are some older studies on this, but most of them are from the last 6-8 years.

4.2 Ethical Considerations

In the article written by Perri & Halford (article summary 1), there were childrens down to 11 years old participating, but they only had to answer questions and their breathing patterns were observed and analysed in different positions (Perri & Halford, 2004).

The article written by Bradley & Esformes, (article summary 2) has ethical approval granted from Cardiff Metropolitan University Ethics Committee and all participants had to sign an informed consent prior to the study (Bradley & Esformes, 2014).

The article written by Bordoni, et al, (article summary 3) reports that they had no conflicts of interests with their work (Bordoni, et al., 2016).

The articles written by Chapman, et al., (article summary 4) and Vidotto, et al., (article summary 5) does not mention anything about ethical considerations (Chapman, et al., 2016); (Vidotto, et al., 2019).

The article written by Stępnik, et al., (article summary 6) reports that they have granted permission for their study by the Etihcal Committee of Józef Rusiecki University Collage in Olsztyn and that all participants had to sign a written consent prior to the study (Stępnik, et al., 2020).

4.3 Selection process

A search on the search engines PubMed, Cinahl and Google Scholar, was carried out looking for articles in medical journals and manual therapy journals. The search strategy is to be seen in “Table 1”. All the searches were carried out between: October 1, 2020 - Mars 1, 2021.

Table 1. ***Search strategy***

Database	Search terms	Number of hits	Relevant hits	Articles included

Google scholar	breathing pattern disorder and musculoskeletal pain *The words "breathing pattern disorder" needed to be included in search results* *The words "dysfunctional breathing" needed to be included in search results*	37 400 *295* *318*	15	3
Pubmed	breathing pattern disorder *Filtered with "free full text"* *Filtered with "Randomized Controlled Trail",*	13 234 *4 482* *420*	9	2

	"Systematic Review", English and humans			
Cinahl	breathing pattern disorder or dysfunctional breathing	67	19	1

The articles that have been chosen for this study has been thorough read and analyzed piece by piece to get a good and wide knowledge about the subject BPD and all the angles that has been studied in this work. There has been selection of the articles with the help of an inclusion- and exclusion criteria regarding what to include and what not to include in this study. See "Table 2.". When there has been to many hits on a search string with limited options on filtering left, only the title of the article has been used as an exclusion, if there were no match at all to the chosen topic.

Table 2. ***Inclusion- and exclusion criteria***

Inclusion criteria	**Exclusion criteria**
Articles written in English	Studies only focusing on pathology
Studies related to some sort of breathing pattern disorder	Paid articles
Studies taking the emotional aspect in concern regarding breathing pattern disorder	Studies with children under 10 years

The articles that fit in the frame of randomized control studies have been reviewed using the PEDro-scale. The PEDro-scale is a protocol that are answered to ensure the quality and evaluate the reliability and validity of the articles using 11 specified criteria. The

presentation of the results is to be seen in “Table 3”. The criteria answered with yes received “1” and the criteria answered with no received “0”.

Table 3. ***PEDro-scale***

Arthur	**1.**	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**	**8.**	**9.**	**10.**	**11.**	**12.**
Bradley & Esformes, 2014	1	0	0	1	0	0	0	1	1	1	1	***6/11***
Perri & Halford, 2004	0	0	0	1	0	0	0	0	1	1	1	***4/11***
Stępnik, et al., 2020	1	1	1	1	1	0	0	0	1	1	1	***8/11***

Criteria description: *1. Clear selection criteria 2. Random distribution 3. Allocation was concealed 4. Similar at baseline 5. Blinded participants 6. Blinded therapists 7. Blinded assessors 8. Adequate follow-up 9. Intention-to-treat analysis 10. Comparison between groups 11. Point measures and variability 12. Total score*

The articles that do not fit in the frame of randomized control studies have been analyzed in the article’s summaries. These articles are Bordoni, et al., 2016 (article summary 3), Chapman, et al., 2016 (article summary 4) which is a clinical commentary, and Vidotto, et al., 2019 (article summary 5) which is a narrative review.

4.4 Methodological issues

There were no big methodological problems during the search of articles prior to this study. One difficulty was that the area of BPD is a bit unexplored and many of the articles that do exist on this subject mention that more research on BPD is needed. It was also a bit hard to filter out articles that was not related to the subject.

5. Results

Results will be analyzed article by article in article summaries.

5.1 Article summary 1

Title: Pain and faulty breathing: a pilot study
Arthurs: Maria A Perri, Elizabeth Halford
Publication year: 2004
Journal: Journal of Bodywork and Movement Therapies

Main area of research:
This study investigates the correlation between a faulty breathing pattern and musculoskeletal pain. In the study they observe breathing patterns in a relaxed state and deep breathing to determine the difference between a faulty and normal breathing pattern. The results of this test were then put together with the results from answers asked about history of pain. If they were able to see a correlation between musculoskeletal pain and faulty breathing pattern, it was suggested that the breathing pattern disorder (BPD) should be addressed by the clinicians working with patients suffering from chronic pain and that they should be able to see an improved outcome.

In this study they performed a test with 111 participants, but only 94 of the participants followed through the whole test. The participants were in the ages between 11 to 80 years old and there were 32% men and 68% females. The article does not mention if the participants were diagnosed with any BPD before this study took place, but since the conclusion the authors draw is that BPD is very common, we can assume that the participants were a random, healthy population. The test started with a survey that was self-administrated and then there was a physical examination. The survey included questions about musculoskeletal pain pattern and radicular pain and also for how long they have experienced the pain. They also got to answer when they for the first time felt this kind of pain and how often it appears.

