

THE JOHN B. PIERCE LABORATORY

RESEARCH IN HEALTH, PHYSIOLOGY, AND ENVIRONMENT

AFFILIATED WITH YALE UNIVERSITY



The John B Pierce Laboratory at the Yale School of Medicine has a long and distinguished history as a leader in testing physiological effects of environmental stressors on the human body. It has also tested equipment and clothing to determine how modifications to said clothing, as well as the environment, impacts metabolic and thermoregulatory responses during physical activity. A primary goal of the Pierce Laboratory is to improve human health and comfort within our present day environment. McCullough approached me in March 2015, with the idea to test how incorporating resistance bands into leggings might impact energy expenditure.

The general idea of adding resistance to the large muscles during daily movement results in a constant, mild, but important increase in metabolic rate, and improved muscle function. These increases may lead to long-term weight loss. *We hypothesized* that even if weight loss was mild, we would see increased muscle tone, and most importantly, see improvement in some of the co-morbidities associated with overweight and/or obesity, such as insulin resistance, and cardiovascular disease.

The laboratory independently tested the metabolic responses to wearing the leggings as a third party. I did not participate in any of the testing, and analyzed the data in a blinded fashion. This meant that when I compared the metabolic data, *I did not know which leggings the participants were wearing*. All subjects voluntarily provided written informed consent to participate in the study, which conformed to guidelines contained in the Declaration of Helsinki, and was approved by the Human Investigation Committee of Yale School of Medicine.

My assistants, Cheryl and Josh, conducted testing. Ms. Leone prepared the data for analysis, but did not participate in the analysis. The protocol consisted of walking on a treadmill for 30 minutes while wearing leggings with and without the resistance bands. Tests on all except three subjects were conducted on separate days. We used a metabolic cart (Parvo Medics), where we observed and measured factors including caloric expenditure, and oxygen consumption. Participants included men and women with varying body types, ranging in age from 18-35.

The amount of tension applied from the resistance bands is roughly four pounds per leg. This level of resistance was chosen, as it was still comfortable to be worn all day. Yet, we expected that this resistance would reap the benefits that we have observed and measured.

Results

Our primary measurements are direct measures of oxygen consumption, or fuel used during walking. While the output per minute was similar, it was clear that the leggings with the bands showed consistently higher values. We also calculated variables based on oxygen consumption, which reflected kcals consumed, as well as work output. This data shows greater energy output when people wear leggings with the bands.

Discussion and Conclusions

It was determined that these leggings can improve health in a number of ways:

First, we have tested the leggings in a sports laboratory, and demonstrated that when worn, participants increase caloric expenditure during steady state walking. These increases were small, but the leggings are designed to be comfortable, and used over long periods of time. Thus, long-term energy expenditure will increase exponentially.

We found slight but consistent increases in energy expenditure from the leggings with the bands during 30 minutes of mild walking exercise. Thus, over the course of daily activities, we would expect to see significant overall increases in energy expenditure. For example, at the end of the 30 min exercise period, the difference in energy expenditure is 1.39 ml/kg/min in oxygen consumption. Assuming 8 hours of movement per day, that is ~

480 minutes, or 667 *more* ml/kg/min oxygen consumption per day compared to leggings without the bands. Viewed another way, for a 55 kg (121 lb.) woman, this adds ~ 255 kcals/day just by wearing these leggings.

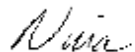
Thus, while minute-by-minute energy expenditure increases are small, these leggings are worn for hours at a time so cumulative energy expenditure through the course of the day has the effect of meaningful calories burned. If an individual wears these leggings over a period of several days, and does not change exercise or diet habits, he or she will be in negative energy balance, and is likely to lose weight. We would expect the weight loss rate to be slow and steady, consistent with the most successful long-term weight loss methods.

Second, the constant resistance may increase muscle mass and improve body composition. The experience is similar to using resistance bands at a gym all day. Using these bands is a constant resistance for the leg muscles, which should increase muscle mass and improve mitochondrial function. The latter is extremely important for glucose (sugar) uptake by the muscle, as well as glucose regulation. Thus, by using a method such as constant resistance throughout the day, insulin sensitivity and glucose uptake by the muscle may improve in insulin resistant individuals.

Research has shown that body composition is directly related to health. If one improves their body composition, they also lower the risk to diseases such as insulin resistance, cardiovascular disease, and diabetes. Better body composition also improves the overall quality of life through ways such as better sleep and higher energy levels. An advantage to achieving a healthier body composition is that muscles will become more toned and defined. By increasing muscle mass, the body replaces fat tissue and is more likely to have a slim physique.

According to the National Institute of Health the following are considered to be benefits of a healthy body composition:

- Healthy blood pressure.
- Increased energy and endurance.
- Improved mood and self-confidence.
- Improved quality of sleep.
- Improved blood circulation in all parts of the body, thereby reducing the risk of heart disease and stroke.
- Reduced respiratory infections and breathlessness, and improved lung function.
- Improved insulin sensitivity and glucose tolerance.



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