Starting Strength

"Balance" Training

by

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The ability to keep our balance is a skill that most people take for granted. That you're able to wake up in the morning and groggily walk down the stairs to get your day started without face-planting is actually pretty remarkable. It requires an incredibly complex set of integrated neurological and musculoskeletal processes that are so hard-wired by evolution that you barely notice their existence in day-to-day life – that is, unless you're getting old, weak, and frail. Then you probably think about these things with every move you make out of fear of falling and being unable to get back up.

This fear is not unfounded – about 1 in 3 adults over the age of 65 fall each year, and about 1 in 5 falls has serious consequences such as bone fractures or head injuries. Many of these people end up hospitalized, resulting in further deconditioning by the time they're discharged back home – if they survive that long without further complications. In addition to all these life-threatening risks, you can imagine how living in constant fear of falling can itself be debilitating.

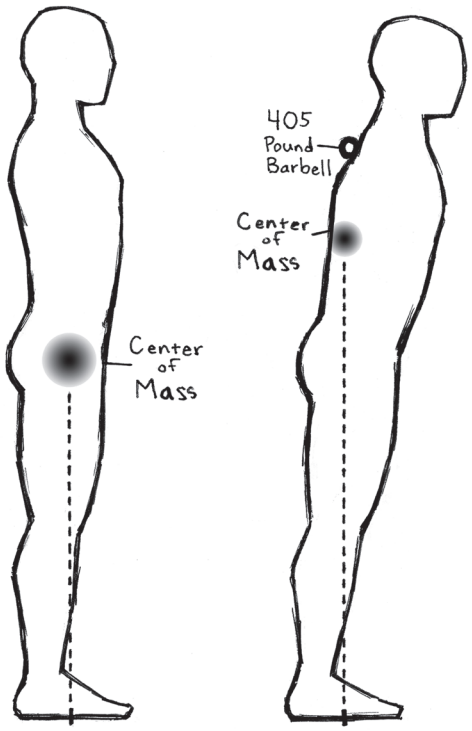
To combat this problem, doctors often order home safety evaluations, refer patients for physical therapy, and prescribe "assistive devices" like rolling walkers and wheelchairs that accommodate and often perpetuate weakness and frailty. Lots of emphasis has been placed on the importance of "balance" and how we can most effectively improve it to decrease fall risk. Numerous "balance-specific" exercise tools and techniques have been invented and popularized for trainees of all ages, including younger athletic populations. In fact, you'll find many of these used in physical therapy clinics or by the kid at your local gym who has "Trainer" written across his back. Just search Google Images for "balance training" to see what I mean.

Unfortunately, most of these techniques fall squarely in the category of "Silly Bullshit", and today I'll tell you why. So let's take a look at balance: what it means, how it works, how we can improve it, and how to recognize silly wastes of time in "balance training".

What is Balance?

Balance can be defined as ***the ability to maintain one's center of mass vertically over the base of support, with minimal postural sway***. Let's break this definition down a bit to make sure everything is crystal clear.

The "**center of mass**" (CoM) is a reference point representing the "averaged" mass of an object or person in space. In other words, if I were to take your body mass distribution in its current position and represent it as a single point, this would be your center of mass. For most humans of average anthropometry standing in anatomical position, this point lies somewhere within the pelvis, typically just in front of the sacrum.



It should be noted that the center of mass is not a static point; it can "move" depending on the shape or position of the body, or by the addition of external load to the system. For example, a pregnant woman's growing belly causes a significant change in her body's mass distribution, moving the center of mass slightly *forward* relative to the non-pregnant state. She therefore must create a slight lordosis by leaning *back* in order to maintain the proper balance relationship and not tip over. This happens "automatically" without conscious thought, due to a few mechanisms I'll discuss shortly. Similarly, during a squat or while sprinting, your center of mass moves forward and "outside" your body as your hips move back and the changing orientation of your limbs and torso reconfigure the position of your averaged mass.

The other defining component of the balance relationship is the ***base of support***. When standing upright, this is located at the **mid-foot**, although it can vary with movement as well. For those of us standing on Earth where gravity always operates vertically downwards, we are by definition "in balance" when the center of mass lies directly vertically over this point. You intuitively know this, and subconsciously default to this position for most of your day-to-day activities because it requires the least amount of effort to maintain with minimal postural sway.

