

## Effect of Carbon Dioxide

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Carbon dioxide (CO<sub>2</sub>) has a profound and reversible effect on cerebral blood flow, such that hypercapnia causes marked dilation of cerebral arteries and arterioles and increased blood flow, whereas hypocapnia causes constriction and decreased blood flow [167,168]. The potent vasodilator effect of CO<sub>2</sub> is demonstrated by the finding that in humans 5% CO<sub>2</sub> inhalation causes an increase in cerebral blood flow by 50% and 7% CO<sub>2</sub> inhalation causes a 100% increase in cerebral blood flow [168]. Although several mechanisms involved in hypercapnic vasodilation have been proposed, the major mechanism appears to be related to a direct effect of extracellular H<sup>+</sup> on vascular smooth muscle [169]. This is supported by findings that neither bicarbonate ion nor changes in *P*CO<sub>2</sub> alone affect cerebral artery diameter [170]. Other proposed mechanisms involved in the response to changes in *P*CO<sub>2</sub> include vasodilator prostanoids and nitric oxide; however, the involvement of these mediators appears to be species-specific [171,172].

<https://www.ncbi.nlm.nih.gov/books/NBK53082/>

## Introduction

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**Breathing Pattern Disorders** (BPD) (or Dysfunctional Breathing) are abnormal respiratory patterns in relation to overbreathing which ranges from simple upper chest breathing to, at the extreme end of the scale, hyperventilation. Dysfunctional breathing (DB) is defined as chronic or recurrent changes in breathing pattern that cannot be attributed to a specific medical diagnosis, causing respiratory and non-respiratory complaints. <sup>[1]</sup>This is not a disease process, simply alterations in breathing patterns that interfere with normal respiratory processes. They can however, co-exist with disease such as COPD or heart disease, and in some cases can mimic cardiac symptoms<sup>[2][3]</sup>.

BPDs are whole person problems, especially in long term conditions where dysfunctional breathing can destabilise mind and muscles, mood and metabolism<sup>[4]</sup>. They can play a part in, for instance, premenstrual syndrome<sup>[5]</sup>, chronic fatigue<sup>[6]</sup>, neck, back and pelvic pain<sup>[7][8]</sup>, fibromyalgia<sup>[9]</sup> <sup>[10]</sup> and some aspects of anxiety and depression.<sup>[11][11]</sup>

## Clinically Relevant Anatomy

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add text here relating to **clinically relevant** anatomy of the condition

## Epidemiology

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It is often reported that around 10% of patients in a population are diagnosed hyperventilation syndrome<sup>[12]</sup>. However, far more people have a more subtle, yet likely clinically significant, breathing pattern disorder. Dysfunctional breathing is more prevalent in women (14%) than in men (2%)<sup>[12]</sup>

Little is known about dysfunctional breathing in children. Preliminary data suggest 5.3% or more of children with asthma have dysfunctional breathing and that, unlike in adults, it is associated with poorer asthma control. It is not known what proportion of the general pediatric population is affected.<sup>[13]</sup>

## Etiology

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Breathing pattern disorders occur when ventilation exceeds metabolic demands, resulting in symptom-producing hemodynamic and chemical changes. Habitual failure to fully exhale - involving an upper chest breathing pattern - may lead to hypocapnia. This involves a deficiency of carbon dioxide in the blood resulting from a breathing pattern disorder, the extreme of which involves hyperventilation. The result is respiratory alkalosis, and eventually hypoxia, or the reduction of oxygen delivery to tissue.<sup>[14]</sup> <sup>[15]</sup>

