

THE POWER OF BREATH: DIAPHRAGMATIC BREATHING

Diaphragmatic breathing is sometimes referred to as belly, deep, relaxed, or abdominal breathing. It optimizes use of the main muscle of breathing, the diaphragm, resulting in slower, deeper breathing. It can be an important skill in a Veteran's self-management toolbox. With practice, most clinicians can teach it to their patients in 5-10 minutes.

In contrast to shallow breathing, diaphragmatic breathing is marked by expansion of the abdomen rather than the chest during the in breath. With shallow breathing, also known as thoracic or chest breathing, minimal breath is drawn into the lungs, using primarily the intercostal muscles and not the diaphragm. When lung expansion occurs lower in the body, breathing is described as "deep" and corresponds with observed or felt movement of the abdomen outward with inhalation.

WAYS DIAPHRAGMATIC BREATHING CAN BE USEFUL

Diaphragmatic breathing:

- Shifts a person from a place of passivity to a place of activity; they are "doing something" about their symptoms
- Introduces training in increasing calm and relaxation
- Provides a simple way to quiet high-arousal states caused by pain or other symptoms and the emotions that it elicits
- Is extremely portable
- Costs nothing except an initial investment of time
- Can be used to manage other life stressors
- Can be helpful during difficult procedures, such as injections, imaging studies, etc.
- Provides a positive distraction
- Can be used to interrupt negative patterns of thought
- Demonstrates that clinicians consider non-pharmacologic interventions important for health
- Found to be helpful in many physical and mental health problems (see Clinical Research below)

PHYSIOLOGICAL EFFECTS

Shallow breathing often accompanies stress, anxiety, and other psychological difficulties. This is typically a result of sympathetic over-arousal, commonly referred to as the "fight or flight response." With practice, diaphragmatic breathing can lead to a quieting response modulated by the parasympathetic nervous system. The following are physiological effects that have been noted:

- Diaphragmatic breathing causes increased venous return to the heart. With inhalation, the diaphragm generates negative intrathoracic pressure, and blood is pulled into the thorax through a vacuum effect. This leads to increased stroke volume, which triggers arterial stretch receptors and results in increased parasympathetic activity and decreased sympathetic activity. These changes bring about decreased heart rate and total peripheral resistance.[1]
- Inhalation at a rate of 6-10 breaths per minute causes increased tidal volume while maintaining optimal minute ventilation. The increase in tidal volume causes cardiopulmonary baroreceptor stretch which in turn leads to decreased sympathetic outflow and subsequently decreased peripheral vascular resistance.[1,2]
- Diaphragmatic breathing increases heart rate variability (HRV), which is a proxy measure of the balance of sympathetic and parasympathetic influence on the heart. Reduced HRV portends a poor prognosis in a variety of clinical contexts, including post-MI, ischemic heart disease, congestive heart failure, and diabetes with autonomic neuropathy.[1-3]
- A part of the diaphragm known as the crural or crus is one of the main components of the esophagogastric junction. Diaphragmatic breathing has been noted to improve pressure generated in the lower esophageal sphincter which appears to benefit symptoms in gastroesophageal reflux disease.[4,5]
- With deep diaphragmatic breathing, EEG studies show an increase in alpha and a decrease in theta power; an fMRI study showed increased activity in cortical (e.g., prefrontal, motor and parietal) and subcortical structures (e.g., pons, thalamus, hypothalamus, etc.[6]

CLINICAL RESEARCH

HYPERTENSION

The antihypertensive mechanisms of slow, deep breathing have not been fully elucidated. Essential hypertension is thought to involve chemoreceptor hypersensitivity causing an excess of sympathetic nervous system activity. The chemoreceptor reflex is mediated by specialized neurons in the central and peripheral vasculature which respond to changes in the concentration of carbon dioxide. Increased carbon dioxide causes an increase in minute ventilation and sympathetic outflow, while decreased carbon dioxide causes a decrease in minute ventilation.[7] As noted above, slow, deep breathing stimulates baroreceptor activity through increased stroke volume promoting vasodilation.[1,2] Slow deep breathing is thought to promote baroreceptor inhibition of chemoreceptors, leading to decreased sympathetic tone, increased vasodilation, and decreased blood pressure.

