


*"PRI Breathing Mechanics  
in COVID Times"*

with Ron Hruska, MPA, PT  
Every Tuesday at 6PM CT



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**WEEK 9:**  
ARM SWING INFLUENCE ON  
ARTERIALIZATION AND AIRWAY OPENING



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The effect of arm and body position on respiratory ventilation for pulmonary recovery after strenuous training is well described in the literature.



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Leaning forward and placing the hands on the knees leads to a significantly greater ventilation compared with standing with the arms at the sides and standing with the hands behind the head at rest.

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Effects of Two Different Recovery Postures during High-Intensity Interval Training

Joana V. Michalson, Leticia R. Bello, David R. Sprack, Wim L. McLaughlin, and Dylan T. Dakajic

ABSTRACT

The purpose of this study was to examine the effects of two different recovery postures, hands on knees (HK) and hands on hips (HO), on a form of interval recovery from high-intensity interval training (HIIT). Twenty female Division II varsity soccer players (age = 20.6 ± 1.1 yr, body mass index = 22.6 ± 1.8 kg/m<sup>2</sup>) performed a 30-min HIIT protocol on a cycle ergometer, counterbalanced order. Each trial consisted of 10 min of rest followed by 10 min of HIIT. During the 10 min of rest, participants were instructed to maintain a neutral posture (standing) or a recovery posture (HK or HO) for the duration of the 10 min of rest. Two sets of 10 min of rest were performed, with 3 min of passive recovery between each interval. HR recovery was collected during the last 60 s of each recovery, where volume of carbon dioxide (V̇CO<sub>2</sub>) and tidal volume (V<sub>T</sub>) were recorded each minute during the 3-min recovery period. Results showed an improved HR recovery (P < 0.05), greater V<sub>T</sub> (P < 0.001), and increased V̇CO<sub>2</sub> (P < 0.05), with HK (25 ± 10.0 liters, 1.44 ± 0.2 L/min<sup>-1</sup>, 1.02 ± 0.2 L/min<sup>-1</sup>) compared with HO (20 ± 9.0 liters, 1.31 ± 0.2 L/min<sup>-1</sup>, 1.02 ± 0.2 L/min<sup>-1</sup>). These data indicate that HK posture may be more beneficial than the traditional HO posture as a form of interval recovery from high-intensity interval training.

INTRODUCTION

Adoption of all levels, from novice to elite, are constantly looking for ways to decrease time to recover and boost athletic performance. It is well known that the respiratory system plays a crucial role during rest and exercise via buffering metabolic by-products, such as hydrogen ions (H<sup>+</sup>) and carbon dioxide (CO<sub>2</sub>), to maintain the acid-base homeostasis and increasing ventilation of the respiratory system, enabling proper blooded muscle mass (1). Future researchers that the acid-base homeostasis during exercise can have downstream effects on performance (2) and other areas when the respiratory system lacks the ability to increase alveolar ventilation.

ventilation, or exercise-induced diaphragmatic fatigue (3). Thus, increasing ventilation could subsequently lead to an increase in tidal volume (V<sub>T</sub>), a component of respiratory rate, and a more efficient work of breathing. Consequently, athletes have investigated the effects of different postures during recovery from exercise and the physiological responses to these various recovery postures (4,5). Most of the research has focused on evaluating three different postures: supine, seated, and upright, with upright standing posture being the most widely used recovery posture in a sport field setting (6). However, new literature has begun to indicate that one can accelerate interval recovery between exercise bouts by maximizing the surface area of the diaphragmatic zone of apposition (ZONA) (8), it has been shown that the ZONA is maximized during spinal flexion rather than extension. Recovery of this, a relaxing posture with hands on head (HH) may be less advantageous to postures that increase the ZONA (e.g., flexed upper and hands on knees (HK) (7). The effects of HIIT versus HK on interval recovery and the ZONA have not been investigated.

Furthermore, the position of recovery may also influence autonomic function, which could lead to a quicker recovery during performance (9). HR recovery (HR<sub>rec</sub>) has been suggested as a valuable tool to monitor recovery and training status (10). A faster HR<sub>rec</sub> has been observed as a result of improvements in aerobic capacity (11). Conversely, a slower HR<sub>rec</sub> results in impaired performance and a greater chance of fatigue (12). Improved HR<sub>rec</sub> in the upper position has been demonstrated following repeated sprint exercise in youth soccer players (14). HR<sub>rec</sub> has been found to be greater following maximal duration recovery from exercise. Baroreflex-mediated and prolonged HR<sub>rec</sub> observed in HR<sub>rec</sub> that occurs during relaxation is hypothesized to improve the efficiency of gas exchange (13). However, it is unknown if improved HR<sub>rec</sub> during resting work is one transition in exercise influences subsequent performance in trained subjects, especially in female athletes.

