Breathing for Improved Outcomes

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Breathing techniques and patterns are regularly advocated for relaxation, stress management, control of psycho physiological states and to improve organ function (Ritz and Roth, 2003). The three common benefits (biomechanical, biochemical and psychophysiological) plus breathing types (diaphragmatic, thoracic and clavicular) as well as how to breathe are sometimes confusing but worth knowing. These factors are the basis for understanding the vital function of breathing.

First, the Difference Between Breathing and Respiration:
Breathing is the physical act of moving air in and out of the lungs.
Respiration has two parts: Physiological (transfer of gas in the lungs) and Cellular (energy production in the cells/mitochondria).

Next Benefits
We can focus on three basic benefits to breath and breath training:

Biomechanical. These are actions of the neuromuscular respiratory pump. Think of the muscles (and organs) doing the work. A 2014 study suggests there is a significant relationship between breathing pattern disorders and movement dysfunction identified by the Functional Movement Screen™. (Bradley and Esformes) Breathing impacts movement.

<u>During quiet breathing</u>, the predominant muscle of respiration is the diaphragm. As it contracts, pleural pressure drops, which lowers the alveolar pressure, and draws air in down the pressure gradient from mouth to alveoli. Expiration during quiet breathing is predominantly a passive phenomenon, as the respiratory muscles are relaxed and the elastic lung and chest wall return passively to their resting volume, the functional residual capacity.

<u>During activity</u>, many other muscles become important to respiration. During inspiration, the external intercostals raise the lower ribs up and out, increasing the lateral and anteroposterior dimensions of the thorax. The scalene muscles and sternomastoids also become involved, serving to raise and push out the upper ribs and the sternum.

<u>During active expiration</u>, the most important muscles are those of the abdominal wall (including the rectus abdominus, internal and external obliques, and transversus abdominus), which drive up intra-abdominal pressure up when they contract, and thus push up the diaphragm, raising pleural pressure, which raises alveolar pressure, which in turn drives air out. The internal intercostals assist with active expiration by pulling the ribs down and in, thus decreasing thoracic volume.

To perform at the highest level as an athlete or just move better in daily life, training muscles for enhanced movement is a no-brainer. But what about our muscles of respiration?

When thinking about the role breathing has, the focus usually tends to be on oxygenation and stress management. What many people may not realize is that the way we breathe has a significant reciprocal relationship with our posture and mobility. (Bradley 2014) A less-than-optimal breathing pattern causes tension and immobility, and immobility and tension prevent optimal breathing. Consequently, the overall quality of our breathing has the power to influence all aspects of our health and wellness, from how we feel and think, to how we sit, stand, and move.

<u>Establishing proper breathing biomechanics should be the foundation of all therapy and training.</u>

Why Breathing Affects Movement

A common misconception is that diaphragmatic breathing is reserved for *deep* breathing. In reality, it's fundamental to all functional breathing. Just as you use your bicep to bend your arm in full and partial elbow flexion, your diaphragm should function during deep and shallow breathing.

However, through exposure to illness, injury, or stress, many people unknowingly develop a less-than-optimal, chest-oriented breathing pattern that pulls the rib cage forward and up, compromising diaphragm function. Consequently, to compensate for the lack of diaphragm action, they recruit chest, neck, shoulder, and upper back muscles to act as "accessory" breathing muscles. This causes chronic tension, locking the upper body into poor—often painful—posture that can include slumped shoulders, winging shoulder blades, and a flattened mid-back. When muscles of the shoulder girdle are pulled into assisting with breathing, it makes them less functionally available for their primary roles in movements like rotating, pushing, and pulling.

Making matters worse, when the diaphragm isn't used properly, it also becomes dysfunctional in its postural role, pulling into its lumbar spine attachments. This can lead to persistent low-back pain. With a dysfunctional diaphragm causing a cascade of faulty muscular chain reactions, it's no surprise that improper breathing doesn't just hurt and make it harder to move, it increases risk of injury (Perri 2004, Chapman 2016). As people age the intervertebral disks compress, impacting the ability to use deep diaphragmatic breathing.

<u>Respiration is a fundamental movement pattern with an influence over all other movement patterns.</u>

And then There's Anatomical Exercise and Biomechanical Exercise Breathing to Discuss…

Anatomical exercise breathing refers to the natural matching of the inhalation and exhalation with extension and flexion of the spine/body. Extension facilitates inhalation and flexion facilitates exhalation. As the body gets compressed (flexion) exhalation dissipates the pressure and extension assists in opening the thoracic area to assist in inhalation. In addition, anatomical breathing can be used in stretching where the exhale is used to enhance the relaxation into a stretch.

