VIBRATION TRAINING: A Unique Training Tool For Anti-Aging

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Physical activity is one of the most cost-effective and innocuous tools for maintaining independence, preventing falls and maintaining wellness in older persons. However, the *Health, United States, 2006 Report* from the Centers for Disease Control and Prevention reported that less than 30 percent of the adult population in this country regularly engages in leisure-time physical activity and 39 percent participates in no leisure time physical activity at all.[1] The picture only gets worse as we age. Arthritis, sarcopenia (age-related muscle loss), declining metabolism, reduced mobility and a host of other age-related disabilities begin to limit our activity levels. Additionally, lack of transportation, disapproval by family members, fear of looking foolish and lack of program availability also are factors.[2] But what are the top reasons people give for not exercising? "I don't have time," followed by "I don't have the energy," "It's painful, boring and inconvenient" and "I just can't make the commitment."[3;4]

It would be wonderful if there were an exercise modality that required limited time commitment, low exertion levels, and was unique, fun and accessible, even to older persons with disabilities. Enter whole-body vibration (WBV). Although this training modality may be new to us, it has a history dating back to the mid-1960s when it was used by Russian cosmonauts to reduce the impact of microgravity on their muscles and connective tissue. Since then, both the technology

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and the research have been growing in leaps and bounds. Today, we have a plethora of information from controlled scientific studies examining its effectiveness in addressing everything from functional performance to specific disease states. There are a number of different types of plates (vertical displacement, tri-directional displacement and central pivoting). Since results may vary by plate, this article will review only the literature on the impact of tri-dimensional/multi-planar plates (**see Figure 1**) on health and independence in older people.

EXISTING STUDIES WITH OLDER PEOPLE

Strength and power: The literature tells us that muscle size and strength decline exponentially after the age of 55 (**see Figure 2**).[21] Additionally, faster contracting muscles "die off," decreasing our movement, speed and power (the product of force production and movement velocity) (**see Figure 3**). Given the fact that the WBV plate moves at very high speeds (25 to 50 Hz), the overload to the muscles incorporates both force and velocity. In fact, WBV training is now commonly referred to as acceleration training in the literature. The nature of this stimulus is reflected in the neuromuscular responses it produces. For example, Bogaerts, et al., compared improvements in muscle mass, isometric strength and explosive strength (power) due to WBV versus standard fitness training in community-dwelling men over 60 years of age.[5] They found that WBV training was as effective as fitness training for increasing muscle mass, isometric strength and power of the knee extensors (**see Figure 4**). However the WBV sessions required less than half the time (40 min. versus 90 min.) and minimal exertion compared to the fitness-training sessions.

Figure 1. Tri-planar whole body vibration platform.

In a similar study, Roelants, et al., compared the effect of WBV to progressive resistance training in a group of 89 postmenopausal women.[6] They reported similar gains in isometric and dynamic strength in both groups. However, only the WBV group improved in movement speed – a critical factor for independence and fall prevention.[7] Once again, the time required for WBV was less than half that required for resistance training

Mobility and dynamic balance: The positive impact of WBV on mobility in older individuals has been demonstrated in a number of studies. Bautmans, et al., examined the impact of

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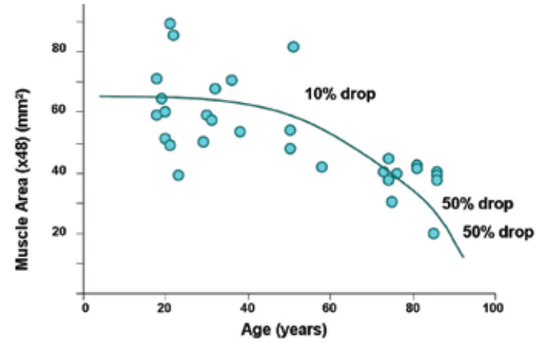

Figure 2. Exponential decline in muscle cross-sectional area with age. After Lexell et al.[21].

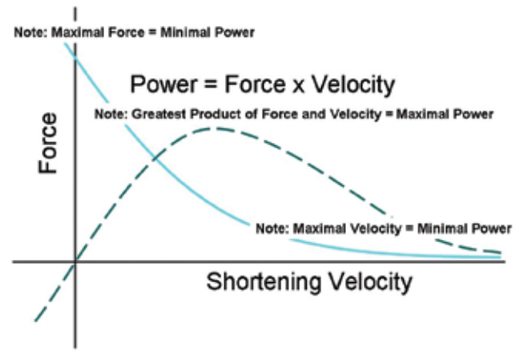

Figure 3. The Force-Velocity and Power curves showing the relationships between force, velocity and power.