In the physical examination there were findings that shown that a lack of lateral rib motion could indicate a mild faulty breathing. A moderate finding could be lifting the collar bones during respiration and a severe finding could be paradoxical breathing or clavicular grooves.

Results of relevance for the study at hand:

The participants who had some kind of pain reached up to 87.2%. In a relaxed breathing pattern, there was 56.4% who showed faulty breathing and when the participant was asked to take a deep breath the number increased to 75% who showed faulty breathing. It is due to the high percentage important to evaluate whether the faulty breathing is really a fault or if it is within normal values. In the criteria for breathing dysfunction, it is a wide spectrum of different dysfunctions all including major to minor forms of BPDs. The article discusses if the criteria for what faulty breathing is needs to be evaluated since faulty breathing might be more common then they first believed or simply if the results may be from examiner error.

One type of musculoskeletal pain that showed a significant relation to faulty breathing is neck pain. The answers from the survey regarding neck pain correlated well with the test results from the physical exam. In general, internal medicine practice a BPD is reported on 10% of all the patients. The study shows that there is a correlation between dysfunctional breathing mechanics and neck pain and that there is a correlation between the amount of pain a person feels and their breathing pattern. According to this study it is more common for a person to have a BPD than not to have one and that there are signs that BPD and musculoskeletal pain is correlated.

The authors claims that there is no widely accepted standard of normal and tried to define what a normal and faulty motor pattern for respiration is. A weakness with this study is that it is rather small. As the title of the article states, it is a pilot study and with this limitation it is difficult to draw definite conclusion from the data of this study.

5.2 Article summary 2

Title: Breathing pattern disorder and functional movement
Arthurs: Helen Bradley, Joseph Dr. Esformes
Publication year: 2014
Journal: International Journal of Sports Physical Therapy

Main area of research:

The aim of this study is to find out if there is a correlation between breathing pattern disorder (BPD) and the functional movement of the body. They investigate people with a normal breathing pattern (diaphragmatic breathing) versus persons with a dysfunctional breathing pattern.

In this study they use a Capnography machine, it is suggested that values lower than 35mmHg is influenced by BPD and that a normal range is between 35-40 mmHg. They also use the screening tool "Functional Movement Screen™" (FMS™), the examinator for this test is Level 1 certified in FMS™ system. Scores like 14 or lower indicating dysfunctional movement pattern.

The study was done with 34 healthy participants, including both women (n = 20; age 30.5 ± 5.8 years; weight 61.2 ± 8.1 kg; height 165.0 ± 5.6 cm) and men (n = 14; age 32.3 ± 8.0 years; weight 81.2 ± 11.6 kg; height 180.5 ± 7.3 cm) and they had to be at least 18 years old and sign an informed consent prior to testing. On the testing day, the participants should not report any pain or be under care for any musculoskeletal pain by another type of medical professional. The participants also needed to be active (physical activity at least three times a week) and live at the same altitude (2484 meters above sea level) as the test was performed (at least for the last three mounts). The test included a session of 20 minutes where they used five types of methods to assess BPD and movement patterns. The tests that they used was: FMS™ to measure the movement pattern (dysfunctional movement), the Nijmegen Questionnaire, respiration rate, Hi Lo assessment and breath-hold time. There was also a health questionnaire done. When the participant answered both questionaries, they were connected to the capnography machine to measure the respiration rate and the average resting end-tidal Carbon dioxide. The capnography machine was also used during the FMS™.

The article mentions some limitations for the study. The altitude may affect the results done with the capnography machine. Reliability was not examined for the Hi Lo breathing assessment in this study. Even though the reliability has been established previously, the method remains to be examined. It is also mentioned that all tests performed during this study had the same examiners, which could be leading to bias amongst data scoring. The study does not mention anything else regarding if the tests included are validated. The study has a score of 2B on "level of evidence", but does not mention on which scale and with which measurement method.

Results of relevance for the study at hand:

The scores from both the Capnography and the FMS™ together assesses respiratory function in the biochemical aspect were correlated (both examined at rest). The indication of effective respiratory function with a higher end-tidal Carbon dioxide (higher then 35mmHg) were correlated with a higher score on the FMS™ (higher then 14). These findings indicates that if a person has a BPD, with scores lower then 35mmHg (based on the results from the capnography) they also, most likely have a problem with movement patterns that are dysfunctional based on the FMS™ test with scores like 14 or lower.

There were some differences between the scores on the different tests that indicated BPD. Over 70% of the participants showed signs of BPD during the test for resting end-tidal Carbon dioxide and resting respiration rate (the authors do not clearly state how this number are calculated. One can thus not interpret where the authors has drawn the line between what is a normal and abnormal breathing pattern). In the active test for end-tidal Carbon dioxide and breath-hold time 50-60% of the participants showed abnormal scores, while in the Nijmegen Questionnaire only 5.88%. Participants who scored worse on the FMS™ showed a less efficient breathing pattern (UCB) in comparison with participants who has a normal breathing pattern (diaphragmic breathing). Of all participants who was classified with having UCB, 75% of them scored less then 14 on the FMS™. The participants that were classified as diaphragmic breathers, 66.6% had scores like 15 or higher on the FMS™. For the participants who were “cleared” on the FMS™, 87.5% were classified as diaphragmatic breathers.

The result from this study indicates that there is a correlation between BPD and functional movement and that diaphragmatic breathing is of high significance. The functional movement gets more dysfunctional the greater BPD there is.

5.3 Article summary 3

Title: Manual evolution of the diaphragm muscle
Arthurs: Bruno Bordoni, F Marelli, B Morabito, B Sacconi
Publication year and issue number: 2016, 11
Journal: International Journal of Chronic Obstructive Pulmonary Disease

Main area of research:

This study investigates ways of how to manually evaluate the diaphragm muscle and if the diaphragm can benefit from both physiotherapy and manual treatment, for example from an osteopath. The study states that the diaphragmatic motion can benefit from respiratory rehabilitation. This study does not compare different type of assessments or treatments but tries to give a tool to evaluate and assess the diaphragm muscle to use while examine, and with the result from the assessments proceed into treatment.