In biomechanical exercise breathing we flip those actions. Inhaling to increase the intra-abdominal pressure during flexion and exhaling to improve muscular action and stability during extension. Biomechanical breathing is key to being able to handle loads through the body during performance. During exertion biomechanical breathing allows us to power up our strength and stability. It allows us forceful, powerful movement.

Back to Benefits – Here are #2 and #3…

Biochemical. The biochemical aspect of breathing/respiration is all about gas exchange: Getting O_2 in and CO_2 out to maintain the O_2/CO_2 balance in the blood/body. This occurs in the cells as cellular respiration (using O_2 as part of producing ATP and getting rid of the waste product CO_2) and in the lungs as gas exchange. Chemical receptors keep an eye on blood pH and adjust breathing rate accordingly to maintain blood pH. Hyperventilation (over-breathing) actually blows off too much CO_2 and causes alkalosis. Medically, CO_2 levels can be measured by capnography or blood tests. In the FMS Breathing Screen, breath holds are used to provide a quick screen for potential breathing issues (these can also be influenced by the other aspects of breathing.)

Psychophysiological. The psychophysiological impact of breathing is significant. Breathing is part of the Autonomic Nervous System (ANS). The autonomic nervous system is broken into the Sympathetic nervous system (fight or flight) and the Parasympathetic nervous system (rest and digest). Most ANS functions are beyond our control because of the blend of skeletal and smooth muscle fibers involved but we can, to a certain extent, control our breathing.

While we do have conscious control over this subconscious system of breathing the physiological controls of the body and brain will alter breathing to “get what they need” regardless of what we “think” we are doing.

Caldwell and Victoria (2011) state: *“It is clear that the physiology and psychology of breathing are inextricably intertwined.* Chaitow, Bradley, and Gilbert (2002) also state that: *Feeling anxious produces a distinctive pattern of upper-chest breathing, which modifies blood chemistry, leading to a chain reaction of effects, inducing anxiety, and so reinforcing the pattern which produced the dysfunctional pattern of breathing in the first place.”*

As we know, breathing is most unique as compared to other visceral (e.g. digestion, endocrine cardiovascular) functions in that it can also be regulated voluntarily. The behavioral (voluntary) control of breathing is located in the cortex of the brain and describes that aspect of breathing with conscious control, such as a self-initiated change in breathing before a vigorous exertion or effort. Speaking, singing and playing some instruments (e.g. clarinet, flute, saxophone, trumpet, etc.) are good examples of the behavioral control of breathing and are short-lived interventions (Guz, 1997). Control of breathing encompasses accommodating changes in breathing such as those changes from stress and emotional stimuli. The differentiation between voluntary and automatic (metabolic) breathing is that automatic breathing requires no attention to maintain, whereas voluntary breathing involves a given amount of focus (Gallego, Nsegbe, and Durand, 2001). Gallego and colleagues note that it is not fully understood how the behavioral and metabolic controls of respirations are linked.

Breathing Types

Diaphragmatic (lower abdominal)

Diaphragmatic is the most efficient and effective breathing system we have. With diaphragmatic breathing the initial focus of attention is on the expansion of the abdomen, sometimes referred to as abdominal or belly breathing. The breathing focus includes the expansion of the rib cage during the inhalation. To help a client learn this, try placing the edge of the hands alongside the lower rib cage (at the level of the xiphoid process); correct diaphragmatic breathing will elicit a noticeable lateral expansion of the rib cage. Exhale by squeezing an imaginary big ocean sponge upwards in the stomach. Or think of squeezing the hips together without any skeletal muscles firing (glutes, hamstrings, etc).

Diaphragmatic breathing should be practiced in the supine, prone and vertical positions, as these are the functional positions of daily life. Sovik suggests the characteristics of optimal breathing (at rest) are that it is diaphragmatic, nasal (inhalation and exhalation), smooth, deep, even, quiet and free of pauses.

Modifications in respiratory patterns come naturally to some individuals after one lesson, however, it may take up to six months to replace bad habits, and ultimately change the way one breathes (Sovik, 2000). The general rule, often noted in studies, and particularly observed by Gallego et al. (2001) was that if a voluntary act is repeated, “learning occurs, and the neurophysiological and cognitive processes underpinning its control may change.”

