



REHABILITATION AND CORE STABILITY

# Pilates and the “powerhouse” — I

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## KEYWORDS

Pilates;  
Powerhouse;  
Core-stabilization;  
Contrology;  
Exercise

**Abstract** The Pilates method is a comprehensive body-conditioning method that is directed toward the development of both the body and the mind of the individual. Toward this end, the Pilates method incorporates six key principles: centering, concentration, control, precision, breath, and flow. The purpose of this paper is to investigate the underlying biomechanical foundation of the principle of “centering”. The principle of centering refers to the concept that all movements of the human body emanate from the center or core or what Joseph Pilates called the *powerhouse* of the body. The Pilates method endeavors to strengthen the powerhouse as one of its primary goals. In effect, strengthening the powerhouse is core-stabilization. Part one of this article investigates what the boundaries and components of the powerhouse are as well as the muscle groups that effect movements of the powerhouse. It then explores the three major effects that Pilates exercises have upon the health and integrity of the powerhouse: (1) its effect upon pelvic posture, (2) its effect of lengthening the spine, and (3) its effect upon the structural integrity or tone of the abdominopelvic cavity. The sum total of these effects is to create what may be termed the *Pilates Powerhouse Posture*. Part two will then illustrate various Pilates exercises and describe their effects upon the powerhouse.

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## Introduction

The Pilates Method of body conditioning was developed by Joseph H. Pilates. Joseph Pilates began to develop his system of body conditioning during the First World War (Siler, 2000) and continued to enhance and refine this system over the next 50 years until his death in 1967. All told, the Pilates system of body conditioning contains over 500 stretching and strengthening exercises. These exercises may be divided into two broad categories: mat and apparatus exercises. The first exercises developed by Joseph Pilates were mat

exercises, which as the name implies are done on a mat on the floor. Pilates next created a number of apparatuses that require one to exercise against resistance, the resistance being provided by the use of springs and pulleys.

Upon creation of his method of body conditioning, Pilates named it “The Art of Contrology”. Inherent in this name is Pilates’ belief that it should be the goal of a healthy person to attain a strong mind and use it to gain total mastery or control over his/her physical body. Therefore, the Pilates Method as advocated by Joseph Pilates is more than just a physical regimen for the body; it is also a balanced regimen for strengthening and conditioning the mind as well (Gallagher and Kryzanowska, 2000; Pilates, 1945).

Pilates felt that modern society had robbed us of our natural physical and mental vitality. He noted that with the advent of civilization and sedentary

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indoor living, our activities have failed to exercise the body in ways that are structured and balanced. Additionally he observed that our compensatory efforts via hobbies, activities and recreation, are all too often performed in ways that are unbalanced and ineffective at truly encouraging good control of the body (Gallagher and Kryzanowska, 2000; Pilates, 1945; Siler, 2000).

## Key principles of Pilates

For this reason, Pilates developed a comprehensive method of stretching and strengthening exercises that together aim to create a strong and limber body as well as a strong will of mind that can control the body. Certainly, any method as comprehensive and diverse as Pilates will have many core principles. This is true for the Pilates Method, which may be said to have six key principles (Liekens, 1997). They are: centering, concentration, control, precision, breath, and flow.

1. Centering is considered to be the main focus point of the Pilates Method. The "center" refers to the center or core of the body and is usually known as the "powerhouse".
2. Concentration is important in that it is the mind that guides the body; hence focused concentration is necessary when carrying out Pilates exercises.
3. Control refers to the fact that when the work of an exercise is being done from the center with concentration, you will be in control of the movements performed.
4. Precision refers to the precision Joseph Pilates employed in developing each exercise and the precision with each exercise should be carried out. A common saying in the world of Pilates that illustrates this is: "It is not how many, but how".
5. Breath is of utmost importance because all exercises should be done with a rhythm to the breathing for the purpose of obtaining optimal circulation of oxygenated blood to all tissues of the body.
6. And finally, flow refers to the graceful and flowing succession of one exercise to another during a Pilates session.

It is not within the scope of this article to try to exhaustively cover every one of these six key principles. Instead, this article narrows its focus in on the concept of Centering. More specifically, the relationship between the Pilates Method and the effect that it has upon strengthening what is called the *powerhouse* is investigated. Then

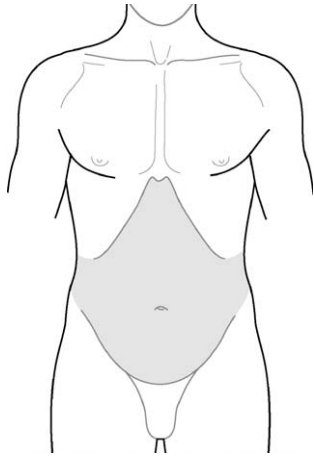
implications that a strong powerhouse has for the healthy structure and function of the human body are explored.