In this study they use seven different assessment techniques for manual evaluation of the diaphragm (table 4).

Table 4. ***Manual evolution techniques, article summary 3***

Technique	Performance	Purpose
Assessment of costal movement	*Patient:* in supine position. *Therapist:* hands placed on lateral sides of costal margins, lateralization in caudal direction during inspiration and the opposite during expiration.	Palpatory feedback of breathing behavior. If the diaphragm is dysfunctional, costal movement is limited.
Assessment of diaphragmatic excursion	*Patient:* in supine position. Therapist: hands anteriorly on costal margins with thumbs at margin´s level and fingers on the ribs.	The diaphragm is lowered during inspiration and rises during expiration, this technique gives a chance to evaluate the diaphragm excursion.
Assessment of diaphragmatic domes	*Patient:* in supine position. Therapist: forearm held parallel to abdomen with	Assesses the elastic response of tissue.

	thenar and hypothenar eminences of hand at level of anterior margin of costal arch. Slight push in cranial direction in both left and right direction.	
Assessment of posterolateral area	*Patient:* in supine position *Therapist:* Hand placed as in the previous technique, but with forearm forming angle of 45° with patient´s abdomen. Slight push obliquely. Repeated on both sides.	Assess higher movement excursion during respiration.
Assessment of xyphoid-costal area	*Patient:* in supine position. *Therapist:* Hand placed as in the previous to test, but slightly more up right in the xyphoid area. Slight push applied cranially.	Assesses if there is a regular elasticity of tissue during inspiration and expiration.
Assessment of medial ligaments	*Patient:* in supine position. *Therapist:* Holds last phalanges of fingers in interspinous spaces of TH11-TH12. To get a passive extension of vertebra, slight push	Assesses spinal elasticity.

	towards the ceiling is applied.	
Assessment of lateral ligaments	*Patient:* in supine position. *Therapist:* one hand placed on the opposite side of which rib that should be examined. Slight traction toward the therapist is applied.	Assesses the managing of tension affecting diaphragm and the thoracolumbar fascia.

These techniques are used to gain an understanding of the diaphragm and if there are any restrictions in the movement. This is used as a tool to be able to plan a manual treatment and/or physiotherapy (rehabilitation) of the diaphragm.

Results of relevance for the study at hand:
Since the diaphragm is the most important muscle for breathing it is significant that the diaphragm is in good shape. It is not only important for people that suffers from a respiratory disease, but for everyone. The article concludes that to combine physiotherapy and manual treatment for the diaphragm, is thought to be beneficial for people with a respiratory dysfunction. This article aim is to give an assessment tool for the diaphragm, so that in the future when the functional movement of the diaphragm is evaluated the therapist knows how to proceed into treatment from the results they got from using the assessment presented in this study.

The aim of this study is to give a suggestion of manual evaluation of the diaphragm, with the anatomical essentials in particular attention. But the authors also mentions that the knowledge on what happens in the anatomical areas around the diaphragm on persons with a respiratory disease is not totally complete.

5.4 Article summary 4

Title: A clinical guide to the assessment and treatment of breathing pattern disorders in the physically active: part 1
Arthurs: Erin B. Chapman, Jena Hansen-Honeycutt, Alan Nasypany, Russell T. Baker, Jim May
Publication year: 2016
Journal: International Journal of Sports Physical Therapy

Main area of research:

This study investigates how to incorporate assessment of a breathing pattern disorder (BPD) into an orthopedic examination in a clinic. They also look at how musculoskeletal pain can correlate with a BPD and if a treatment of the BPD can help the pain. According to this article, it may be a missing component in the treatment for patients that suffers from musculoskeletal pain to be able to assess and treat a BPD. To assess a BPD, it is possible to use different kind of assessment techniques. But the assessment does not start when the test starts, it begins from the second the patient enters the room. Looking at a patient when they are not aware of the fact that they are being assessed can give some hints of how their breathing and their posture can affect them.

This article brings up four types of assessments, the “Hi Lo assessment”, “Manual Assessment of Respiratory Motion”, assessment of tender areas to see if dysfunctional breathing can arise from it and assessment for withdrawal reflexes and jump signs. The first type of assessment mentioned is the “Hi Lo assessment”. With this assessment the patient lies down in a supine position with one hand on their abdomen and one hand on their chest, while being asked questions for the anamnesis. The second assessment mentioned is a palpatory assessment method, “Manual Assessment of Respiratory Motion”. This method gives the opportunity to assess the diaphragm function and see what type of breaths the patient takes. The patient is seated, and the therapist is standing behind the patient with their hands on the ribs of TH11 and TH12, on the lateral and posterior aspect. The patient breathes while the therapist holds the hands in position to feel the functional movement of the ribcage. The results of the test are either positive

(vertical movement/chest breathing) or negative (lateral movement/abdominal breathing). A positive test indicates some sort of dysfunctional breathing. The third assessment assesses a dysfunctional breathing pattern by palpating for tender areas and the fourth assessment observe the patient for withdrawal reflexes and jump signs around the ribcage.

This study proposes that there are six types of primary BPDs and that these can be classified as described in table 5.