Additionally, it is hypothesized that slow deep breathing exerts an autonomic balancing effect at centers of cross-talk between cardiovascular and respiratory control centers in the central nervous system.[8] Device-assisted slow breathing, such as with the RESPeRATE, has shown robust evidence for the management of hypertension. In 2013, the American Heart Association issued a scientific statement about the use of complementary and

alternative therapies for hypertension management, wherein the committee states, “Device-guided breathing is reasonable to perform in clinical practice to reduce blood pressure.”[8] Since that time, a 2021 literature review concluded that voluntary diaphragmatic deep breathing (without device) resulted in decreased systolic and diastolic blood pressures, reduced heart rate and had a relaxing and anxiety-reducing effect in hypertensive or prehypertensive individuals.[9]

CONGESTIVE HEART FAILURE (CHF)

Inspiratory muscle strength is an independent predictor of survival in heart failure. Decreased inspiratory muscle strength and endurance leads to a variety of derangements including inefficient ventilation and preferential blood shunting to respiratory muscles—and away from exercising limbs. This leads to decreased exercise tolerance in patients with CHF. Inspiratory muscle training (IMF) is a special form of resistance training for increasing the strength and fatigue resistance of inspiratory muscles. IMF has been shown to increase inspiratory muscle strength and endurance, which brings about more efficient ventilation, functional capacity, quality of life and increased exercise tolerance.[10-12] IMF was found in randomized controlled trials to lead to additional benefits of decrease in fatigue and breathlessness.[13], or when combined with exercise to increase maximal inspiratory pressure and quality of life[14].

CHRONIC OBSTRUCTIVE PULMONARY DISEASE (COPD)

In patients with COPD, hyperinflation places the diaphragm in a state of chronic partial stretch. This mechanical disadvantage leads to increased work of breathing and relative respiratory muscle weakness. Inspiratory muscle training has been shown to increase inspiratory muscle strength and endurance, decrease dyspnea and improve exercise capacity and health care related quality of life.[15] Multiple meta-analyses and systematic reviews have found that different types of breathing exercises have benefit for COPD. Diaphragmatic breathing, yoga breathing, and pursed lip breathing have been found to have significant benefit to COPD pulmonary function and exercise capacity.[16-18]

ASTHMA

A 2009 systematic review found that training in diaphragmatic breathing led to short-term and long-term improvement in health care related quality of life. One of the included studies also demonstrated physiologic improvements including higher end-tidal carbon dioxide, decreased resting respiratory rate, and increased FEV1% following the diaphragmatic breathing intervention, but these results were not consistent across studies.[19] When aerobic training was compared to breathing exercises for moderate-severe asthma in a randomized controlled trial, interventions showed some similar results. This included decreasing psychological distress, airway inflammation, asthma symptom free days, daily life physical activity. However, aerobic exercise showed greater benefit in terms of asthma control and reduced use of rescue medication.[20]

HOT FLASHES

In 2012, Sood and colleagues published a randomized controlled trial investigating the effectiveness of slow-paced breathing for the management of hot flashes. The intervention group paced the breathing at a slow rate of six breaths per minute, while the control group paced breathing at a normal rate of 14 breaths per minute. All groups saw a statistically significant decrease in vasomotor symptoms and there was no difference between groups.[21]. Other studies have shown similarly promising results in terms of vasomotor symptoms.[22] Another randomized control trial of slow breathing for hot flashes found that the women did report modest improvement in the frequency and severity of hot flashes but was significantly less effective than the parallel group who had a music-listening intervention.[23]

INSOMNIA

In 1995, Choliz published results from a randomized controlled trial wherein voluntary hypoventilation brought about drowsiness and subsequently sleep in the treatment group.[24] The proposed mechanism of action was hypercarbia leading to sedation, though this hypothesis was called into question by results of a follow-up study which showed hypoventilation produced a protracted state of hypocarbia.[25] Subsequently, in 2006, the American Academy of Sleep Medicine published guidelines for the behavioral and psychological management of insomnia, wherein “relaxation” is recommended as a stand-alone treatment for insomnia based on review of the evidence, though breathing exercises are not specifically mentioned.[26] In some studies of insomnia, deep breathing is used in combination with other relaxation techniques or cognitive-behavioral therapy with good result; however, it is difficult to determine the impact of the deep breathing practice itself on sleep without further evidence.