How do humans detect imbalance?

So we've established that balance is maintained when the center of mass lies directly over the base of support (i.e., the mid-foot). Now let's consider how humans *detect* imbalance. Although generally taken for granted, it requires a fascinating integration of three systems:

1. The **Vestibular system** is located in the inner ear and is connected to multiple other areas of the brain and body through the brainstem. It detects **linear acceleration** and **rotation** of the head, and triggers reflexive compensatory movements to help us maintain equilibrium. For example, when focused on an object while rapidly turning your head to the right, you'll notice that your eyes compensate by turning leftward in order to stay "locked" on your target. In addition, we can sense acceleration or tilting and adjust our posture appropriately due to the activity of our vestibular system, even in complete darkness. Impairments in this system typically result in dizziness or vertigo, and can result from various neurological disorders and diseases of the inner ear, trauma, strokes, tumors, medications, and drug/alcohol use (e.g. "the spins").

2. The **Somatosensory system** provides us with "**proprioceptive**" (*position*) and "**kinesthetic**" (*movement*) senses, among several others. The skin and musculoskeletal system detect and relay proprioceptive information along specialized sets of nerves to tell our brain about the position and movement of our bodies and joints. This is how you still know where your hands and feet are without looking at them, and how you can feel where your weight is being distributed across your feet. The sensory information coming from this system helps you maintain desired positions and stay in balance without having to watch your own body while you move. This is important since we can't *see* our lower back during a deadlift, and we don't actively watch our knees while we squat. Impairments in this system typically result from conditions affecting the nervous system (brain, spinal cord, and peripheral nerves) which commonly include diabetes, strokes, medications, and drug/alcohol use among numerous other conditions.
3. The **Visual system**'s role should be intuitively obvious: a major component of sensing our position and movement is simply *seeing* it. Impairments in the visual system result in blindness and can result from things like diabetes, cataracts, macular degeneration, and glaucoma.

Interestingly, as long as at least two of the three systems we've discussed are working normally, people can still compensate enough to maintain their balance. For this reason you might encounter the "Romberg test" in hospitals or at drunk driving checkpoints, where the subject stands with the feet together and eyes closed (effectively "turning off" the visual system), and the examiner watches for significant swaying, unsteadiness, or falls that might indicate a problem with one of the two "remaining" sensory systems, usually proprioception.

How do humans overcome imbalance?

At this point I'd like you to try something: stand up right where you are and slowly lean forward onto your toes. You'll immediately detect imbalance using the systems I just described, then you'll notice feeling slightly uncomfortable as your calves, low back, and other leg muscles start tugging to prevent you from falling on your face. This all relaxes as you come back to the mid-foot balance point. Now, lean backwards onto your heels and you'll feel even more apprehensive as your quadriceps and lower leg muscles start pulling very hard to prevent a fall backwards. You might even reflexively extend your arms out in front of you in an attempt to shift the center of mass forward again. This again resolves as you come back to the mid-foot. **All of this "extra" muscular force is required to overcome the imbalance resulting from the center of mass not being positioned directly over the mid-foot**. Read that again and be sure you understand, because this is fundamental. ***Muscular force is required to overcome imbalance, and therefore to maintain it***.

Let's summarize:

1. Balance is achieved when the center of mass is positioned vertically over the base of support.
2. Humans sense disturbances in this relationship using the Vestibular, Somatosensory, and Visual systems.
3. Based on this sensory information, humans can correct and maintain their balance by exerting sufficient muscular force to restore this relationship.

So when I see someone with "difficulty balancing" in the clinic or in the hospital, I need to determine "where" the problem lies. Is it a *sensory* problem from the vestibular, somatosensory, or visual systems? If so, they'll need individualized treatment for their specific condition. For example, someone with difficulty balancing due to an underlying brain tumor will obviously benefit from removal of the tumor first.

But in the real world, the vast majority of people aren't at risk for falls because of a disease affecting these sensory systems – and even if one *is* affected, they might still be able to compensate fairly well. Instead, most of these people physically can't generate the muscular force necessary to restore and maintain the fundamental relationship between their center of mass and base of support. Consider that a "1-rep max" type muscular effort for these folks is *still* not be enough to correct for minor deviations in their center of mass, resulting in a fall. Simply put, they're just *weak*.