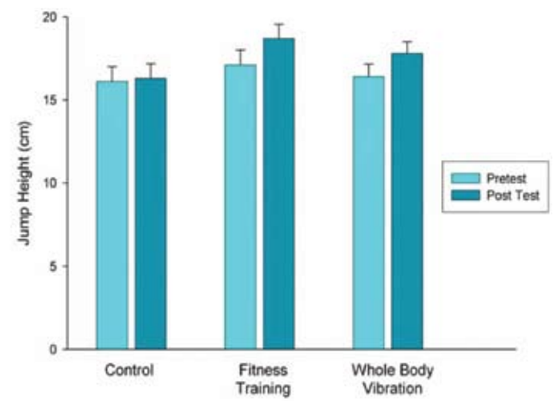

Figure 4. Graph demonstrating similar significant increases in countermovement jump height for both fitness and WBV training. After Bogaerts et al.[5]

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six weeks static WBV exercise on a Power Plate platform in 24 nursing home residents (15 female, nine male; mean age 77.5 ± 11.0 years).[8] They reported significant increases in a timed up-and-go test, and in the balance score of the Tinetti gait test (**see Figure 5**).

More recently, Bogaerts, et al., examined the impact of 12 months of Power Plate® training on balance in 220 older individuals 60 to 80 years of age.[9] The Power Plate training group (n=94) showed a reduced frequency of falling on a moving platform when vision was partially impaired, and improvements in the response to toes-down rotations at the ankle induced by the moving platform. The fitness group (n=60) also showed reduced fall frequency on the moving surface when vision was disturbed. Thus, whole-body vibration training may improve some aspects of postural control in community-dwelling older individuals.

These studies demonstrate that WBV can positively affect mobility, balance and proprioception, thereby improving quality of life and reducing the risk of injury in older persons.

Bone mineral density: Reductions in bone mineral density (BMD) in postmenopausal women and very old men increase the likelihood of serious injury and death following a fall. Vibration training provides a unique stimulus for increasing BMD. Both animal and human studies have shown this.[10-13] For example, a study by Verschueren, et al., compared the impact of 24 weeks of resistance training or WBV on bone density in 70 women, ages 58-74.[11] DXA scans revealed a significant increase in total hip BMD, but not in total body BMD (**see Figure 6**). Additionally, there were no changes in serum markers of bone turnover for any group. Finally, a preliminary study by Corrie, et al., demonstrated that WBV can increase bone formation in 33 older patients.[14] The results of these studies, though limited, are indicative of the potential for WBV to counteract bone loss due to menopause of the aging process.

Sarcopenic obesity: The combined loss of muscle tissue and increase in body fat with aging is termed *sarcopenic obesity*. As Roubenoff stated in his commentary on sarcopenic obesity, "The 'fat frail' have the worst of both worlds as they age – increased weakness due to sarcopenia and a need to carry greater weight due to obesity"[15] (**see Figure 7**). We have already seen that WBV can positively affect lean body tissue, including muscle mass. But what about reductions in body fat? The answer to this question is addressed by Verschueren, et al., comparing WBV to resistance training.[11] They reported no significant changes in lean body mass due to either intervention, but a significant decrease in fat mass as a result of each (**see Figure 8**).

HARBINGERS OF FUTURE SUCCESS

Flexibility: A number of studies have demonstrated the positive impact of WBV on flexibility in younger individuals (**see Figure 9**).[16-19] To date, no study has applied a flexibility specific flexibility program to an older population. However, Bautmans,

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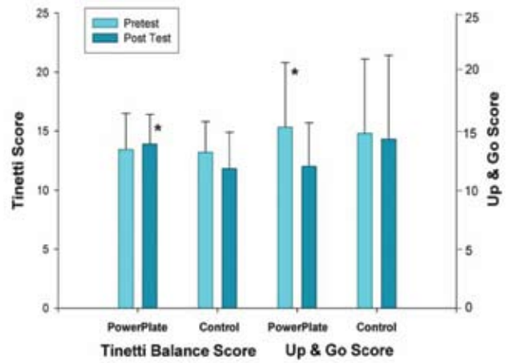

Figure 5. Illustration of significant improvements (*) in both the Tinetti Balance and Up and Go scores due to WBV training. After Bautmans et al., [8]