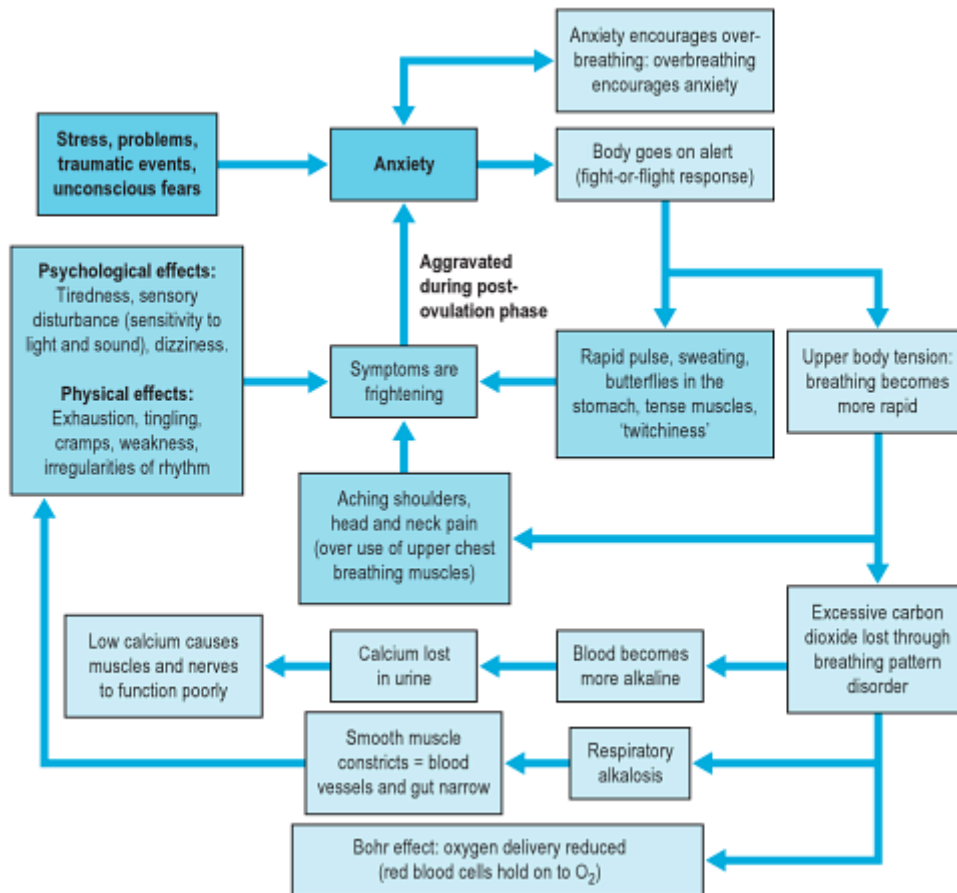
As well as having a marked effect on the biochemistry of the body BPD can influence emotions<sup>[16]</sup>, circulation, digestive function as well as musculoskeletal structures involved in the respiratory process. Essentially a sympathetic state and a subtle, yet fairly constant state of fight-or-flight becomes prevalent. This can lead to changes in anxiety, blood pH, muscle tone, pain threshold, and many central and peripheral nervous system symptoms. So, despite not being a disease, BPDs are capable of producing symptoms that mimic pathological processes. For example, overuse of accessory breathing muscles can lead to neck and shoulder pain/dysfunction. Some even mimic cardiac and gastrointestinal problems.

This diagram (from <sup>[17]</sup>) shows the stress-anxiety-breathing flow chart demonstrating multiple possible effects and influences of breathing pattern disorders.

## Clinical Presentation

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There are a wide variety of symptoms, the most extreme as shown in the diagram below:



Typical symptoms can include:

- Frequent sighing and yawning
- Breathing discomfort
- Disturbed sleep
- Erratic heartbeats
- Feeling anxious and uptight
- Pins and needles
- Upset gut/nausea
- Clammy hands
- Chest Pains
- Shattered confidence
- Tired all the time
- Achy muscles and joints
- Dizzy spells or feeling spaced out
- Irritability or hypervigilance
- Feeling of 'air hunger'
- Breathing discomfort

Back Pain?

There may be a correlation between BPD and low back pain: See: [www.physio-pedia.com/Low\\_Back\\_Pain\\_and\\_Breathing\\_Pattern\\_Disorders](http://www.physio-pedia.com/Low_Back_Pain_and_Breathing_Pattern_Disorders)

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## Diagnostic Procedures

### Nijmegen questionnaire

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High scores on the Nijmegen questionnaire have been shown to be both sensitive and specific for detecting people with tendencies consistent with breathing pattern disorders. The sensitivity of the Nijmegen Questionnaire in relation to the clinical diagnosis was 91% and the specificity 95%<sup>[18]</sup>