Table 5. ***Classification of BPD, article summary 4***

Breathing pattern disorders
Only belly
Only belly and lateral
Asymmetrical
Startle reflex
Paradoxical
Apical (chest breath)

A normal breathing pattern is abdominal/diaphragmatic breathing, but it is important to note that this might not be the most optimal or ideal for every person. There can be some deviations of abdominal breathing of the BPDs mentioned in table 5 that can classify into normal breathing, as long as they are not too dominating. What is an ideal breathing pattern for one person, might not be the ideal breathing pattern for someone else.

Results of relevance for the study at hand:

This study points out how that musculoskeletal pain can be caused by a BPD and how to examine and classify the BPD treatment before or after the BPD is found. They are also looking at the connection between the BPD and musculoskeletal pain. The difficulty with diagnosing a BPD is that it is no disease, it is usually hard to recognize it until the assessment is accomplished. There are many different causes for a BPD to

arise and some are still unknown, but the most common ones according to this article are due to psychological, biomechanical, or biochemical factors. Dysfunctional breathing patterns can be connected with neuromuscular patterns. Pain and dysfunction in different structures can occur by structural and postural adaptation and is prone to result in BPD. However, the authors have not specified what these conclusions are based on.

According to this article, the respiration system is under big influence from the biochemical component. Breathlessness, dyspnea, premature fatigue or muscle pain can occur and if there is a change in the body's pH level, hormone levels, allergies, dietary factors or in the internal organs. Emotional factors, like anxiety and stress can also contribute to a BPD. This study suggests that the BPD can be affected by past experiences and memories. But the authors also mention the fact that the understanding of emotional factors is limitedly researched.

According to this article both normal and abnormal breathing pattern can affect functional movement. It is of important to be able to identify and classify a BPD so that a person can get the correct help. Maybe the person needs to be reeducated in their motor control patterns or needs exercises to help the muscles relax. With this help, the person may have an increase of their quality of life.

This article has 5 points on "level of evidence", but do not mention on which scale and with which measurement method.

5.5 Article summary 5

Title: Dysfunctional breathing: what do we know?
Arthurs: Laís Silva Vidotto, Celso Ricardo Femandes de Carvalho, Alex Harvey, Mandy Jones
Publication year: 2019
Journal: Jornal Brasileiro de Pneumologia

Main area of research:

This study investigates dysfunctional breathing, how it is underdiagnosed, misdiagnosed and the fact that there it is no clear way of diagnosing this condition. One of the main reasons for misdiagnosing dysfunctional breathing is that there are too few studies done on classification, pathophysiology and symptoms. There is also resemblance between the symptoms (e.g., dizziness, paresthesia, tachycardia, paresthesia and dyspnea) of dysfunctional breathing and some of the most common cardiopulmonary diseases. Dysfunctional breathing includes different forms of breathing pattern dysfunctions. If a person goes undiagnosed or misdiagnosed, it may impact on one's quality of life. A breathing pattern disorder (BPD) is often secondary to neurological diseases or caused by anxiety. According to this article, dysfunctional breathing is a common problem present in people from 17-88 years of age (the age span seen in approximately 9.5% of all adults in primary care in the United Kingdom) and females are more represented than men. It is also more prevalent in people with asthma.

This study proposes some different ways to identify and classify a BPD. One way of identifying a BPD is with the help of the Nijmegen Questionnaire, which from the beginning was intended to be a questionnaire for screening hyperventilation syndrome. This questionnaire is composed by 16 questions regarding complaints and how often they have symptoms and is most correlated with the physiological and psychological factors. Then there is a provocation test to identify hyperventilation syndrome. With this provocation test the patient is asked to breath as quickly as possible with deep breaths for approximately 2-3 minutes. If the patient can report any symptoms resembling what they experience in their day-to-day life after the test, then the patient can be diagnosed with hyperventilation syndrome. The last test they suggested to identify hyperventilation syndrome is a cardiopulmonary exercise. This test is for patients who are suspected of having hyperventilation syndrome, but who do not experience symptoms at rest. This test is for persons where they suspect hyperventilation syndrome, but the test can also be used as an exclusion for causes of dyspnea.

The different tests to identify and to diagnose dysfunctional breathing are summed up in table 6.

Table 6. ***Diagnosing dysfunctional breathing, article summary 5***

Diagnosing	Application
Nijmegen Questionnaire	Questionnaire to identify patients with dysfunctional breathing.
Hyperventilation provocation test	Diagnosing hyperventilation syndrome.
Cardiopulmonary exercise test	Diagnosing hyperventilation syndrome on a patient who do not know if they have hyperventilation syndrome.

These tests can be a good complement to manual assessment tools when trying to diagnose a BPD.

Results of relevance for the study at hand:
This study tries to give assessment tools to identify and diagnosing a BPD, but mostly looking at how to diagnose hyperventilation syndrome and what the causes of hyperventilation syndrome is.

This study points out that it is important to look at all angles regarding BPD. There are some aspects that needs to be addressed if there is s suspicion that someone suffers from BPD. These aspects are the social, psychological, physiological and biochemical aspects. It is common among people that suffers from hyperventilation syndrome to also suffer from depression and anxiety. It is also common that people with dysfunctional breathing have deviating psychophysiological responses to situations that are emotionally challenging. When this type of situations occur, changes can be seen in depth of breath, breath-hold time and respiratory rate. If this is a chronic state, it may affect the quality of life.

There is a correlation between dysfunctional breathing and the psychological condition. When diagnosing a BPD it is important to take the emotional state in consideration.

5.6 Article summary 6

Title: Short-term effect of osteopathic manual techniques (OMT) on respiratory function in healthy individuals
Arthurs: Jakub Stępnik, Agnieszka Kędra, Dariusz Czaprowski

Publication year: 2020

Journal: Plos One

Main area of research:

This study examines the impact osteopathic techniques can have on the breathing function. The aim is to see whether both soft tissue techniques and manipulative osteopathic manual therapy (OMT) techniques can have a positive effect on the respiratory function or not. The study also investigates if OMT can affect the mobility of the thorax (including all ligaments, muscles, fascia, bones, intervertebral joints and costovertebral joints) and also pleura, lungs and diaphragm, and their innervation.