## Centering and the powerhouse

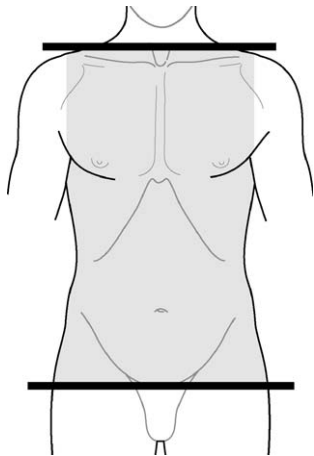
Perhaps the major tenet of the Pilates method is the concept of centering. While Joseph Pilates believed that all muscles of the body should be strengthened and stretched (Gallagher and Kryzanowska, 2000; Pilates, 1945), he felt that the major emphasis should be placed upon the muscles of the center, or core, of the body (Selby, 2002; Siler, 2000; Winsor, 1999). He referred to this region as the *powerhouse* of the body. Joseph Pilates himself never set down in writing what the exact parameters of the powerhouse were and there does not seem to be exact agreement amongst the master teachers of Pilates today.

It is worth mentioning that after the death of Joseph Pilates, his student and disciple, Romana Kryzanowska, was chosen by Clara Pilates to carry on the artistic interpretation and dissemination of the Pilates Method (Siler, 2000). Meanwhile, the archival material and trademark of the name Pilates became the property of Sean Gallagher, P.T. In a recent legal decision, the ability to trademark the name Pilates, and consequently the sole right of certification of Pilates instructors was lost. This means that there is no longer one certifying or governing body that determines exactly what the Pilates Method is or is not. As a result, the practice and method of Pilates, along with the underlying biomechanical basis, has been diverging greatly in recent years. There are now many techniques within the Pilates world, some adhering strictly to the system of exercises developed by Joseph Pilates, and others that are incorporating changes into this system. This article tries to address the biomechanical basis of the original Pilates method as far as is possible.

When most strictly defined, the powerhouse is said to be the "...center of the body. It is the exact point between the upper half of your body and the lower half of your body, between the right side and the left side" (Winsor, 1999, p. 30). Others have defined it as a 6-inch band that runs around the entire body and is located just inferior to the navel. However, many in the Pilates world view the powerhouse more broadly and define it as ranging from the pelvic floor inferiorly to the ribcage superiorly (Winsor, 1999) (see Fig. 1). Another term that is of importance to the subject of centering is the *box* (Liekens, 1997). The box is defined by two horizontal lines: one running from the top of one



**Figure 1** The powerhouse: The *powerhouse* in Pilates is usually defined as extending from the pelvic floor inferiorly to the ribcage superiorly. Effectively, the powerhouse is the center of the body.



**Figure 2** The box: The *box* is defined by two horizontal lines; one running from the top of one shoulder to the top of the other shoulder, and the second line running from one hip joint to the other hip joint, i.e., the box encompasses the entire pelvis and trunk. Just as the powerhouse is defined as being the center of the human body, the box is a more broadly defined center of the body.

shoulder to the top of the other shoulder, and the second line running from one hip joint to the other hip joint (Liekens, 1997) (see Fig. 2). In effect, the box incorporates the entire trunk and pelvis as a whole. The concept of centering may be broadened beyond the powerhouse to include the rest of the trunk and when this is done, the box becomes the center in that the box is a broader center of the human body. Thus the concept of centering refers to strengthening the center of the body. For the purpose of this article, the core powerhouse is defined as ranging from the pelvic floor to the

ribcage. However, this will have an effect upon, and will incorporate to some degree, the larger center known as the box. What is clear and universally accepted within the world of Pilates is that the powerhouse is thought of as the core of the body from which the power and strength of the body is derived (Winsor, 1999). In other words, the powerhouse is the core center of the body from which peripheral muscle actions are carried out.

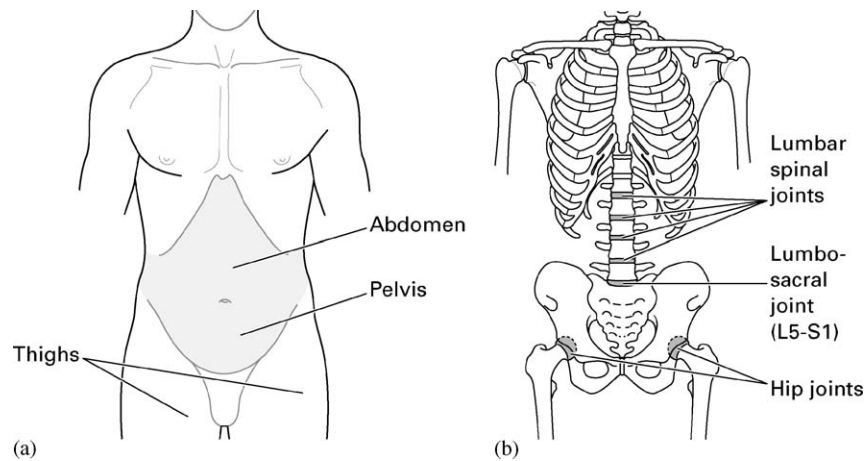
The concept of centering is to create not only a strong structural powerhouse, but also a flexible one. Indeed, Joseph Pilates used to have the following maxim on his business card: “A man is only as old as his spine is inflexible”. With a core center to the body that is strong and flexible, Pilates asserted that the integrity of functioning would be improved. That is, the ability to move and function throughout the activities of daily life would be optimized (Pilates, 1945; Siler, 2000). The Pilates method of body conditioning does not aim to bulk a person’s musculature; it aims to strengthen and lengthen a person’s posture and musculature (Gallagher and Kryzanowska, 2000; Pilates, 1945; Selby, 2002; Siler, 2000).

