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Study Shows Vibrating Insoles Could Reduce Falls Among Seniors

Boston researchers find vibratory stimulation applied to the sole of the foot using novel piezoelectric technology shows promise for fall prevention.

BOSTON — Findings published in the *Archives of Physical Medicine and Rehabilitation* show that imperceptible vibratory stimulation applied to the soles of the feet improved balance by reducing postural sway and gait variability in elderly study participants. The vibratory stimulation is delivered by a urethane foam insole with embedded piezoelectric actuators, which generates the mechanical stimulation. The study was conducted by researchers from the Institute for Aging Research (IFAR) at Hebrew SeniorLife, Beth Israel Deaconess Medical Center, the Wyss Institute for Biologically Inspired Engineering at Harvard University, and Harvard Medical School, all of Boston, Massachusetts; and Merck Sharpe and Dohme (MSD) Consumer Care, Inc., of Memphis, Tennessee.

These findings are significant because poor balance and an irregular gait are directly related to fall risk. Falls are the leading cause of death from injury among seniors. Risk increases with age and even the fear of falling can reduce quality of life.

- 1 in 3 seniors falls each year, and 25% of those who fall suffer moderate to severe injuries, such as hip fractures.
- Only 25% of hip fracture patients make a full recovery; 40% require nursing home care; and nearly 25% die within 12 months.
- By 2020, the annual direct and indirect cost of fall injuries is expected to reach nearly $55 billion.

“Although loss of sensation in the feet is a common problem among elderly people that can impair balance and gait and result in falls, there are currently no interventions available that can reverse sensory impairments and prevent these dangerous consequences,” said study lead author Lewis Lipsitz, M.D., Director of the Institute for Aging Research. “We were very excited to discover that small amounts of vibratory noise applied to the soles of the feet may be able to do just that.”

This study follows earlier research that looked at how the physical principle of stochastic resonance could be applied to mitigate deficits in the human somatosensory systems that develop due to disease, injury, or age. The *somatosensory* system informs us about objects in our external environment through touch. Receptors are distributed all over the body and different types of receptors respond to many different kinds of stimuli. Stochastic resonance (SR) is a phenomenon whereby the detectability of weak signals in certain types of systems can be improved through the careful addition of low-amplitude white noise. This may seem paradoxical because noise is usually thought to reduce our ability to detect a signal, for example, we may have difficulty hearing someone talking to us at a noisy party, but the principle of SR states in fact that a certain low level of white noise can actually enhance signal detection.

Earlier studies, by Wyss Institute Core Faculty member James Collins, Ph.D., a Professor of Medicine and Biomedical Engineering at Boston University, have shown that imperceptible vibratory noise applied to the feet can improve balance in healthy young and elderly subjects and patients with diabetic neuropathy and stroke. IFAR researchers showed that this approach could significantly reduce the stride-, stance- and swing-time variability exhibited in walking by elderly people with a history of falling down. However, the devices that delivered the stimulation in the earlier IFAR studies required large energy sources, limiting their practical and portable application.

Following the experiments with these limiting early devices, the device was completely redesigned by Wyss Institute researchers to use piezoelectric actuators to improve portability and energy efficiency. Piezoelectric actuators convert electrical energy into mechanical signals, such as pressure or movement of some kind. These actuators, inserted into a typical insole using a standard manufacturing process, are driven by a small encasement on the tongue of the shoe that contains a tiny circuit and rechargeable battery.

The vibrating insole study enrolled 12 elderly volunteers in good health, between the ages of 65 and 90 years old. Two piezoelectric actuators to deliver the vibratory stimulation were placed in the medial arch region of commonly-available insoles. Then, participants underwent a battery of tests that measured their balance and assessed their gait. They were also given a timed “Get Up and Go” test, which measured how long it took participants to stand up from sitting, walk three meters, turn around, walk back, and sit down again.

Results of this study demonstrated that the vibratory insoles significantly improved performance on the timed “Get Up and Go” test, reduced the range of postural sway, and reduced the variability of walking. Also, the effect of the insoles persisted throughout the course of a day.

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About the Institute for Aging Research

Scientists at the Institute for Aging Research seek to transform the human experience of aging by conducting research that will ensure a life of health, dignity and productivity into advanced age. The Institute carries out rigorous studies that discover the mechanisms of age-related disease and disability; lead to the prevention, treatment and cure of disease; advance the standard of care for older people; and inform public decision-making.

About Hebrew SeniorLife

Hebrew SeniorLife, an affiliate of Harvard Medical School, is a national senior services leader uniquely dedicated to rethinking, researching and redefining the possibilities of aging. Based in Boston, the non-profit, non-sectarian organization has provided communities and health care for seniors, research into aging, and education for geriatric care providers since 1903. For more information about Hebrew SeniorLife, visit http://www.hebrewseniorlife.org, follow us on Twitter @H_SeniorLife, like us on Facebook or read our blog.

The Wyss Institute for Biologically Inspired Engineering at Harvard University (http://wyss.harvard.edu) uses Nature's design principles to develop bioinspired materials and devices that will transform medicine and create a more sustainable world. Working as an alliance among all of Harvard's Schools, and in partnership with Beth Israel Deaconess Medical Center, Brigham and Women's Hospital, Boston Children's Hospital, Dana Farber Cancer Institute, Massachusetts General Hospital, the University of Massachusetts Medical School, Spaulding Rehabilitation Hospital, Boston University, Tufts University, and Charité - Universitätsmedizin Berlin, and the University of Zurich, the Institute crosses disciplinary and institutional barriers to engage in high-risk research that leads to transformative technological breakthroughs. By emulating Nature's principles for self-organizing and self-regulating, Wyss researchers are developing innovative new engineering solutions for healthcare, energy, architecture, robotics, and manufacturing. These technologies are translated into commercial products and therapies through collaborations with clinical investigators, corporate alliances, and new start-ups.