When a person suffers from a pulmonary disease, symptoms like coughing, anxiety/depression, dyspnea, exhaustion, and pain is often seen. Normally osteopathic manual therapy (OMT) is not the traditionally way to treat someone that suffers from a pulmonary disease, but in the recent years more research has been done in this area and there seems to be positive treatment effects of OMT treatment on pulmonary diseases. This study is concerning OMT and pulmonary diseases includes people with chronic COPD or asthma. These persons received specific soft tissue techniques but has not indicated any statistically improvement to their lung function from the treatment.

The study's duration time was six weeks. They had a sample group of thirty volunteering people with ages between 19-46. The sample group are then randomly divided in to two groups, one placebo and one experimental group. In the placebo group the ages were 25-46 years and in the experimental group the ages were 19-42 years on the participants. They have used different exclusion criteria when the sample group was chosen. The exclusion criteria is; males, known allergies, chronic diseases, headache, acute visceral problems, heart problems (e.g. high blood pressure – over 140/90, arrhythmia, hypertrophic heart disease, congenital heart disease, coronary artery disease, mitral regurgitation), lung problems (e.g. influenza, lung infection, lung cancer, pulmonary edema, pulmonary embolism, COPD, asthma, pneumothorax bronchitis, cystic fibrosis, tuberculosis, sarcoidosis), acute illnesses in the past three months, drug taken in the past 3 months related to heart or respiration, pregnancy, vertigo, previous surgery done on the thorax area and contraindications known from before to manipulation.

Before they started with the treatment techniques, they did a test with the help of a spirometry device, a pneumotachometer. Both the experimental group and the placebo group were asked to use the spirometry test. When preforming the spirometer test the participants where well prepared on how the test works and what they should do. To perform the test correctly they should use their maximal exhalation force. The participants were instructed to do the test with only underwear on and they sat on a chair with their head held in a neutral position. The test was always done with the same temperature in the same room. The spirometry test was also done after the treatments to compare with the results from before.

All techniques in both the experimental group and the placebo group were performed by an osteopath who also is a physiotherapist with 10 years' experience and also consulted with two additionally osteopaths with 20 years' experience at least. In the experimental group they used three techniques aiming to influence lung function (see table 5).

Table 7. ***Experimental group, article summary 6***

Technique	**Position**	**Performance**
Supine thoracic thrust manipulation	Participant: supine position, grabbing their own shoulders with opposite hands, elbows pointing downwards, head turned to the left. Therapist: approached the participant from left side, rolled her towards himself (only until therapist could put one hand under her spine), putting left hand under the spine with a pistol	Joint play was tested in the direction of traction. Pressure was applied on segment until capsule tension was reached. Thrust applied by therapist placing right hand across participant's left arm and thorax, applying traction by pushing

	grip to fixate the vertebra underneath.	participant's elbow toward the shoulders.
Sternal Pump and sternal recoil	Participant: supine position Therapist: standing behind participant's head, both hands placed on participant's sternum on top of each other.	Participant inhales deep and when exhaling pressure was applied in both a posterior and caudal direction. Pressure released during next inhalation. Repeated five times and the two last timed preformed with recoil.
Diaphragm stretch in sitting position	Participant: sitting position Therapist: standing behind participant with both hands around the participants holding on underneath the lower part of costal border grabbing the whole costal margin.	Therapist following the inspiration movement of the ribs and stopping the ribs from returning during exhalation. During inhalation the therapist followed the movement. During exhalation therapist resisted the thoracic border by pulling gently until feeling of resistance. Then the position was maintained. The performance was repeated several times with different positions on the thoracic border.

In the placebo group they used soft tissue therapy on the masseter muscle (see table 6). The participant was given an explanation on way they received this type of treatment and to evaluate the treatment they used a basic spirometry. The masseter muscle was chosen because there is no direct influence on the lungs.

Table 8. ***Placebo group, article summary 6***

Technique	Position	Performance
Soft tissue therapy	Participant: prone position, head positioned as close to neutral as possible but adjusted for the participant to be comfortable. Therapist: sitting behind participant's head.	Therapist preforming friction techniques on masseter muscle and stretches longitudinal until local spasm and tenderness decreases.

To check the compliance of the results with normal distribution they used the "Shapiro-Wilk test". To investigate the differences in the results from the spirometry parameters before and after OMT they used "Wilcoxon signed rank test". The "Mann-Whitney U test" used to examine the differences of the values before and after OMT between the experimental group and the placebo group.

Results of relevance for the study at hand:

The techniques used in the study is affecting the joint mobility of the thoracic cage and they have also had a direct or indirect influence on the respiratory function. The mobility of the thoracic cage is important for the respiratory function. The expansion of the lungs is probably reduced or limited if the mobility of each joint of the chest is not adequate. Increasing the mobility of the cartilaginous connections between the ribs and sternum and also improving lung expansion is done by the recoil technique and may have a good effect. According to this study, the most important technique is the

diaphragm stretch since the diaphragm is the most important muscle for breathing with its direct impact on the lung function.

The spirometry test preformed before OMT and the soft tissue techniques showed no significant differences in the pulmonary parameters between the placebo group and the experimental group. After treatment with OMT and soft tissue techniques there were no significant difference between the placebo group and experimental group regarding pulmonary parameters, but there was a significant difference in increase of expiratory flow.