### Assessment of breathing patterns

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- Breath Holding – People can normally hold their breath between 25 and 30 seconds. If less than 15 seconds may mean low tolerance to carbon dioxide.
- Breathing Hi-Low Test (seated or supine) – Hands on chest and stomach, breathe normal – what moves first? What moves most? Looking for lateral expansion and upward hand pivot.
- Breathing Wave – Lay prone, breathe normal, spine should flex in a wave-like pattern towards head. Segments that rise as a group may represent thoracic restrictions.
- Seated Lateral Expansion – Place hands on lower thorax and monitor motion while breathing. Looking for symmetrical lateral expansion.
- Manual Assessment of Respiratory Motion (MARM) - Assess and quantify breathing pattern, in particular the distribution of breathing motion between the upper and lower parts of the rib cage and abdomen under various conditions. It is a manual technique that once acquired is practical, quick and inexpensive.<sup>[19]</sup>
- Respiratory Induction Plethysmography (RIP) and Magnetometry

### Assessment of musculoskeletal system

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- elevated and depressed ribs and clavicle.
- muscle tone and length especially psoas, QL, latissimus, upper trap, scalene, and SCM.
- alterations in mobility of thoracic and rib articulations.

### Assessment of respiratory function

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- Oximetry - to measure oxygen saturation (SpO2)
- Capnography - to measure end tidal CO2 levels in exhaled air
- Peak expiratory flow rate - the highest flow of air out of the lungs from peak inspiration in a fast single forced breath out
- Manual Assessment of Respiratory Motion (MARM) - SEE: [www.physio-pedia.com/Manual\\_Assessment\\_of\\_Respiratory\\_Motion\\_\(MARM\)](http://www.physio-pedia.com/Manual_Assessment_of_Respiratory_Motion_(MARM))

### Outcome Measures

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- [Nijmegen Questionnaire](#)
- [Rowley Breathing Self-Efficacy Scale \(RoBE\)](#)
- [Self Evaluation of Breathing Questionnaire \(SEBQ\)](#)
- [Hospital Anxiety and Depression Questionnaire \(HAD\)](#)

### Management / Interventions

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Management commonly requires the removal of causative factors and the rehabilitation of habitual acquired dysfunctional breathing patterns. In order to achieve this most efficiently it may be necessary to restore normal function of the respiratory system such as thoracic mobility and muscle tone and length.

## Manual Therapy Techniques

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Based on your assessment, there are several manual therapy techniques that can be performed to treat muscles that have increased tone or activity, elevated and depressed ribs and alterations in mobility of thoracic articulations. These techniques include muscle energy techniques (MET), positional release, trigger point release and integrated neuromuscular inhibition techniques<sup>[17]</sup>.

## Breathing Retraining

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- Awareness of faulty breathing patterns
- Relaxation of the jaw, upper chest, shoulders and accessory muscles
- Abdominal/low-chest nose breathing pattern reeducation
- Awareness of normal breathing rates and rhythms, both at rest, during speech and activity.

## Respiratory Techniques

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- Pursed lip breathing has been shown to relieve dyspnoea, slow respiratory rate, increase tidal volume, and restore diaphragmatic function.
- Dynamic Neuromuscular Stabilisation - to optimise a postural respiratory pattern<sup>[17]</sup>

## Complimentary methods

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- Sleep retraining
- Relaxation
- Nutrition
- Capnography

## Differential Diagnosis

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BPDs can often mimic more serious conditions such as cardiac, neurological and gastrointestinal conditions which must all be ruled out by the medical team.

## Key Evidence

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[Breathing pattern disorders and functional movement](#). Bradley H, Dr Esformes J. Int J Sports Phys Ther. 2014 Feb;9(1):28-39.

[Breathing exercises for dysfunctional breathing/hyperventilation syndrome in children](#). Barker NJ, Jones M, O'Connell NE, Everard ML. Cochrane Database Syst Rev. 2013 Dec 18;12:CD010376.

[Breathing exercises for dysfunctional breathing/hyperventilation syndrome in adults](#). Jones M, Harvey A, Marston L, O'Connell NE. Cochrane Database Syst Rev. 2013 May 31;5:CD009041.

## Related pages

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[Low Back Pain and Breathing Pattern Disorders](#)

## Resources

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- [Leon Chaitow's website](#)
- [Website containing videos to go with the book - Recognizing and Treating Breathing Pattern Disorders<sup>\[17\]</sup>](#)
- [Clinical interest group for physiotherapists interested in hyperventilation](#)

## Recent Related Research (from [Pubmed](#))

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- [Abnormal vocal cord movement in patients with and without airway obstruction and asthma symptoms.](#)

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