Because of the limited information on different standing postures that could directly affect the ZONA and recovery in a

Article available free online: *Translational Journal of the ACSM*, February 2019

Arms, however, are also very important in maximizing respiratory perfusion during exercise-induced increased ventilation.

Very little research exists regarding the position and swing of arms during forward locomotor movement, regardless of the body speed, body elevation, or ground elevation.

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One of the best studies regarding upper body function (*Control and function of arm swing in human walking and running*, by Herman Pontzer et al, Journal of Experimental Biology 2009), support the postulate that the trunk and shoulders act primarily as elastic linkages and act as passive mass dampers which reduce torque on the head and neck.



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This last webinar in this series, will focus on the value of arm swing for reducing the ventilatory demands on you and your body during strenuous exercise.

Actively moving your arms is not only an essential part of active walking, it is also an essential part of active arterialization.

Also, passive movement of your arms improves ventilatory elasticity.



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One study (*Improvement of pulmonary function with arm swing exercise in patients with type 2 diabetes*, by Orathai Tunkamnerdthai et al, Journal of Physical Therapy Science 2015), demonstrated how “arm swing exercise” improves pulmonary functions via improvement of hyperglycemia, antioxidant activity, and fat metabolism.



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If you recall in week 1 of this webinar series, I stated that “Changes in posture secondary to position of ease and comfort or habitual patterning, changes perfusion and ventilation positions, and patterns of arterialization.”

There probably is nothing that re-positions, nor re-centers, patterns of ventilation and perfusion better than our two arms. Our TWO arms.

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Arms that swing off each other increase lateralization of the ribcage, abdominals and intercostals and therefore, improves arterialization at the distal arterioles of our lungs.

Argumentatively, our best “personal” trainer are our two arms.

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We want our lungs, especially our lower lungs, to change positions, wring and unwring.

This movement is not necessarily a shoulder function.

It is produced by both shoulder and mid to upper thoracic reciprocal function and accompanying rib cage alternating lateralization.

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“In normal breathing, alveolar pressure must be less than atmospheric pressure during inhalation, and greater than atmospheric pressure, as the chest recoils, during exhalation.” (Week 1)

“The most common site of limitation is the right anterior apical lobe and the left posterior based lobe.”

The most common site of limitation of arm movement or swing is at the mid lateral chest walls.

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Bipedal Arm Swing  
Respiratory Considerations

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1. Arm swing, counters twisting motion on the mid to low thorax created by the legs, for efficient ventilation and forward, straight ahead, movement.

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2. Uneven arm swing results in over-rotation of the trunk resulting in wasted energy and inefficient overuse of the upper torso and thorax; and inefficient arterialization from the lower lobes of the static lung tissue.



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3. Arm swing should be rhythmic and similar to a pendulum, providing a source of pumping air in and out of the lung and around the bronchioles.

It also keeps the smooth muscle around the bronchioles, elastic.



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4. The angle of the lower arm and upper arm at the elbow should be approximately 90 degrees and may increase slightly as they are swung straight back.

The increase of the angle at the elbow during take back allows for the opposite leg to complete its cycle of movement backward.



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Bipedal elbow angulation should decrease on forward movement from backward movement angulation values, to prevent elevation of the shoulder complex from overuse of neck and back extensors.

These elbow considerations, should enhance hemi-rib alternation and move blood and gas around arterioles, decrease arteriole smooth muscle vascular resistance and increase lung capillary flow.

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5. Arm swing reduces negative intrathoracic pressure swings and vertical angular movement (body moving up and down during forward locomotor movement), by maintaining wrist extension (not wrist pumping) and ankle dorsiflexion necessary for forward locomotor movement. (Week 7)

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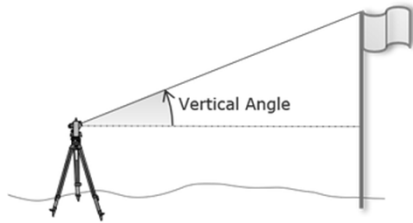


Figure F-1  
Angle Orientation

Image from: <http://www.jerryamahun.com/index.php/home/open-access/1-basic-principles/85-14-vert-angles>

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### Surveying

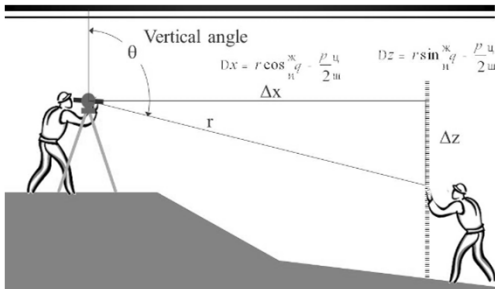


Image from: <https://slideplayer.com/slide/5054633/16/images/31/Surveying+Vertical+angle+q+Dx+r+Dz.jpg>

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6. Head and neck rotation effort for torso and thoracic direction (Head on Body reflex) is reduced by the influence arm swing has on the upper thorax to the lower thorax rotation.