## Components of the powerhouse

Using this expanded concept of the powerhouse that reaches from the pelvic floor to the ribcage, it can be seen that the body parts that are contained within the powerhouse are the pelvis and the abdomen; the abdomen being defined as the anterior abdomen as well as the posterior abdomen, i.e., the lower back. The joints that are involved with the powerhouse are the lumbar spinal joints, including the lumbosacral joint between the lumbar spine and the pelvis, and the hip joints (femoroacetabular joints) between the pelvis and the thighs (see Fig. 3). The muscles of the powerhouse are the major muscles and muscle groups that are located within this region; of particular importance to the purpose of this article will be the muscles and muscle groups that move the body within the sagittal plane.

Taking a closer look at the muscles of the powerhouse, they may be divided into the following five major groups (see Fig. 4):

- Anterior abdominals (also known as spinal flexors). These muscles include the rectus abdominis, external abdominal oblique, internal abdominal oblique and the transversus abdominis.
- Posterior abdominals (also known as spinal extensors or low back muscles). These muscles



**Figure 3** (a) Components of the *powerhouse*: The *powerhouse* contains the pelvis and the abdomen. (b) The joints within the abdomen are the lumbar spinal joints. The pelvis is a body part that is bounded by the lumbosacral joint superiorly and the hip joints inferiorly.

include the erector spinae group and the transversospinalis group, as well as the quadratus lumborum.

- Hip extensors. These muscles include the gluteus maximus and may also include the hamstrings and the posterior head of the adductor magnus.
- Hip flexors. These muscles include the iliopsoas, rectus femoris, sartorius, tensor fasciae latae and the more anterior adductors of the thigh at the hip joint.
- Pelvic floor musculature (also known as perineal muscles). These muscles include the levator ani, coccygeus, superficial and deep transverse perineals and others.

Given the structural components of the powerhouse, it can be stated that the principal tenet of working the powerhouse will be to affect the muscles and joints of the pelvis and lumbar spine; the thrust being to not only affect the static posture of this region, but also to affect the dynamic strength and flexibility of this region as well.

