

Maintain your Blood Pressure for Better Brain Function

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Most people are well aware that numerous health complications are associated with hypertension (high blood pressure), including both heart disease and stroke. Blood pressure reporting involves two numbers, the peak pressure created in your circulatory system when your heart is contracting – which we call systolic pressure, and, the minimum pressure in your circulatory system when your heart is relaxed – which we call diastolic pressure. The normal values for these two numbers are 120 mmHg for systolic, and 80mmHg for diastolic - unfortunately, we still use the rather confusing terms of millimeters of mercury (mmHg) to report blood pressures, which refers back to a time when we measured pressures using mercury gages. As we enter middle age, our blood pressure tends to rise, and with this rise the risk of heart disease and stroke also increases. What far fewer people realize is that age related increases in blood pressure continues only up to our mid-50s or early 60s.

As we continue to age, our blood pressure, in particular our diastolic pressure, usually starts to decline. This decline can lead to a condition called orthostatic hypotension, that is, when blood pressure is too low to support adequate blood flow to the brain when we are sitting or standing. For individuals over age 65 and still living independently, up to 20% have been shown to have orthostatic hypotension. By age 75, up to one-third of all individuals are affected, and for those in senior living centers, one-half or more have orthostatic hypotension. Just as with high blood pressure, low blood pressure leads to numerous complications, though these complications tend to fall into the category of quality of life issues rather than medical complications. Symptoms of orthostatic hypotension include dizziness, blurry vision, “brain fog”, nausea, and even fainting. However, low blood pressure which leads to dizziness and fainting can also lead to an increased risk of falling and fracturing a hip, and a hip fracture is very much a life threatening condition.

So, why does our blood pressure start dropping after middle age? The most common reason is that our legs muscles weaken as we age. When we are sitting or standing upright, gravity pulls our blood down into the veins of our legs. This is often first noticed as swollen feet and ankles, or the development of varicose veins. However, the heart can only maintain normal blood pressure if it gets sufficient blood pumped back from the lower body. It is the leg muscles which serve this pumping role. Without sufficient leg muscle activity, our blood cannot get back to our hearts when we are upright, and so our circulation decreases, and our blood pressure drops.

Of course, when we are sitting quietly we are not usually using our leg muscles, so how does blood gets pumped out of the legs? The answer is, by a specialized set of involuntary muscles in your lower legs; the soleus muscles. While you are sitting or standing quietly, your soleus muscles slowly fill with blood, and once they are filled, they slowly contract to push this blood back up to the heart. That you don't have to think about contracting these muscles is why they are called ‘involuntary’. In fact, the motion of the soleus muscles is so slow that very few people can even feel these muscles contracting. Nonetheless, these muscles are so important that physiologists often refer to them as the secondary hearts of the body. Unfortunately, if we lead a sedentary lifestyle, that is, if we primarily sit all day long, and the average American sits for over 13 hours a day, then the soleus muscles lose their ability to effectively pump blood back up to the heart.

Importantly, long before someone develops symptoms of orthostatic hypotension chronic low blood pressure can lead to a degradation in brain function. The brain needs adequate oxygen flow to function normally, and oxygen is carried to all the tissues of our body by circulating blood. As the brain is at the top of the body, a normal blood pressure is essential for ensuring adequate blood flow to the brain tissues when we are sitting or standing, and even small decreases in blood pressure can lead to inadequate flow to the brain, even in young adults. Recent research from our lab has demonstrated that below normal blood

pressures can also significantly affect the ability of older individuals to complete common tasks such as reading and handling distractions.¹

In this study, older individuals who had a resting diastolic blood pressure below 70 mmHg (which is typical for more than two-thirds of independently living older adults) required 10% more time to complete a task, for each 1mmHg decrease in blood pressure below 70 mmHg. As a result, individuals with a resting diastolic pressure of 60mmHg required twice as long to complete the task as those with a diastolic blood pressure of 70mmHg. Short term deficits observed in brain function due to insufficient blood flow also include decreased attention span, difficulty remembering, and slow response times.

Perhaps of greater concern, long-term low blood pressure is also associated with an increased risk of developing dementia. In long-term studies where individuals are followed for up to 20 years, sustained low pressure has been shown to be associated with a 5-10 fold increase in the likelihood of developing some form of dementia, and up to a two-fold increased risk of developing Alzheimer's Disease.

Fortunately, like any muscle, the soleus muscles can be trained back up if they become weakened. The soleus muscles are deep postural muscles (like the neck muscles) and so the trick to training them is long duration, low-level, exercise. Standing on your toes for long durations, for example, is a good way to train up the soleus muscles and so exercises such as Tai Chi and Yoga are excellent techniques for training up these muscles. Similarly, heel lifts, undertaken when you are sitting, utilizes the soleus muscles exclusively. On a somewhat more difficult scale, squatting, instead of sitting, is probably the best way to train up the soleus muscles, and the primary way our ancestors were able to maintain soleus muscle function throughout life.

The challenge with such exercise routines is that they have to be performed for at least one hour a day, preferably two to three hours per day, and so these routines do not fit into many peoples' lifestyle. To assist in achieving the long duration activation required to retrain the soleus muscles, a number of devices have recently been introduced to the market. Some require constant ankle motion, while others rely on electrical stimulation using electrodes placed directly on the skin. Alternatively, the HeartPartner passive exercise device from Sonostics relies on a natural reflex response to activate the soleus muscles. You only need to place the front of your feet on the device, and a low level vibration stimulates sensory nerves on the bottom of your feet, leading to soleus muscle contraction. You may wear your socks and shoes when using this device, and as it takes no conscious effort, you can continue to read, work on a computer, talk on the phone, watch television, or perform any other daily sitting activity while exercising your soleus muscles.

The crucial point is that if you know you have chronically low blood pressure (diastolic pressure below 70mmHg) or you have symptoms of fluid pooling into your feet and legs (swollen feet and ankles, night-time leg cramps, varicose veins), then you should focus on getting your soleus muscles trained back up, as eventually the reduced circulation will affect your brain performance, and possibly lead to increased risk of dementia. An ancient saying is "Health begins in your feet" and perhaps nowhere is this more accurate than in maintaining heart and brain health in older individuals.

1. McLeod KJ and Jain T (2017) Postural hypotension and cognitive function in older adults, *Gerontology & Geriatric Medicine*3:1-8.