This influence on the mid to low thorax (T8 and below) decreases accessory respiration from T8 and above, including the neck.

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7. Most optimal arm swing for respiratory and postural balance is .8 m/s (meter per second) which is 1.79 miles per hour.

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8. Passive arm swing has been shown to effectively act on the spinal column and shoulders as a spring.

The more active the elbow becomes, the more active the shoulders become and the more “stiff” the “spring” becomes between the pelvis, shoulders, and arms, resulting in poorer ventilatory perfusion.

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9. When the inertia of movement is decreased, arm swing is set in motion, the amplitude of the shoulder and rib rotation increases.

This biomechanically allows the intercostals to expand and integrate intercostal intrinsic 'intelligence' during walking respiration or running respiration. (Week 7)

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10. Arm swinging, and associated body movement, is a self-tuned and self-stabilizing phenomenon that reduces multi-segment, multi-muscle, and multi-system disassociation and enhances physiology and physical association through the rib cage and underlying respiratory function.

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**Racewalking**

There are two rules that govern racewalking.

1. The first dictates that the athlete's back toe cannot leave the ground until the heel of the front foot has touched. Violation of this rule is known as 'loss of contact'.
2. The second rule requires that the supporting leg must straighten from the point of contact with the ground and remain straightened until the body passes directly over it.

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Athletes stay low to the ground by keeping their arms swinging low, close to their hips.

If one sees a racewalker's shoulders rising, it may be a sign that the athlete is losing contact with the ground.



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This position of walking reinforces abdominal, intercostal, inter-scapula and subscapular alternation during alternation of zones of apposition (Weeks 5 and 6), zones of ventilation (Week 1) and associated desired arterialization. (Week 2)



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Qigong Arm Swing  
YouTube Suggestions



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First Form: Waist Rotation with Swinging Arms  
22,074 views • Mar 24, 2015

First Form: Waist Rotation with Swinging Arms  
(0:00 to 1:16)

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Fifth Form: Arm Swing with Bending Knees  
27,252 views • Mar 24, 2015

Fifth Form: Arm Swing with Bending Knees  
(0:00 to 1:36)

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Counter Swing - Qigong Exercise  
2,793 views • Jul 9, 2014

Counter Swing – Qigong Exercise  
(0:45 to 1:33)

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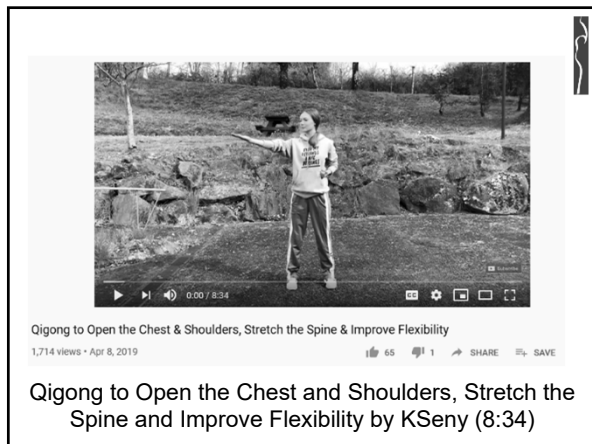
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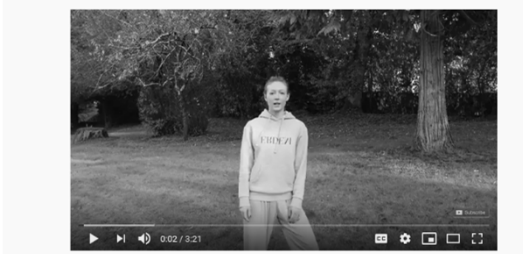
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Qigong Chest & Lungs Opening Exercise  
5,431 views · Nov 21, 2017

Qigong Chest and Lungs Opening Exercise by KSeny  
(3:22)

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Thank you for joining Jen and I over the last 9 weeks. We hope this information will help anyone and everyone, who watched or will watch in the future, better understand the relationships between lung and chest function, Postural Respiration guidelines and techniques taught by the Postural Restoration Institute® and breathing mechanics during and after COVID times.

Gratefully yours,  
*Ron Aruska*

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