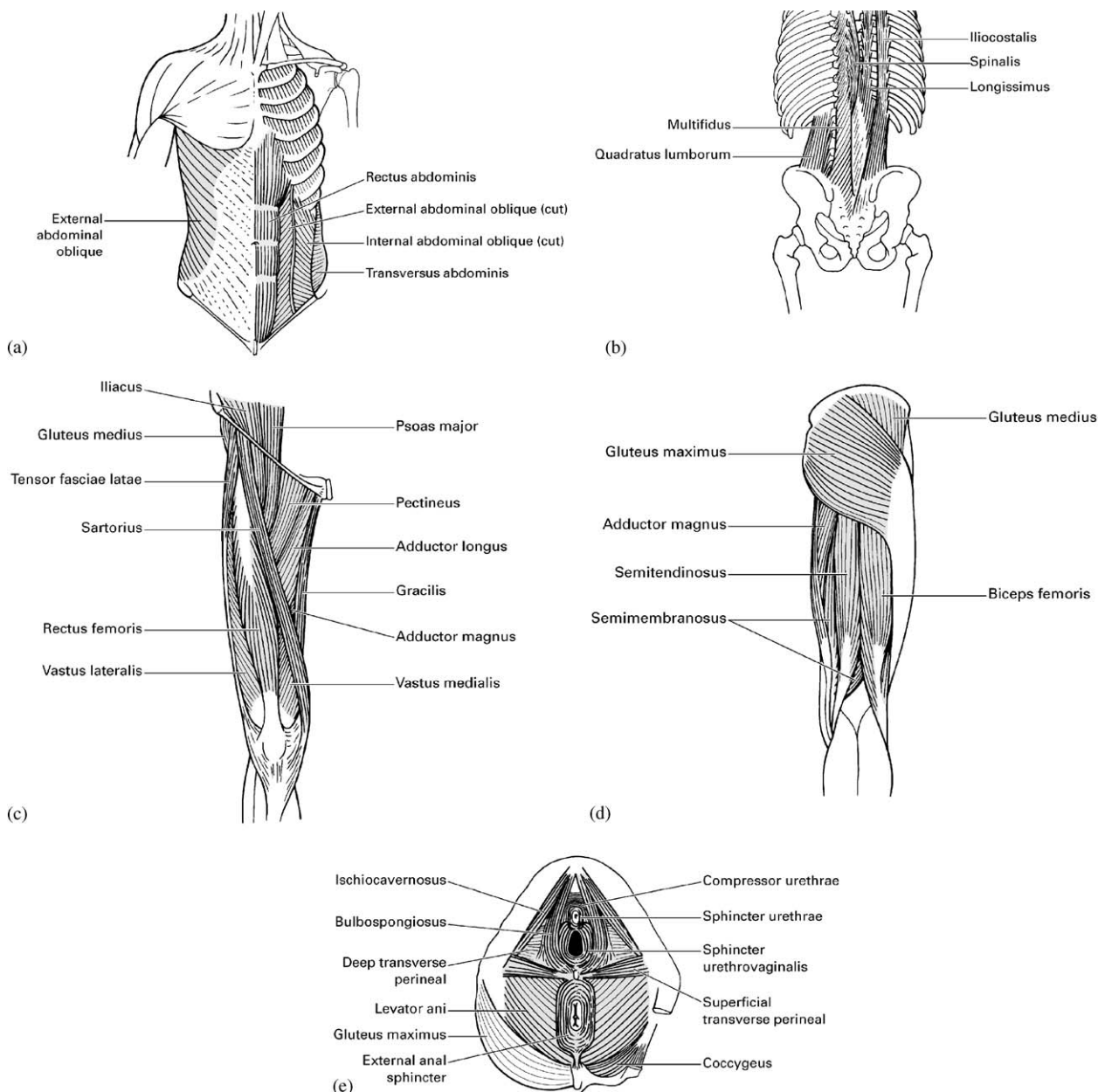
### Effects of working the powerhouse

The Pilates method of body conditioning may be generalized to have three major effects upon the powerhouse. First, Pilates affects the posture of the pelvis, which results in postural changes to the lumbar spine. Second, it works directly upon the musculoskeletal structure of the spine (the lumbar spine in particular) by strengthening, stretching, and lengthening the spine. Third, Pilates affects the structural integrity or tone of the abdomino-pelvic cavity as a whole.

### The neutral pelvis and its effect upon the spine

It is often said that the pelvis is the keystone of the skeletal structure of our body. Examining the structural and functional considerations of the pelvis, it is seen that the pelvis is a body part that is located between the trunk and the thighs. When the pelvis moves, it may move relative to the trunk at the lumbosacral joint and/or it may move relative to the thigh(s) at the hip joint(s) (see Fig. 5). Muscles that attach from the trunk to the pelvis move the pelvis at the lumbosacral joint; muscles that attach from the lower extremity to the pelvis move the pelvis at the hip joint(s). A primary concern involves pelvic sagittal plane movements and the resultant sagittal plane effects on the spine. Unfortunately, there are a plethora of terms used to describe the movements of the pelvis. Probably the most common terminology for sagittal plane pelvic movements and the one that will be used in the article is posterior tilt and anterior tilt of the pelvis (see Fig. 6).

The posture of the pelvis largely determines the posture of the spine. The spine sits upon the base of the sacrum; therefore, any change in the sagittal posture of the pelvis will change the level of the base of the sacrum. The level of the base of the sacrum will then affect the curve of the lumbar spine. For example, if the base of the sacrum were level, the spine would be totally straight. However, once the base of the sacrum is unlevel to any degree, the spine must have a curve in it to compensate. This curve is necessary to eventually create a level base for the head to sit upon. This righting mechanism to create a level base for the head is necessary to place the eyes and the

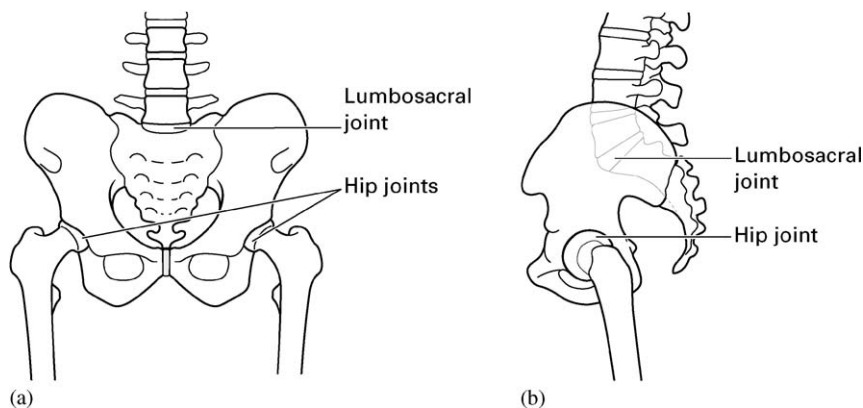


**Figure 4** The major muscle groups of the *powerhouse*: The five major muscle groups of the *powerhouse* are the anterior abdominals (a), posterior abdominals, i.e., low back muscles (see b), hip flexors (c), hip extensors (d), and the pelvic floor muscles (e).