To use a combination of different osteopathic techniques has shown the best results, combining joint mobilization, joint manipulation, soft tissue, and cranial techniques. Although there were signs that this way of treating could be beneficial for people with dysfunctional breathing, the study had some limitations, too short duration time that made it hard to see the long-term effect and thereby made the results of the tests a bit weak, and too few participants to get statistically relevant information. This study should be seen as a pointing toward OMT possibly being of value to this type of patients.

6. Discussion

The aim of this study was to find out if there is any correlation between breathing pattern disorder (BPD) and musculoskeletal pain. The question was if a BPD is somehow correlated with musculoskeletal pain and what the causes of its emergence are, e.g., emotional distress and anxiety. The articles that got selected to this study helps answer the research questions.

During the research for this study, it becomes clear that the area of BPDs and the solution for this dysfunction needs more research, every article on the subject is a step in the right direction. All articles read for this study has mentioned that more research is needed in this area and that their work is a steppingstone towards a better knowledge and help to classify and identify a BPD and for possible manual methods. When searching for articles to be included in this study, one could see that most of the studies that have been done is fairly new. This could indicate that this area is not that well explored because it has not been researched for that long.

Regarding the analyses of the articles, the low score (4/11) in the PEDro-scale on the article written by Perri & Halford can be explained by the fact that they did not use different groups for the participants in their study. They performed a couple of assessment on all participants, due to the fact that they did not investigate how different techniques can help but examined different types of breathing patterns (Perri & Halford, 2004). The score (6/11) in the PEDro-scale for the article written by Bradley & Esformes, is just above half and that is due to the fact that they did not specify if the allocation of groups were done by randomization or not (Bradley & Esformes, 2014). The score (8/11) in the PEDro-scale on the article written by Stępnik, et al., is quite high. The three criteria that the article did not qualify for is due to the fact that the therapists and the assistants did know which group the participants were assigned and that the duration time of the study was too short to give an adequate follow-up (Stępnik, et al., 2020). For the articles that did not fit in the PEDro-scale; (Bordoni, et al., 2016, Chapman, et al., 2016, and Vidotto, et al., 2019), they are analyzed in their own article summary.

To be able to live a healthy pain free life one condition is that the respiratory function is working properly (Perri & Halford, 2004); (Chapman, et al., 2016). Results shows that there is a correlation between BPD and functional movement and how important it is to use a proper breathing technique, the importance in using the diaphragmic breathing. (Bradley & Esformes, 2014). There is also too be seen a correlation between BPD and musculoskeletal pain. Chapman, et al., state that it can be difficult to diagnose a BPD disorder, since it is not a disease (Chapman, et al., 2016). Vidotto, et al., state that there is no clear way of diagnosing a BPD and that there are too little studies done on classification of BPD and that's way it can be difficult to identify a BPD (Vidotto, et al., 2019). Bradley & Esformes, also agrees with the fact that there is no clear way to clinically diagnose a BPD (Bradley & Esformes, 2014). Bordoni, et al., tries to give a tool for assessment of the diaphragm so it will be easier to build up a plan to plan a treatment (Bordoni, et al., 2016).

There are many causes for a BPD to emerge and in many cases the BPD goes undiagnosed or misdiagnosed (Vidotto, et al., 2019). The most common causes of BPD are psychological, biochemical and biomechanical factors (Chapman, et al., 2016). The diaphragm is the most important muscle for breathing and Bordoni, et al., has come up

with an evaluation tool for the diaphragm to assess the functional movement. The aim of this tool is to give therapist a standardized assessment plan of the diaphragm, and with this help the therapist build up a treatment plan (Bordoni, et al., 2016).

According to Perri & Halford, the amount of pain a person feels is influenced by their breathing pattern and that neck pain is one of the most known pain correlated to BPD. They also state that it is more common to have some sort of BPD then not to have a BPD and that the musculoskeletal pain is correlated (Perri & Halford, 2004). In the study by Bradley & Esformes, they state that there is a correlation between BPD and functional movement and the importance of having good function of the diaphragm so that the diaphragm breathing is the used breathing pattern. More than half of the participants in the article written by Bradley & Esformes, suffered from a BPD (Bradley & Esformes, 2014).

According to Bordoni, et al., a combination of manual therapy and physiotherapy is a good way to treat a BPD. They also state that motion of the diaphragm can benefit from respiratory rehabilitation (Bordoni, et al., 2016). According to Stępnik, et al., the diaphragm has a direct impact on the lung function and therefore, the most important manual technique is a diaphragm stretch. They also state that the best results in treating a BPD is to combine different osteopathic techniques. The osteopathic treatment does not seem to improve the lung health, but the respiratory function and expiratory flow increases with osteopathic treatment (Stępnik, et al., 2020). But due to the cohort size, it makes it difficult to get statistically relevant information, so this need to be seen as a benchmark that this area needs further research (Stępnik, et al., 2020). If a person gets the correct help with their BPD, that increases their respiratory function, it is possible to improve their quality of life (Chapman, et al., 2016).

Since a BPD can arise from many different causes, it is important to take all the causes under consideration when making a plan to treat a BPD. This study points out a couple of evaluation techniques for assessment and identifying a BPD. It is not only important to look at the physical aspect, but also the psychological aspect. If both of these aspects are taken under consideration, it may be a beneficial effect for a person that suffers from a BPD and may increase their quality of life. The area of BPD needs more research in order to be able to help more people with undiagnosed and misdiagnosed breathing

dysfunctions in the future. At the moment it is no clear way to identify and classify a BPD. This study can be of help for future studies done on the subject BPD.

Since this area of research is relatively new, which makes the studies, results, and articles quite new as well. This may entail that further research and broader basis in the future may affect the results. The results of this study can only be based on research that are available, in which certain articles it may appear that the authors call for further empirical studies to strengthen their studies to date and strengthen (or change) their conclusions and reasoning.