DEPRESSION AND ANXIETY

In a recent (2021) meta-analytic review and regression, Leyro et.al. found that interventions that focused on respiration yielded significantly greater improvements (moderate to large effect) in anxiety symptoms. Their conclusion was that respiratory interventions show good clinical utility whether used alone or in conjunction with other interventions.[27] A systematic review of randomized controlled trials studied two spiritual/religious practices of breathwork and chanting on mental health outcomes. Chanting is an ancient practice that includes the rhythmical repetition of a prayer, mantra, syllable or sound. Moderate to strong support was found for the effectiveness of these practices on depression, stress and symptoms of PTSD.[28] A randomized controlled trial of an extensive intervention of breathing (20 sessions over 8 weeks) with an average respiratory rate of 4 breaths/minute showed a significant decrease in negative affect and significantly lower cortisol levels when compared to baseline.[29]

Yogic breathing has been explored for the management of depression, anxiety and stress. Brown and Gerbarg present a systematic evidence review which supports the use of yogic breathing.[30,31] In 2009, Descilo and colleagues published results from a non-randomized trial evaluating a yogic breathing intervention with and without exposure-based therapy for survivors of the 2004 South East Asian tsunami. There were clinically

significant improvements on the Beck Depression Inventory-21 and the Posttraumatic Checklist-17 in the groups receiving the breathing and the breathing plus exposure therapy interventions, but not in the control group.[32]

PAIN

A 2022 systematic review and meta-analysis of randomized controlled trials found that slow deep breathing was associated with significantly lower pain scores compared to control groups in acute pain. These findings were noted to have less certainty as they were generally associated with high level of heterogeneity [33] Published in 2017 in the *Journal of Pain*, a systematic review reported findings across clinical and experimental studies related to respiration. Noted is that pain itself influences respiration by impacting its flow, frequency and volume. Paced slow breathing was associated with pain reduction in some of the studies.[34]

Chronic-tension type headaches were the focus of a randomized controlled trial which combined treatments of breathing exercise and progressive muscle relaxation. The results suggest that compared to the control, the intervention group had less pain severity and disability and better sleep quality after a 12-week intervention.[35] Unclear is how much impact the breathing exercises specifically had on these results.

A literature search explored the question of whether breathing exercises were effective in reducing pain, improving respiratory function and/or health-related quality of life in chronic, nonspecific low back pain. Findings suggested that breathing exercise programs were shown to be effective in improving lung function, reducing back pain and improving quality of life for those with chronic, nonspecific low back pain.[36] In a 2005 study of chronic low back pain, patients with chronic low back pain were randomized to a breath therapy or physical therapy intervention. Patients in both groups experienced statistically and clinically significant improvements in pain intensity and self-reported overall health with both groups performing equally well. These studies suggest that slow, paced breathing can be a useful self-regulatory tool for the management of pain.[37] Another experimental study found that deep and slow breathing resulted in the modulation of sympathetic arousal and pain perception.[38]

PHYSIOLOGICAL, OXIDATIVE AND PSYCHOLOGICAL STRESS

Oxidative stress is a risk factor for heart disease and many other adverse health outcomes.[39] There is evidence that oxidative stress is reduced with diaphragmatic breathing. In a 2011 retrospective cohort study, data were analyzed from competitive cyclists before and after a 900-calorie meal. Hyperglycemia is known to induce oxidative stress in diabetic and healthy subjects.[40,41] In the diaphragmatic breathing group, blood glucose was lower, insulin was higher, and circulating antioxidants were higher than controls after eating. Like the above results, exercise-induced oxidative stress was attenuated by diaphragmatic breathing and these same competitive athletes demonstrated lower levels of circulating reactive oxygen metabolites, higher levels of circulating

antioxidants, lower levels of circulating cortisol, and higher nocturnal melatonin levels as compared to controls who sat quietly reading.[42]

A systematic review found that diaphragmatic breathing was effective in reducing stress including improvement in the biomarkers of respiratory rate and salivary cortisol levels, improvement in systolic and diastolic blood pressure and improvement in the stress subscale of the Depression Anxiety Stress Scales-21.[43]