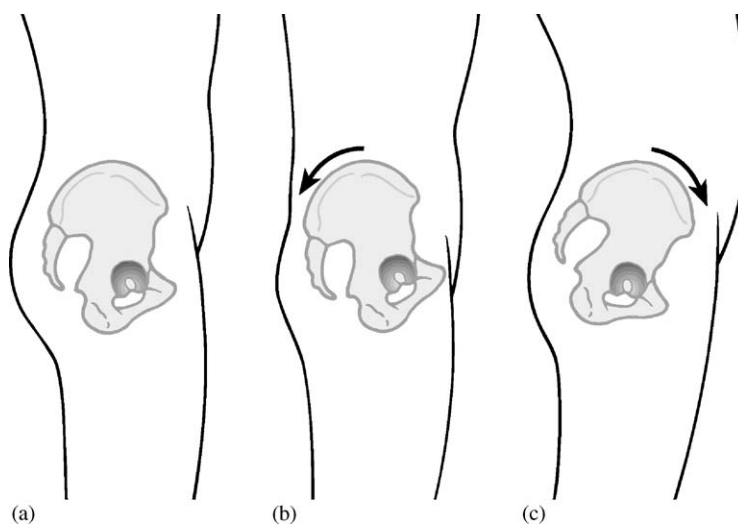
labyrinthine receptors of the inner ear on a level plane, this being necessary for proper static and dynamic proprioception of our body.

Fig. 7a illustrates a normal healthy pelvis, or what may be termed a neutral pelvis. A neutral pelvis may be defined as having a pure vertical line that runs along the anterior surfaces of the anterior superior iliac spine (A.S.I.S.) and the pubic tubercle (Neumann, 2002). In Fig. 7a, we see that the base of the sacrum of a neutral pelvis has a tilt angle of 30 degrees. This tilt angle is usually known as the lumbosacral joint angle and is measured by drawing

two lines: a horizontal level line and a line along the top of the base of the sacrum; and then measuring the angle that is formed by the intersection of these two lines. Given that a neutral pelvis has a lumbosacral base angle of 30 degrees, i.e., an anteriorly tilted pelvis of 30 degrees, the lumbar spine sits on this unlevel surface and must curve sufficiently to compensate. This curve of the lower spine is the lumbar lordosis and the degree illustrated in Fig. 7a may be considered to be a normal healthy lumbar lordosis. Any curve of a lesser degree, i.e., flattening of the lumbar curve,



**Figure 5** Joints of the pelvis: The pelvis may move at the lumbosacral joint and/or the hip joint(s).



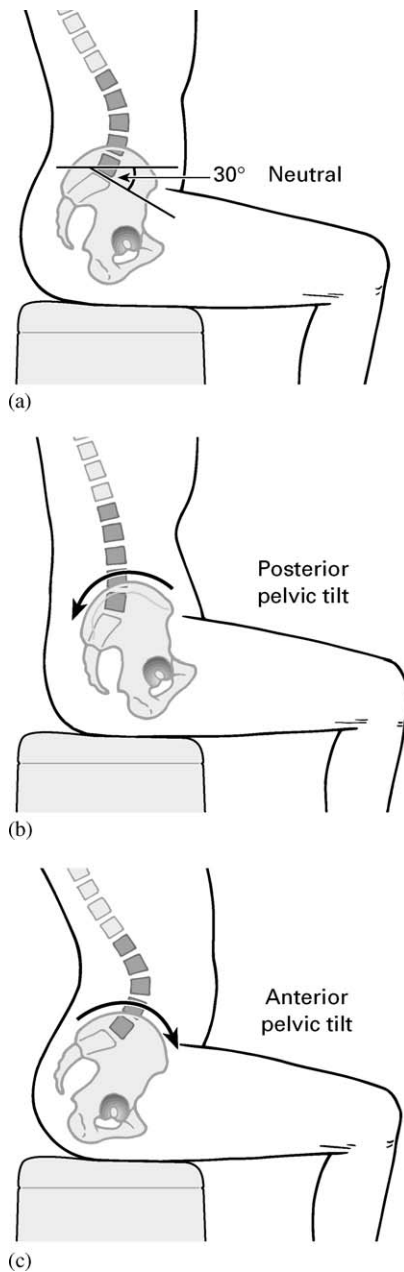
**Figure 6** Sagittal plane movements of the pelvis: (a) Demonstrates a pelvis in neutral position. (b) Demonstrates a posteriorly tilted pelvis. (c) Demonstrates an anteriorly tilted pelvis.

may be labeled as a hypolordosis of the lumbar spine; any lumbar curve that is greater may be labeled a hyperlordosis of the lumbar spine (also known as a “swayback”). [Figure 7b](#) shows a pelvis that is posteriorly tilted compared to neutral and the resultant lumbar hypolordosis. [Figure 7c](#) illustrates a pelvis with greater than normal anterior tilt and the resultant lumbar hyperlordosis. Therefore, it is clear that if a body-conditioning regimen can directly affect the postural tilt of the pelvis, the lumbar spine will also be affected.

