Low-gravity training machine reduces joint, muscle impacts

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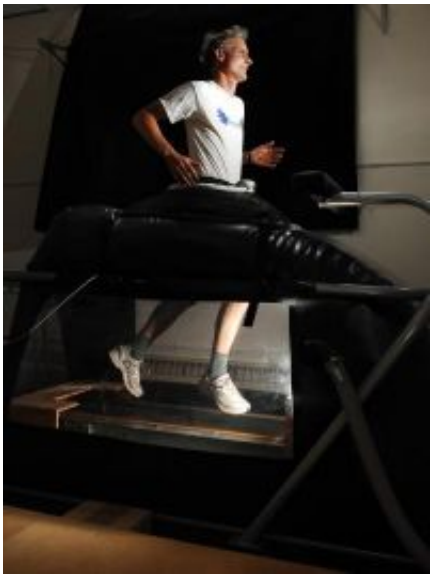

A new CU-Boulder study led by Associate Professor Rodger Kram, pictured here, shows that a space-age, low-gravity training device can vastly reduce the impacts of running on the joints of study subjects. Credit: Casey A. Cass, University of Colorado

A University of Colorado at Boulder study of a space-age, low-gravity training machine used by several 2008 Olympic runners showed it reduced impacts on muscles and joints by nearly half when subjects ran at the equivalent of 50 percent of their body weight.

The new study has implications for both competitive runners

rehabilitating from injuries and for ordinary people returning from knee and hip surgeries, according to Associate Professor Rodger Kram of CU-Boulder's integrative physiology department.

Known as the "G-Trainer," the machine consists of a treadmill surrounded by an inflatable plastic chamber that encases the lower body of the runner, said Kram. Air pumped into the chamber increases the pressure and effectively reduces the weight of runners, who are sealed in the machine at the waist in a donut-shaped device with a special zipper and "literally lifted up by their padded neoprene shorts," he said.

Published in the August issue of the *Journal of Applied Biomechanics,* the study is the first to quantify the effects of running in the G-Trainer, built by Alter-G Inc. of Menlo Park, Calif., using technology developed at NASA's Ames Research Center in California. The paper was authored by Kram and former CU-Boulder doctoral student Alena Grabowski, now a postdoctoral researcher at the Massachusetts Institute of Technology.

Although G-Trainers have been used in some sports clinics and college and professional sports training rooms since 2006, the new study is the first scientific analysis of the device as a training tool for running, said Grabowski.

"The idea was to measure which levels of weight support and speeds give us the best combination of aerobic workout while reducing the impact on joints," said Kram. "We showed that a person can run faster in the G-Trainer at a lower weight and still get substantial aerobic benefits while maintaining good neuromuscular coordination."

The results indicated a subject running at the equivalent of half their weight in the G-Trainer at about 10 feet per second, for example -- the equivalent of a seven-minute mile -- decreased the "peak" force resulting

from heel impact by 44 percent, said Grabowski. That is important, she said, because each foot impact at high speed can jar the body with a force equal to twice a runner's weight.

Several former CU track athletes participating in the 2008 Olympics in Beijing have used the machine, said Kram. Alumna Kara Goucher, who will be running the 5,000- and 10,000-meter races in Beijing, has used the one in Kram's CU-Boulder lab and one in Eugene, Ore., for rehabilitation, and former CU All-American and Olympic marathoner Dathan Ritzenhein also uses a G-Trainer in his home in Oregon. Other current CU track athletes who have been injured have tried the machine in Kram's lab and found it helpful to maintain their fitness as they recovered, Kram said.

For the study, the researchers retrofitted the G-Trainer with a force-measuring treadmill invented by Kram's team that charts vertical and horizontal stress load on each foot during locomotion, measuring the variation of biomechanical forces on the legs during running. Ten subjects each ran at three different speeds at various reduced weights, with each run lasting seven minutes. The researchers also measured oxygen consumption during each test, Kram said.

Grabowski likened the effect of the G-Trainer on a runner to pressurized air pushing on the cork of a bottle. "If you can decrease the intensity of these peak forces during running, then you probably will decrease the risk of injury to the runner."

The G-Trainer is a spinoff of technology originally developed by Rob Whalen, who conceived the idea while working at NASA Ames as a National Research Council fellow to help astronauts maintain fitness during prolonged space flight. While the NASA technology was designed to effectively increase the weight of the astronauts to stem muscle atrophy and bone loss in low-gravity conditions, the G-Trainer

reverses the process, said Grabowski.

In the past, sports trainers and researchers have used climbing harnesses over treadmills or flotation devices in deep-water swimming pools to help support the weight of subjects, said Kram. Harnesses are cumbersome, while pool exercises don't provide sufficient aerobic stimulation and biomechanical loading on the legs, he said.

Marathon world-record holder Paula Radcliffe of Great Britain is currently using a G-Trainer in her high-altitude training base in Font-Remeu, France. Radcliffe is trying to stay in top running shape while recovering from a stress fracture in her femur in time for the 2008 Olympic women's marathon on Aug. 17, according to the London Telegraph.

Kram and Grabowski have begun a follow-up study of walking using the G-Trainer. By studying subjects walking at various weights and speeds in the machine, the researchers should be able to quantify its effectiveness as a rehabilitation device for people recovering from surgeries, stress fractures and other lower body injuries, Kram said.

Source: University of Colorado at Boulder