7. Conclusion

Results shows that there is a knowledge gap in this area and the writers of the articles included in this article trying their best to fill that gap. They have laid the groundwork for identifying and classifying a breathing pattern disorder (BPD) and also how to treat a person that suffers from this. More research needs to be done in this area but with the knowledge that exists now, a correlation between BPD and musculoskeletal pain can be seen.

It seems like randomized controlled trails is not the most common way to write articles of the subjects and maybe that is not totally wrong. Maybe this is where the osteopaths can bring out their knowledge about BPD in terms of case studies. At this point it is important to continue to build up knowledge about BPD, because it affects a lot of people. In the future it has to be more research done on this subject. Not only for the persons who suffers from BPD, but also for the therapist to have something to work with. An assessment plan, clear classification, and tools to assess and identify a BPD.

The purpose of this study was to investigate if there is a correlation between BPD and musculoskeletal pain and what the cause may be. The findings in this study shows that musculoskeletal pain can be caused from a BPD and that a BPD can be caused from psychological/emotional distress of different kinds. It can also be the other way around; psychological/emotional distress can cause a BPD. When a person suffers from psychological/emotional distress, it is usual that they hyperventilate and that can be the arising of a BPD. The findings also show that osteopathic manual therapy (OMT) techniques can be beneficial for a person that suffers from BPD.

8. References

Bordoni, B., Marelli, F., Morabito, B. & Sacconi, B., 2016. Manual evaluation of the diaphragm muscle. *International Journal of COPD*, 18 August, Issue 11, pp. 1949-1956.

Boulding, R., Stacey, R., Niven, R. & Fowler, S. J., 2016. Dysfunctional breathing: a review of the literature and proposal for classification. *Dysfunctional breathing: a review of the literature and proposal for classification*, 25(141), pp. 287-294.

Bradley, H. & Esformes, D. J., 2014. BREATHING PATTERN DISORDERS AND FUNCTIONAL MOVEMENT. *The International Journal of Sports Physical Therapy*, February, 9(1), pp. 28-39.

Chaitow, L., 2004. Breathing pattern disorders, motor control, and low back pain. *Journal of Osteopathic Medicine*, 7(1), pp. 34-41.

Chaitow, L., Bradley, D. & Gilbert, C., 2014. *Recongnizing and Treating Breathing Disorders.* Second edition ed. s.l.:Elsevier Health Sciences.

Chapman, E. B. et al., 2016. A CLINICAL GUIDE TO THE ASSESSMENT AND TREATMENT OF BREATHING PATTERN DISORDERS IN THE PHYSICALLY ACTIVE: PART 1. *The International Journal of Sports Physical Therapy*, October, 11(5), pp. 803-809.

Courtney, R., 2009. The functions of breathing and its dysfunctions and their relationship to breathing therapy. *International Journal of Osteopathic Medicine*, Volume 12, pp. 78-85.

Courtney, R., Greenwood, K. M. & Cohen, M., 2011. Relationships between measures of dysfunctional breathing in a population with concerns about their breathing. *Journal of Bodywork and Movement Therapies*, 15(1), pp. 24-34.

Hansen-Honeycutt, J. et al., 2016. A CLINICAL GUIDE TO THE ASSESSMENT AND TREATMENT OF BREATHING PATTERN DISORDERS IN THE PHYSICALLY ACTIVE: PART 2, A CASE SERIES. *The International Journal of Sports Physical Therapy*, December, 11(6), pp. 971-979.

Kiesel, K. et al., 2017. DEVELOPMENT OF A SCREENING PROTOCOL TO IDENTIFY INDIVIDUALS WITH DYSFUNCTIONAL BREATHING. *International Journal of Sports Physical Therapy*, 12(5), pp. 774-786.

Perri, M. A. & Halford, E., 2004. Pain and faulty breathing: a pilot study. *Journal of Bodywork and Movement Therapies*, October, 8(4), pp. 297-306.

Stępnik, J., Kędra, A. & Czaprowski, D., 2020. Short-term effect of osteopathic manual techniques (OMT) on respiratory function in healthy individuals. *PLOS ONE*, 30 June, 15(6), pp. 1-9.

Swender, D. A. et al., 2014. Osteopathic Manipulative Treatment for Inpatients With Pulmonary Exacerbations of Cystic Fibrosis: Effects on Spirometry Findings and Patient Assessments of Breathing, Anxiety, and Pain. *The Journal of the American Osteopathic Association*, 114(6), pp. 450-458.

VanPutte, C. et al., 2017. *Seeley's Anatomy & physiology.* 11 ed. New York: Mc Graw Hill Education.

Vidotto, L. S., Carvalho, C. R. F. d., Harvey, A. & Jones, M., 2019. Dysfunctional breathing: what do we know?. *J Bras Pneumol*, Jan-Feb, 45(1), pp. 1-9.