One of the major emphases of Pilates is to address the posture of the pelvis by addressing the musculature of the pelvis. Theoretically, if a person has a perfectly healthy pelvic posture, no change need be done via Pilates, or any other exercise regimen. (Instead, this proper posture need only be maintained via regular body conditioning). However, the average individual, especially as the aging process continues, tends to lose the battle with gravity and gradually finds that the posture of the

pelvis has an increased anterior tilt. This is due not just due to ligamentous/joint capsule laxity of the pelvic region, but also to an imbalance of the musculature of the pelvis. In [Fig. 8](#), we see that there are basically four major muscle groups that affect the sagittal plane posture of the pelvis. The anterior abdominals and hip extensors create a posterior tilt force upon the pelvis, and the low back spinal extensors (posterior abdominals) and the hip flexors create a force of anterior tilt upon the pelvis.

If the relative balance between these posterior and anterior tilt muscles of the pelvis changes, the posture of the pelvis will change. Thus, weakened anterior abdominal muscles and a weakened gluteus maximus muscle (hip extensor of the buttocks) and/or tightened spinal extensor and hip flexor muscles will result in the typical posture of an anteriorly tilted pelvis. Intuitively, most lay people, let alone people who study musculoskeletal structure and function, will immediately realize



**Figure 7** Sagittal plane pelvic positions with the resultant lumbar curves: (a) Demonstrates a neutral pelvis with a lumbosacral angle of 30 degrees. (b) Demonstrates a posterior tilted pelvis with a resultant lumbar hypolordosis. (c) Demonstrates an anterior tilted pelvis with the resultant lumbar hyperlordosis.

that the average person suffers from weak abdominal and buttocks musculature and tight low back musculature. This is exactly the prescription for an anteriorly tilted pelvis now or in the future; and an anteriorly tilted pelvis creates a hyperlordotic lumbar spine.

One of the overriding principles behind nearly every Pilates exercise is to address this potential problem of the center or powerhouse of the body

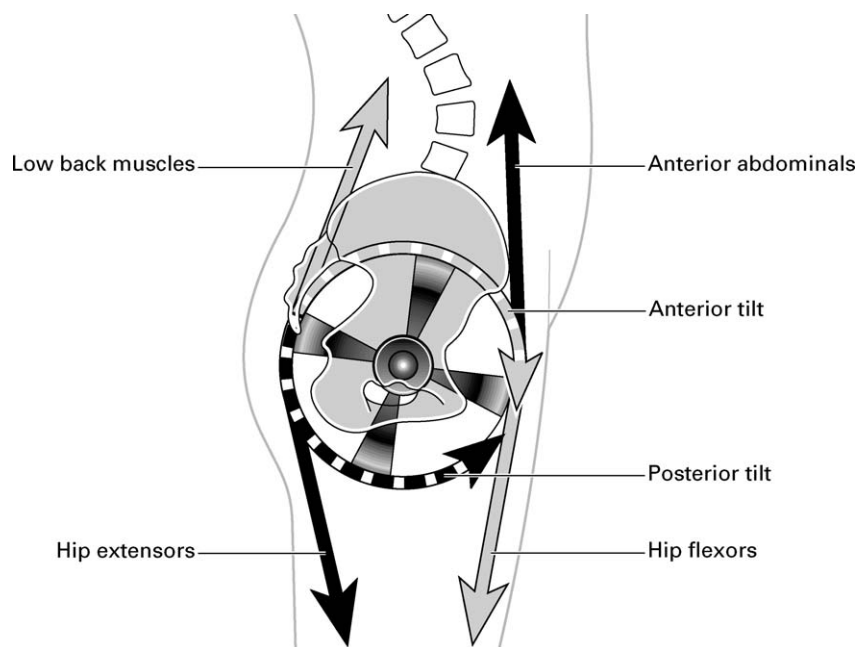
by strengthening the anterior abdominal muscles and the gluteus maximus (Siler, 2000; Winsor, 1999). Pilates further corrects this imbalance by placing a strong emphasis on stretching the low back musculature. In this manner, Pilates aims to create a neutral pelvis, and thereby create a healthy lumbar lordosis. In those who already have a neutral pelvis, Pilates aims to maintain this proper posture of the pelvis and thereby maintain a healthy lumbar lordosis.

### Lengthening of the spine

The second major effect of Pilates upon the powerhouse is lengthening the spine (Pilates, 1945; Siler, 2000). Lengthening the spine results in a person that stands taller and a decompression of the joints of the spine. The concept of lengthening the spine and standing taller is not unique to Pilates. Indeed, many other body-conditioning methods aim to lengthen the spine as a part of their philosophy. Although the concept of a lengthened spine is important throughout the entire spinal column, the focus of this article will be primarily upon the lumbar spine and to some degree the thoracic spine.

The concept behind lengthening the spine is to effectively lessen the curves of the spine (Gallagher and Kryzanowska, 2000; Pilates, 1945). It has been previously stated that as our bodies age, the force of gravity tends to increase the anterior tilt of the pelvis, which increases the lordosis, i.e., the degree of the lumbar curve. This increased lumbar lordotic curve then causes an increase in the amount of the thoracic kyphotic curve. The result of all of this is a trunk that is shortened in stature and a greater compression upon the joints of the spine.