Slow diaphragmatic breathing techniques show the most practical and physiological benefit, yet the underlying mechanism how they work is not fully understood in the research (Jerath et al., 2006). Jerath and colleagues hypothesize that “*the voluntary, slow deep breathing functionally resets the autonomic nervous system through stretch-induced inhibitory signals and hyperpolarization (slowing electrical action potentials) currents…which synchronizes neural elements in the heart, lungs, limbic system and cortex.”* Investigations have demonstrated that slow diaphragmatic (or pranayama) breathing techniques activate the parasympathetic (inhibitory) nervous system, thus slowing certain physiological processes down that may be functioning too fast or conflicting with the homeostasis of the cells (Jerath et al., 2006).

Diaphragmatic breathing decreases:

- Blood Pressure
- Tone and contractures
- Spasticity (spasticity increases with stress, breath-holding and thoracic breathing)
- Stress
- Heart Rate
- Pain and pain awareness

Sympathetic response
Breathing cadence
Use of accessory muscles

Diaphragmatic breathing increases:
Circulation
Blood flow to the muscles
Parasympathetic response (calms the reticular system)
Relaxation and comfort in the water
Digestion
Focus
Restorative rest
Deep tissue abdominal muscle activation
Rib cage mobility and lung expansion for gas exchange

Thoracic (serratus/rib) – Upper rib cage expands. Chest breathing requires more work to accomplish the same blood/gas mixing than does slow, deep diaphragmatic breathing, and since more work is required, more O_2 is needed, resulting in one's taking more frequent breaths. Anxiety is more frequently associated with chest breathing as opposed to diaphragmatic breathing.

Clavicular (trapezius) – This is thought to be used in sobbing and sighing. When people feel short of breath, do they need to breathe faster to get more air? Actually, just the opposite. If they breathe fast, they may start to over breathe and lower the carbon dioxide levels. Once again, slow deep diaphragmatic breathing is recommended.

Hyperventilation syndrome is also known as overbreathing. Breathing too frequently causes this phenomenon. Although it feels like a lack of oxygen, this is not the case at all. The overbreathing causes the body to lose considerable carbon dioxide. This loss of carbon dioxide triggers symptoms such as gasping, trembling, choking and the feeling of being smothered. Regrettably, overbreathing often perpetuates more overbreathing, lowering carbon dioxide levels more, and thus become a nasty sequence. Repich (2002) notes that this hyperventilation syndrome is common in 10% of the population. Fortunately, slow, diaphragmatic breathing readily alleviates it. The deliberate, even deep breaths helps to transition the person to a preferable diaphragmatic breathing pattern.

Finally: Applying All This Info (How to Breathe)

Although breathing is arguably the most fundamental element of life, how to breathe optimally is rarely, if ever, taught. Instead, well-intentioned professionals, tell their clients to "take long, deep breaths" without acknowledging that the effectiveness of their directive is predicated on actually knowing *how to breathe*.

All of us should have a basic understanding of breathing anatomy, beginning with the king of the core: the diaphragm. The diaphragm is a thin dome-shaped respiratory and postural muscle that attaches to both your rib cage and lumbar spine, and runs through your psoas. With inhalation, the diaphragm contracts by flattening and descending to pull air into the lungs. Upon exhalation, when the lungs empty, the diaphragm relaxes in a dome shape within the rib cage.

Dysfunctional inhalation recruits accessory breathing muscles and wreaks havoc on muscle chains. However, when it comes to establishing proper breathing mechanics, it's the exhalation that's the true game-changer. That's because the diaphragm cannot relax without the lower ribs internally rotating to form the "cage" for it to dome. If air is left in the lungs and the lower ribs remain flared and immobile, the diaphragm is chronically held in a semi-contracted state, unable to relax or fully contract. That's why exhaling completely, with correct rib movement, has the power to "reset" proper diaphragm function by enabling it to relax and dome—restoring the ability to initiate a full contraction on inhalation.

Too often, especially when people focus on "belly" breathing or belly expansion, there's little or no emphasis on rib movement. Many people aren't aware that the most substantial movement during inhalation should occur in the lower ribs as they externally rotate and expand out to the sides to accommodate the inflation of the lungs. Upon exhalation, the lower ribs should internally rotate (close in), creating the necessary space for the diaphragm to dome inside the rib cage. If you place your hands on your lower ribs while breathing deeply, your hands should ride your ribs out laterally as you inhale, and in toward each other as you exhale.

Try it with your hands on your lower rib cage. Tongue behind your top front teeth (this forces a diaphragmatic breath) as you inhale, exhale squeezing a sponge upwards.