GASTROINTESTINAL DISORDERS

Gastroesophageal reflux disease (GERD) represents one of the most common gastrointestinal disorders. Medications are not successful in all patients, and their long-term consumption has raised concerns.[44] A meta-analysis addressed the effect of breathing exercises on patients with GERD and results found that there was a significant improvement in pressure generated by the lower esophageal sphincter. The authors suggest that the possible mechanism for benefit to GERD symptoms is due to the enhancement of the anti-regurgitation barrier, especially crural diaphragm tension.[5]. Diaphragmatic breathing training has evidence that there is potential to alleviate symptoms in selected patients with GERD.[4,5,44]

Rumination Syndrome is a “functional gastrointestinal disorder which is characterized by effortless postprandial regurgitation” and diaphragmatic breathing (with or without biofeedback) is considered first-line therapy.[45, 46] Diaphragmatic breathing is noted to reduce the number of rumination events by a mechanism not completely understood and not related to changes in vagal tone.[47]

Several studies have looked at the use of diaphragmatic breathing to assist with nausea and vomiting. One study found that breast cancer patients undergoing chemotherapy and in the breathing exercises group did have a smaller number of nausea, vomiting and retching episodes compared to routine care.[48] Post-operative symptoms of nausea and vomiting were the focus of another study looking at controlled breathing with or without peppermint aromatherapy. The results suggest that breathing alone is an effective alternative to antiemetics or could be used in conjunction with peppermint aromatherapy.[49]

FIVE STEPS TO TEACHING DIAPHRAGMATIC BREATHING

STEP 1: OBSERVATION

Observe patients' breathing while they are seated for a minute or so. It is helpful to have them place one hand on the abdomen and another on the chest. To reduce performance anxiety, you could have them close their eyes or distract them with a different activity to allow you to observe comfortably.

- Ask them to breathe normally, just as they would in their life outside the clinic.

- Observe the movements of the hands including whether there is more movement in the upper hand (chest) or the bottom hand (abdomen).
- Notice if their breathing rate is fast, slow or somewhere in between. Observe whether the breathing pattern is smooth or choppy.

STEP 2: EDUCATION

The acronym DASS—Deep, Abdominal, Slow and Smooth—describes the goal pattern. If patient's breathing pattern is shallow, fast or choppy consider discussing or demonstrating:

- The importance of the diaphragm muscle as the main muscle of breathing.
- Breathing as it relates to the sympathetic and parasympathetic nervous systems.
- What diaphragmatic breathing looks like (the provider can use DASS breathing to demonstrate to the patient).
- The role of stress and/or pain and how it can lead to shallow chest breathing. Clinicians can acknowledge symptoms and conditions that are significant stressors and can influence their breathing patterns.
- Taking time with the exhalation assists in activating the quieting response mediated by the parasympathetic nervous system.

STEP 3: INSTRUCTION

Teaching several different techniques and finding what works best for everyone can be helpful. If an examination table is present, training can begin with patients lying down. Each technique can be practiced for a minute or so to give the patient ample time to determine what works best. *Note: Some individuals become much more anxious when they focus on their breathing, and other techniques may be more appropriate. Refer to other relaxation techniques described in “[Power of the Mind](#)”.* Here are four simple diaphragmatic breathing techniques that can be tried below with additional techniques and practices to be found in “[Breathing](#)”.

TECHNIQUE 1

Start simply by having them place a hand on the abdomen and gently attempt to breathe under that hand. If this is too effortful or they are “trying too hard” (over breathing or too forceful), move on to other techniques or see if they can reduce effort.

TECHNIQUE 2

This next technique encourages deeper breaths. Have the patient breathe in for a count of “2” (with each counted number taking a second) and out for the count of “3”. If this feels too fast, try slowing it to breathing in for “3” and out for “4.” Adjust the numbers so that the exercise is comfortable and not stressful. The elongation of the outbreath can often create an opportunity for a deeper next breath.

TECHNIQUE 3

In this technique, the individual inhales normally. On exhalation, the goal is to focus on exhaling all of the air completely out of their lungs. Then, rather than quickly inhaling again, they pause and wait until the body wants to breathe again. They should let any sense of effort drop away.