Before beginning an investigation of the manner in which Pilates directly lengthens the lumbar spine, it should be noted that the effect of Pilates upon the posture of the pelvis that has just been discussed, indirectly contributes to lengthening the spine. An excessively anterior tilted pelvis that has been corrected due to Pilates exercises to have less anterior tilt will result in a lessened lumbar curve and a concomitant lessened thoracic curve, all of this resulting in a somewhat lengthened spine overall. However, Pilates also works to lengthen the spine directly. When doing every Pilates exercise, the Pilates instructor looks for the client to create this lengthened posture of the spine by using such verbal cues and visual images as: “suck the stomach in and up” or “hold the belly button in and up” or “bring the navel to the spine” (Siler, 2000).



**Figure 8** Major sagittal plane muscle groups of the pelvis: Fig. 8 demonstrates the four major muscle groups that move the pelvis in the sagittal plane. It can be seen that the anterior abdominals and hip joint extensors create a posterior tilt of the pelvis while the low back muscles and hip joint flexors create an anterior tilt of the pelvis.

Given the fact that the lumbar lordosis is actually a posture of extension of the lumbar spine at the spinal joints, these verbal cues are important because they engage the spinal flexor musculature of the lumbar region (anterior abdominals) to contract concentrically and then isometrically, creating a force of flexion that will lessen the lumbar curve and lengthen the lumbar spine. At the same time, the extensor musculature of the lumbar region (low back muscles) must be relaxed so that it can stretch to allow this lengthened posture of the lumbar spine to be created and isometrically held.

When the concept of lengthening the spine into the thoracic region is examined, the classic definition of the powerhouse extending up to the ribcage as the center of the body must be expanded to now include the *box* as previously mentioned. First, by lengthening and straightening the lumbar spine, the thoracic spine automatically tends to become straighter and longer since the thoracic spine must begin its posture upon the lumbar spine, and a change in the posture of the lumbar spine automatically creates some degree of change in the thoracic spine. However, Pilates also acts directly upon the thoracic spine itself to lengthen it. Looking at the thoracic spine, it can be seen that the effect of these verbal cues of “in and up” works the musculature of the thoracic spine in a manner that is opposite to the lumbar musculature. The thoracic kyphotic curve is a curve created by flexion of the thoracic vertebrae at the spinal

joints. Therefore, in the thoracic region, lengthening requires upper thoracic spinal extensors to contract concentrically and then isometrically to lessen the kyphosis, resulting in a lengthened thoracic spine; concomitant with this, upper thoracic spinal flexors must relax and stretch to allow this lengthened posture of the thoracic spine to be created and isometrically held.

### Tone of the abdominopelvic cavity

The third major effect that Pilates has upon the powerhouse of the body is its ability to affect the structural integrity or tone of the abdominopelvic cavity as a whole. Although the abdomen is often thought of as just being anterior, the abdomen actually wraps 360 degrees around the entire body. As such, the abdomen has anterior, lateral and posterior walls. The posterior wall of the abdomen is made up of the muscles of the lower back. The anterior and lateral walls are made up of the muscles that we call the abdominal wall muscles: the rectus abdominis, external and internal abdominal obliques and the transversus abdominis. Since there truly is no separation between the abdominal cavity and the pelvic cavity, the pelvic cavity must be added to the picture. The pelvic cavity is nearly entirely surrounded by solid bone. However, the floor of the pelvic cavity is made up of

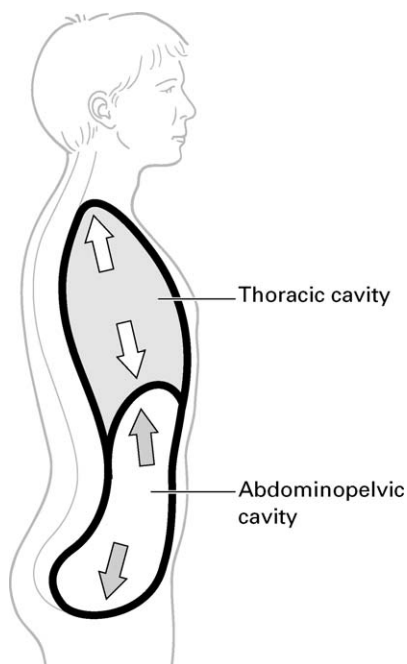


the perineal muscles. Thus, the abdominopelvic cavity is bounded by low back, anterior abdominal, and perineal muscles.