Appendix 1. ***PEDro-scale***

PEDro scale

1.	eligibility criteria were specified	no ❑ yes ❑ where:
2.	subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received)	no ❑ yes ❑ where:
3.	allocation was concealed	no ❑ yes ❑ where:
4.	the groups were similar at baseline regarding the most important prognostic indicators	no ❑ yes ❑ where:
5.	there was blinding of all subjects	no ❑ yes ❑ where:
6.	there was blinding of all therapists who administered the therapy	no ❑ yes ❑ where:
7.	there was blinding of all assessors who measured at least one key outcome	no ❑ yes ❑ where:
8.	measures of at least one key outcome were obtained from more than 85% of the subjects initially allocated to groups	no ❑ yes ❑ where:
9.	all subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analysed by "intention to treat"	no ❑ yes ❑ where:
10.	the results of between-group statistical comparisons are reported for at least one key outcome	no ❑ yes ❑ where:
11.	the study provides both point measures and measures of variability for at least one key outcome	no ❑ yes ❑ where:

The PEDro scale is based on the Delphi list developed by Verhagen and colleagues at the Department of Epidemiology, University of Maastricht (*Verhagen AP et al (1998). The Delphi list: a criteria list for quality assessment of randomised clinical trials for conducting systematic reviews developed by Delphi consensus. Journal of Clinical Epidemiology, 51(12):1235-41*). The list is based on "expert consensus" not, for the most part, on empirical data. Two additional items not on the Delphi list (PEDro scale items 8 and 10) have been included in the PEDro scale. As more empirical data comes to hand it may become possible to "weight" scale items so that the PEDro score reflects the importance of individual scale items.

The purpose of the PEDro scale is to help the users of the PEDro database rapidly identify which of the known or suspected randomised clinical trials (ie RCTs or CCTs) archived on the PEDro database are likely to be internally valid (criteria 2-9), and could have sufficient statistical information to make their results interpretable (criteria 10-11). An additional criterion (criterion 1) that relates to the external validity (or "generalisability" or "applicability" of the trial) has been retained so that the Delphi list is complete, but this criterion will not be used to calculate the PEDro score reported on the PEDro web site.

The PEDro scale should not be used as a measure of the "validity" of a study's conclusions. In particular, we caution users of the PEDro scale that studies which show significant treatment effects and which score highly on the PEDro scale do not necessarily provide evidence that the treatment is clinically useful. Additional considerations include whether the treatment effect was big enough to be clinically worthwhile, whether the positive effects of the treatment outweigh its negative effects, and the cost-effectiveness of the treatment. The scale should not be used to compare the "quality" of trials performed in different areas of therapy, primarily because it is not possible to satisfy all scale items in some areas of physiotherapy practice.

Notes on administration of the PEDro scale:

All criteria	**Points are only awarded when a criterion is clearly satisfied.** If on a literal reading of the trial report it is possible that a criterion was not satisfied, a point should not be awarded for that criterion.
Criterion 1	This criterion is satisfied if the report describes the source of subjects and a list of criteria used to determine who was eligible to participate in the study.
Criterion 2	A study is considered to have used random allocation if the report states that allocation was random. The precise method of randomisation need not be specified. Procedures such as coin-tossing and dice-rolling should be considered random. Quasi-randomisation allocation procedures such as allocation by hospital record number or birth date, or alternation, do not satisfy this criterion.
Criterion 3	*Concealed allocation* means that the person who determined if a subject was eligible for inclusion in the trial was unaware, when this decision was made, of which group the subject would be allocated to. A point is awarded for this criteria, even if it is not stated that allocation was concealed, when the report states that allocation was by sealed opaque envelopes or that allocation involved contacting the holder of the allocation schedule who was "off-site".
Criterion 4	At a minimum, in studies of therapeutic interventions, the report must describe at least one measure of the severity of the condition being treated and at least one (different) key outcome measure at baseline. The rater must be satisfied that the groups' outcomes would not be expected to differ, on the basis of baseline differences in prognostic variables alone, by a clinically significant amount. This criterion is satisfied even if only baseline data of study completers are presented.
Criteria 4, 7-11	*Key outcomes* are those outcomes which provide the primary measure of the effectiveness (or lack of effectiveness) of the therapy. In most studies, more than one variable is used as an outcome measure.
Criterion 5-7	*Blinding* means the person in question (subject, therapist or assessor) did not know which group the subject had been allocated to. In addition, subjects and therapists are only considered to be "blind" if it could be expected that they would have been unable to distinguish between the treatments applied to different groups. In trials in which key outcomes are self-reported (eg, visual analogue scale, pain diary), the assessor is considered to be blind if the subject was blind.
Criterion 8	This criterion is only satisfied if the report explicitly states *both* the number of subjects initially allocated to groups *and* the number of subjects from whom key outcome measures were obtained. In trials in which outcomes are measured at several points in time, a key outcome must have been measured in more than 85% of subjects at one of those points in time.
Criterion 9	An *intention to treat* analysis means that, where subjects did not receive treatment (or the control condition) as allocated, and where measures of outcomes were available, the analysis was performed as if subjects received the treatment (or control condition) they were allocated to. This criterion is satisfied, even if there is no mention of analysis by intention to treat, if the report explicitly states that all subjects received treatment or control conditions as allocated.
Criterion 10	A *between-group* statistical comparison involves statistical comparison of one group with another. Depending on the design of the study, this may involve comparison of two or more treatments, or comparison of treatment with a control condition. The analysis may be a simple comparison of outcomes measured after the treatment was administered, or a comparison of the change in one group with the change in another (when a factorial analysis of variance has been used to analyse the data, the latter is often reported as a group × time interaction). The comparison may be in the form hypothesis testing (which provides a "p" value, describing the probability that the groups differed only by chance) or in the form of an estimate (for example, the mean or median difference, or a difference in proportions, or number needed to treat, or a relative risk or hazard ratio) and its confidence interval.
Criterion 11	A *point measure* is a measure of the size of the treatment effect. The treatment effect may be described as a difference in group outcomes, or as the outcome in (each of) all groups. *Measures of variability* include standard deviations, standard errors, confidence intervals, interquartile ranges (or other quantile ranges), and ranges. Point measures and/or measures of variability may be provided graphically (for example, SDs may be given as error bars in a Figure) as long as it is clear what is being graphed (for example, as long as it is clear whether error bars represent SDs or SEs). Where outcomes are categorical, this criterion is considered to have been met if the number of subjects in each category is given for each group.