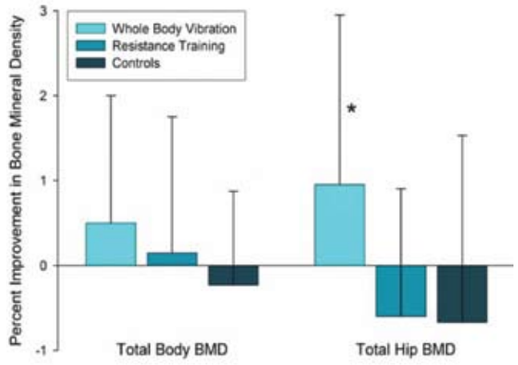

Figure 6. Increases in bone mineral density (BMD) with WBV training. *statistically significant increase. After Verschueren et al. [11]

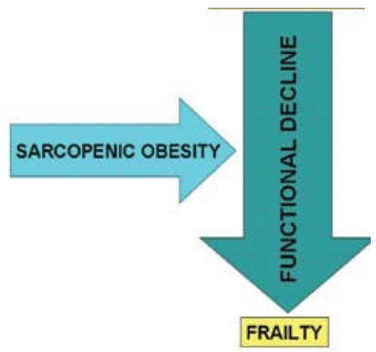

Figure 7. Diagram illustrating the negative impact of sarcopenic obesity on functional performance in older persons.

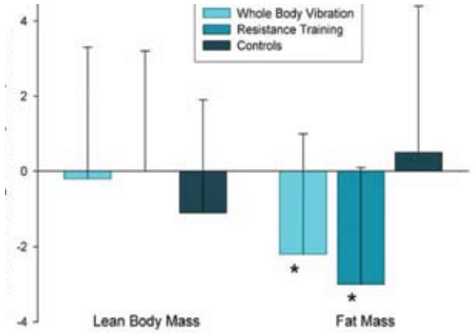

Figure 8. Graph illustrating similar significant decreases in body fat (*) due to resistance and WBV training. After Verschueren et al. [11]

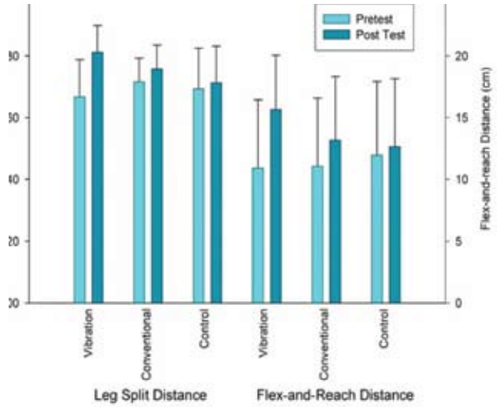

Figure 9. Increases in heel-to-heel split and sit-and-reach distances due to vibration training. After Issurin et al., [16]

et al., reported no change in the sit-and-reach or back-scratch tests following a strength-training WBV protocol.[8] In our laboratory, we have demonstrated that a flexibility training program can improve multiple measures associated with functionality in older persons. Given the results with younger participants when protocols designed to increase flexibility were used (**see Figure 10**), it appears that WBV should be further examined as an important training modality for addressing the dramatic losses in joint range of motion associated with the aging process.

Cardiovascular health and metabolic syndrome: Another area which has received only limited attention in the scientific literature is the impact of WBV on cardiovascular health and metabolism. We have examined sarcopenic obesity as it relates to functional performance, but there is a more insidious concern related to the current obesity epidemic: metabolic syndrome or syndrome X (**see Figure 11**) and associated health problems (**see Figure 12**). WBV provides an attractive tool to address this problem, since it offers a low-exertion, individualized program without the inherent negative perceptions often associated with formalized exercise. This is especially important for older obese individuals who may not have the capacity to engage in more rigorous activities, yet still wish to improve their cardiovascular and metabolic health.

To our knowledge, only one study has examined oxygen consumption and caloric output in older persons as a result of WBV. Boegerts, et al., examined the impacts of WBV and mixed fitness exercise on oxygen consumption in 220 older adults (WBV group, n=94; fitness group, n=60; control group, n=66).[20] The WBV and FIT groups exercised three times weekly for one year. The WBV

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Figure 10. Illustration of hip flexor stretch on WBV.

METABOLIC SYNDROME (SYNDROME X)

CENTRAL OBESITY (APPLE SHAPE): A waistline of 40 inches or more for men and 35 inches or more for women

HYPERTENSION (HIGH BLOOD PRESSURE): 130/85 mm Hg or higher or on blood pressure medications

HIGH TRIGLYCERIDES: Level above 150 mg/dl

LOW HDL CHOLESTEROL: Below 40 mg/dl (men) or under 50 mg/dl (women)

INSULIN SENSITIVITY: A fasting blood glucose (sugar) level greater than 100 mg/dl or are on glucose lowering medications.