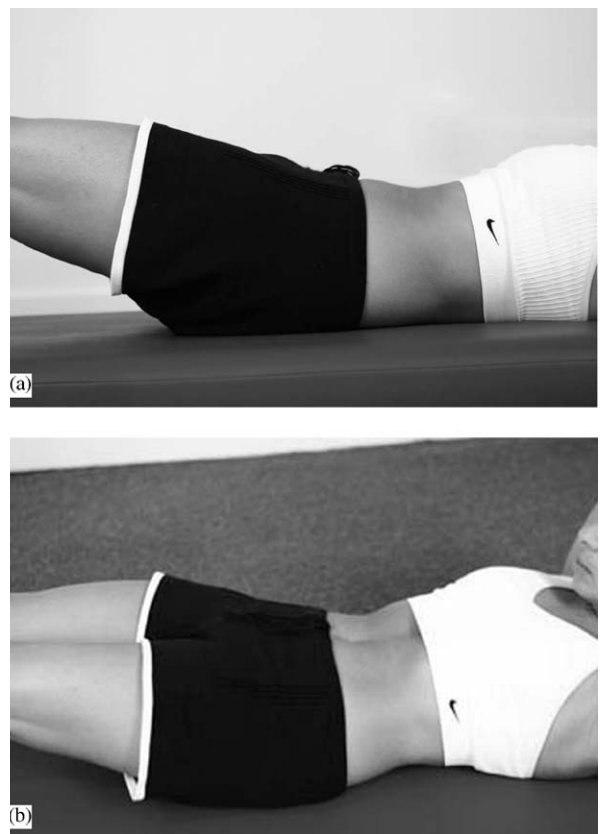
The abdominopelvic cavity can be thought of as a cylinder that connects the thighs to the ribcage. Although the abdominal region is often thought of as a soft underbelly, the more toned the muscles of the abdominopelvic region become, the more rigid this cylinder becomes. As the cylinder increases in rigidity, the core of the body increases its stabilization (Chaitow and DeLany, 2002). The term intra-abdominal pressure is sometimes applied to the concept of abdominal rigidity (Chaitow and DeLany, 2002) because when a person inhales deeply, the diaphragm drops, allowing more air to enter the lungs; this volume of air within the lungs increases the pneumatic pressure within the thoracic cavity; and the dropping of the dome of the diaphragm then increases the pressure within the abdominopelvic cavity (see Fig. 9). The result is that the pressure within the entire trunk, i.e., the *box*, has increased. This translates into greater core stability of the trunk, resulting in greater strength of movement. This concept is intuitively clear even to

the lay person; when someone needs to lift a heavy object, in anticipation of the effort needed to lift this object, a deep breath is taken in and held. This deep breath is done to increase the pneumatic pressure and stability of the trunk and pelvis.

The ability of the walls of the abdominopelvic cavity to hold this increased pressure, and indeed add to it by isometric contraction of the muscles of the wall of the abdominopelvic cavity, is crucial. As previously stated, the Pilates Method aims to strengthen and stretch every muscle of the body; however, working on the abdominopelvic region is the major focus. In particular, it has been asserted that the strengthening of certain muscles of the abdominopelvic region may be of primary importance. These muscles are the multifidus (Chaitow and DeLany, 2002; Winsor, 1999), and the transversus abdominis (Chaitow and DeLany, 2002; Selby, 2002; Winsor, 1999), and the perineal muscles (Chaitow and DeLany, 2002), as well as a few others. Recent studies point to the role that these particular muscles have as postural, endurance, stabilizing muscles. Whether it is through the strengthening of these particular muscles alone,



**Figure 9** Increased pressure within the powerhouse: Fig. 9 demonstrates how taking in a deep breath and holding it in can cause an increase in the pneumatic pressure of the thoracic cavity. The dropping of the diaphragm against the soft tissue of the abdominopelvic cavity raises the pressure within the abdominopelvic cavity as well. The result is a more rigid, i.e., more stabilized core. The muscles of the abdominopelvic wall must be sufficiently strong enough to be able to contain this pressure.



**Figure 10** The powerhouse posture: (a) and (b) demonstrate two views of the Pilates Powerhouse Posture.

or the effect upon all muscles of the powerhouse, it can be confidently stated that Pilates increases the tone and structural integrity of the abdominopelvic cavity.

## Conclusion

To sum up, the Pilates method of body conditioning affects the powerhouse in three major ways: posterior tilt of the pelvis, lengthening of the spine, and increasing the tone or structural integrity of the abdominopelvic cavity. These components of Pilates may be viewed separately to facilitate the study and understanding of Pilates and its effect upon the powerhouse, but these divisions are somewhat false. Upon closer examination of these three components, it becomes clear that they cannot truly be separated from each other. Common and necessary to all three components is an isometrically strengthened anterior abdominal wall. These anterior abdominal wall muscles are engaged when the pelvis is posteriorly tilted, the lumbar spine is lengthened, and the internal pressure, i.e., the structural integrity, of the abdominopelvic cavity is increased.

When anterior abdominal wall engagement is coupled with a focus on engagement of the gluteus maximus and the muscles of the pelvic floor, and also a focus on stretching and strengthening the low back spinal extensors, what may be termed the *Pilates Powerhouse Posture* is created (see [Figs. 10a and b](#)). It is this Pilates Powerhouse Posture that is integral and at the basis of the concept of Centering and working the powerhouse.

And a strong and flexible powerhouse is the result of centering and working the powerhouse.

Part II of this article will describe and illustrate various Pilates exercises and describe their effects on the *powerhouse*.

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