TECHNIQUE 4

Imagery can be helpful to some patients. The patient imagines a breathing hole (like a whale's or dolphin's) in the bottom of each foot. With each breath, they imagine breathing in through the bottom of their feet and up to their abdomen. On the exhalation, this is reversed as they imagine breathing out the bottom of their feet.

STEP 4: EVALUATION OF TECHNIQUES AND ASSIGNMENT OF AT-HOME PRACTICE

Some patients will say that the above activities were challenging or felt "different," due to the fact that they habitually engage in shallow breathing. This is perfectly normal, and as they become more accustomed to deeper breathing, it will feel more natural. *Note: Any sense of feeling light-headed is a sign of trying too hard or over breathing, and effort should be decreased. Changing techniques might prove more helpful.*

- Ask the patient which of the techniques worked and was easiest for them, or which they enjoyed the most. Encourage them to practice this technique at home.
- Practice 5-10 minutes, twice daily, in a comfortable position. Many patients have sleep disruptions. Times when a person is having difficulty falling asleep or experiencing intermittent awakening are additional practice opportunities. Diaphragmatic breathing may assist with increasing comfort or falling back to sleep.
- In addition, ask them to practice off and on throughout the day and in a variety of positions (this is to encourage generalization). It is also helpful to have them practice at times of relatively low stress until they become accustomed to it.

WHAT TO DO IF ALL OF THIS PROVED DIFFICULT OR EXTREMELY TAXING FOR THE PATIENT.

Have the patient practice at home, lying on the belly if possible. Not all patients can lie on their stomachs, but most can for the few minutes needed to become aware of their breathing. Lying down on the belly typically allows people to feel the diaphragm muscle even when breathing with minimal effort. This can be practiced for five minutes, focusing on the sensation of deeper breathing. Following this, they can turn over on their back and recall the sensations experienced when they were on their belly.

The goal is for the individual to practice feeling the sensations and experience of diaphragmatic breathing until they become habituated to it. Twice-daily practice should aid in their learning. Eventually, once more comfort and familiarity has been achieved, another goal will be to do diaphragmatic breathing while sitting up.

STEP 5: FOLLOW-UP

Follow-up is critical to the integration of this activity, and it can be challenging for the busy clinician; making use of a team approach and working with other team members becoming skilled in teaching these techniques can be helpful. Even brief attention from a clinician communicates to patients that these approaches are important and that they should follow through. Breathing patterns can be a very strong habit forged over many years and change needs time and reinforcement. Consider the following for follow-up:

- Review the exercise to determine if the patient still understands the practice. Have them demonstrate slower, deeper abdominal breathing.
- Discuss how and when they are using it (e.g., when awake in the middle of the night due to pain, when upset or distressed about finances, after a challenging conversation, etc.) and encourage continued use. Reinforce the ways that it might help them, even if it helps more with decreasing emotions related to symptoms rather than the symptoms themselves.
- Explore how they can apply these skills more generally in their lives, which is a final important part of following up with training. Ask them to consider other times when they could use the skill, such as when they are in a doctor's waiting room, driving the car, off and on throughout the day, etc.
- Remember the goal. Natural, effortless breathing using the diaphragm is optimal for breathing most of the time, except perhaps during certain limited situations where sympathetic arousal (the fight or flight response) is truly helpful.

SUMMARY

Breathing can be a useful tool for quieting sympathetic arousal. It has several positive physiological effects, and potential clinical benefits. The five easy steps to teaching diaphragmatic breathing are:

1. Observation
2. Education
3. Instruction
4. Evaluation and homework
5. Follow-up in future appointments

RESOURCE LINKS

- “[Breathing](https://www.va.gov/WHOLEHEALTHLIBRARY/tools/breathing.asp)”: <https://www.va.gov/WHOLEHEALTHLIBRARY/tools/breathing.asp>
- “[Power of the Mind](https://www.va.gov/WHOLEHEALTHLIBRARY/self-care/power-of-the-mind.asp)”: <https://www.va.gov/WHOLEHEALTHLIBRARY/self-care/power-of-the-mind.asp>

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