Challenging Poor Functional Movement

Considering that we take up to 24,000 breaths each day, and most people have likely been breathing less than optimally for quite some time, clients may find it challenging to get the ribs to move, or get the upper-body compensatory breathing muscles to release. Overcoming a "bad" breathing pattern takes training, and maintaining it takes awareness and commitment. That said, clients can experience results in as little as a few minutes, but, for a functional breathing pattern to hold, they need to train it through regular practice.

When training breathing, appropriate muscular effort is required to reposition the rib cage and get lower ribs to move, especially on the exhale. The primary muscles associated with that movement are internal and external obliques (side waist muscles) and transverse abdominis (low, deep core muscle that runs transversely).

Establishing diaphragmatic breathing with better rib cage position and rib movement can help release and restore the function of the upper-body muscles previously being used as accessory breathing muscles. Consequently, you may see measurable changes in shoulder internal rotation, flexion and abduction in only two sets of five breaths. When working with clients on breathing, you can do quick measurements on shoulder internal rotation before and after breathing exercises to give them demonstrable evidence of how their breathing can impact their movement.

Regaining diaphragm function and rib cage position not only creates measurable shoulder movement improvements, it increases strength, stability, and mobility throughout the core by providing access to previously inhibited core muscles, aligning the respiratory diaphragm with the pelvic floor, and facilitating rib movement. This translates to enhanced performance and durability. (Chapman 2016)

Understanding the power of breathing to impact movement allows you to benefit your clients during all functional movement training. Here's an example of how to focus breathing biomechanics during a thoracic rotation exercise:

Sit stable so hips/LE are not involved. R hand on left ribs (or traditional hands on rib cage). Inhale to turn R, exhale relax but stay there, inhale to turn further R, exhale relax, inhale one more time to turn R, exhale and return to center. Repeat to L. Try it standing and in other positions.

Breathing is especially effective when incorporated into stretching and mobility exercises. Facilitating a series of quality breaths into your exercises can significantly increase their effectiveness. Additionally, consider prescribing all stretching exercises by breath counts rather than time. Instead of having a client stretch for 30 seconds ask that they hold the position for od "5 deep breaths." This technique not only enhances the stretch itself but demands that the client is much more mentally engaged in the drill.

No matter how often you train a body for functional movement, if you don't train the respiration for optimal function, you're waging a losing battle. Poor breathing mechanics will overmatch training every time.

Pain

Although frequently going undetected, dysfunctional breathing patterns have the potential to create more pain. Inhibition of respiratory stabilizers like the diaphragm, TVA, multifidus, obliques and the pelvic floor muscles will force a body to rely on other less efficient muscles to keep it alive and breathing. Most often respiratory dysfunction will drive compensatory facilitation upward and downward into the surrounding muscles of the shoulders and hips.

The result is often pain/stiffness in at least 1 of 3 places:
1). Neck/Shoulders (Specifically the Scalenes, SCM and Pectoralis Minor)
2). SI Joint/Lumbar Spine
3). Anterior Hip

The Illiacus, Scalenes and Pectoralis Minor are usually overactive and painful while unnecessarily compensating to assist in respiration.

What's even worse: inefficient breathing has the potential to kick off a chemically driven feedback loop, possibly making already painful dysfunction even worse. The repeated inefficient gas exchange associated with dysfunctional breathing can bring about a shift in pH levels in our bodies. A number of studies have demonstrated that an acidic pH, relative to normal can bring about nasty and painful reactions in soft tissue structures. Most notably, an acidic pH will stimulate the production of Bradykinin (an inflammatory pre-cursor), increase pain threshold sensitivity and promote the development of taut bands resulting in trigger points. (Shah 2008) This cascade pushes the body further into a state of stress, continuing the painful cycle.

In order to re-program our respiratory muscles and develop efficient core function we must practice our breathing pattern just like we would any other pattern. Reconditioning the muscles of our pelvic canister (diaphragm, transverse abdominis, pelvic floor, obliques and multifidi) not only proves valuable in treating dysfunction and improving movement quality but can also serve as a window into our parasympathtic nervous system. By practicing controlled breathing we have the ability to shift our bodies into a parasympathtic state. All of this is good news as it relates to optimizing our internal environment for rest and recovery.

The research is very clear that breathing exercises can enhance parasympathetic (inhibit neural responses) tone, decrease sympathetic (excitatory) nervous activity, improve respiratory and cardiovascular function, decrease the effects of stress, and improve physical and mental health (Pal, Velkumary, and Madanmohan, 2004). Health professionals can utilize this knowledge and regularly incorporate proper slow breathing exercises with their clients in their sessions.

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