So it seems logical that **for the vast majority of people, the best way to improve balance is to increase their capacity for producing muscular force**. This improves their ability to correct for center of mass deviations and therefore maintain balance. In other words, they should *get stronger*.

Since these people are aging and don't exactly have time to waste, how do we get them strong in the most efficient way possible? It is our general position that the best approach involves applying regular, incremental stress to the body using exercises that (1) engage the greatest amount of muscle mass, (2) over the longest effective range of motion, (3) using the heaviest weights they can handle correctly. This results in (4) the greatest strength adaptation in the shortest amount of time. The exercises we've found that best meet *all* of these criteria include the barbell squat, standing press, deadlift, and bench press, with most other exercises tending to fail one or more criteria. And believe it or not, we've developed ways of coaching just about *everyone* – yes, including your great-grandmother – to perform these movements, or to progress towards performing them, safely and correctly.

In addition, note that the first three exercises I mentioned must be performed *in the standing position*. In this situation, the center of mass now includes a loaded barbell that must be maintained over the base of support under incrementally increasing loads. This requires incrementally increasing force production to correct for any deviations in this relationship, which improves balance *by definition*.

Also remember that the neurologic mechanisms that help us to detect imbalances are all active during these exercises too. Under these increasing loads, progressively smaller deviations become "noticeable" and prompt the necessary adjustments to maintain balance. In other words, whereas it's possible to perform a bodyweight squat and be slightly off balance; as the weight increases from 135 lbs to 405 lbs, the "tolerance" for deviations becomes progressively smaller, which trains your neurological systems to be more sensitive, and therefore more responsive to center of mass imbalances.

In contrast to most seated machine-based exercises, the simple act of squatting, pressing, or deadlifting a barbell *without falling over* simultaneously trains strength while *demanding* balance. Performing these movements is literally training for aging while simultaneously *practicing* the skills it requires!

Unstable surface exercise: a waste of time

Now, some of the best ways to waste valuable training time trying to improve balance involve "unstable surface" exercises. Of course, the *idea* behind these seems plausible to most people: stabilizing yourself in an inherently unstable situation, like standing on a rubber ball or on one foot, should make it "easier" to stabilize yourself on flat ground. But when you analyze the demands of these exercises – and

therefore the adaptations they generate – things don't make as much sense anymore in the context of our definition of balance.

Once again, recall our basic mechanisms of balance: 1) maintain the CoM over the base of support, 2) detect imbalances neurologically, and 3) correct imbalances using muscular force. Of course, by standing on a Bosu ball, a balance board, or a water bed you'll immediately *feel* very unstable, simply due to your neurological system telling you so. You'll feel your weight constantly shifting around, you'll feel the rapid corrections necessary to avoid falling, and you might therefore be convinced you're improving your balance with this truly "functional" exercise. But simply consider: did this exercise require you to *increase force production*, the fundamental mechanism of maintaining balance? It did not. In fact, there is ample data showing that force production actually *decreases* during unstable surface training (and this should make perfect logical sense).

So if you get better at standing on a rubber ball… *what did you actually accomplish?* It probably only made you better at one thing – standing on a rubber ball. Given the fact that we live and walk around on the Earth with a stable surface below our feet, if the stress we apply in the gym is to be useful in this context, it needs to be trained this way. In addition, it ought to be train-*able* – that is, something which can be progressively improved over time. How can we incrementally adjust the stress of standing on a rubber ball in a way that increases your capacity for force production over a long period of time? You simply *can't*.

Now, please don't go trying to walk across the Grand Canyon on a high wire after training with barbells for a few months, because that clearly involves a very specific *skill set* which must be practiced *using methods specific to the task*. Specific skills require repetitive practice that precisely and accurately duplicate the skill required – in this case, walking on a high wire in the wind and not getting killed. So standing on a rubber ball won't prepare you for this either.

I'm simply making the argument that, for the vast majority of people at risk for falls in day-to-day life, the first and most important step involves increasing the capacity for force production, because strength is a very general adaptation that plays a primary role in the mechanism of balance. And the best way gain strength is using the barbell exercises that simultaneously increase force production while requiring the maintenance of balance.

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