Figure 11. Factors associated with metabolic syndrome.

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group performed squats, deep squats and lunges. Using a progressive cycle ergometer protocol, they showed that VO_{2max} and time to exhaustion during the test increased significantly for both the WBV and fitness groups; however, the fitness group had significantly greater improvements in time to exhaustion (**see Figure 13**). These researchers concluded that WBV

OTHER HEALTH PROBLEMS ASSOCIATED WITH OBESITY

- DIABETES
- RENAL FAILURE
- ATHEROSCLEROSIS
- GALLBLADDER DISEASE
- HIGH TRIGLYCERIDES
- HEART ATTACK OR STROKE
- CANCER

Figure 12. Additional problems associated with obesity.

may provide an exercise alternative that can provide similar improvements in both cardio-respiratory and neuromuscular fitness with a much lower potential for injury.

To examine optimal protocols for increasing oxygen consumption during WBV, our laboratory recently examined the impact of load (no load, 20 percent and 40 percent of body weight) and vibration (0Hz, 0mm; 35Hz, 2-3mm; 50Hz, 5-6mm) on VO_2 during active squatting in 10 physically active males, 27.22 ± 4.79 yrs; 81.41 ± 10.03 kg, not currently training. Our data revealed that for WBV to effectively increase oxygen consumption, an external load was required. If lower loading conditions, such as 20 percent, were used, low frequencies and displacements were most effective. However, when higher loads were used, higher frequencies and displacements were superior (**see Figure 14**). We are currently recruiting participants for a training study comparing changes in body composition, lipoproteins and inflammatory markers in postmenopausal obese and overweight women.

CONCLUSION

The above controlled studies indicate that WBV is an effective training tool to increase strength, power, mobility, balance, bone density and sarcopenic obesity. Additionally, there are strong finding in younger individuals indicating that flexibility, cardiovascular health and metabolic syndrome may also be improved. Given the greatly reduced time commitment, lower

perceived exertion levels and rapid improvements associated with WBV, this exercise intervention constitutes a significant addition to the tools we have in our anti-aging campaign. u

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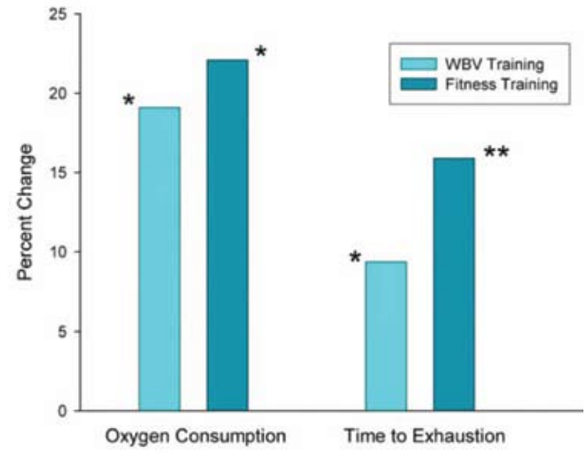

Figure 13. Improvements in oxygen consumption and time to exhaustion following one year of training. *significantly improvement above controls. **significantly better than controls and WBV. After data by Boegerts et al.[20]

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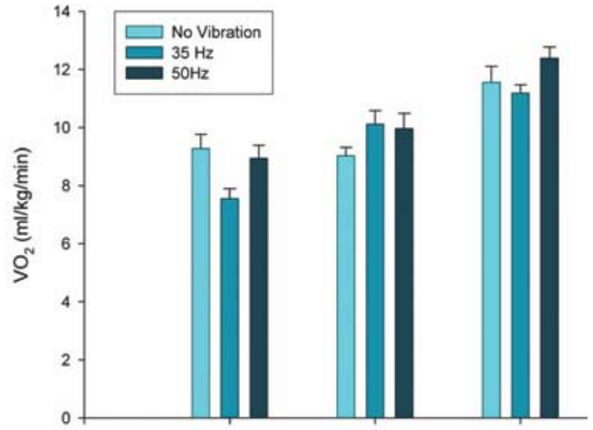

Figure 14. Preliminary data showing the combined impact of external loading and WBV on oxygen consumption. *significantly higher than 35Hz. **significantly higher than no vibration. †significantly higher than 35Hz. (Signorile et al; personal communication).

DR. SIGNORILE has been involved in research using exercise to address independence and fall prevention for over 15 years, has over 50 refereed manuscripts and 175 national and international scientific and 200 industry presentations. He is currently a Professor of Exercise Physiology at the University of Miami and a Research Specialist at the Miami VA Medical Center Geriatrics Research Center.