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Study Examines Associations Between Bone Health and Skeletal Muscle Mass in Adult Women and Men

Although prior research has established that skeletal muscle and bone form highly integrated systems that undergo significant age-related changes, the relationships between muscle mass and trabecular versus cortical bone or trabecular microarchitecture have not been systematically investigated.

A recent study at Mayo Clinic, published in the *Journal of Bone and Mineral Research*, examined skeletal muscle mass and bone health across the life span and determined distinct differences in how muscle affects the two layers of bone in both men and women.

“Our study adds to the growing body of evidence supporting the highly integrated nature of skeletal muscle and bone,” says lead author Nathan K. LeBrasseur, Ph.D., of the Department of Physical Medicine and Rehabilitation at Mayo Clinic in Rochester, Minn., “and it provides new insights into potential biomarkers that reflect the health of the musculoskeletal system.”

Study background and findings

Mayo researchers used data from a long-standing Mayo Clinic study of bone health involving 272 women and 317 men ages 20 to 97. They examined the association between appendicular skeletal muscle mass (ASM) relative to height squared

Points to Remember

- A Mayo Clinic study examined skeletal muscle mass and bone health across the life span and determined distinct differences in how muscle affects the two layers of bone in both men and women.
- Study findings show correlations between muscle mass and different types of bone health and strength, at nonload-bearing as well as load-bearing sites, and how these associations differ in men and women.
- Serum insulin-like growth factor (IGF) binding protein-2 (IGFBP-2) levels were the most robust negative predictors of muscle mass in both sexes.

(relative ASM) and a number of measures of bone health by conventional as well as high-resolution peripheral QCT at several sites. Looking beyond just bone marrow density, Dr. LeBrasseur’s team measured the density and strength of cortical bone and trabecular bone (Figure).

“We saw that there were really nice correlations between muscle mass and different types of bone health and strength,” says Dr. LeBrasseur. “Even if we adjust for age and physical activity levels, the fact that those relationships still persist at nonload-bearing as well as load-bearing sites shows that there’s some clear relationship between how muscle and bone health are regulated



Figure. High-resolution peripheral quantitative tomography (HRpQCT) scan of the distal radius, now often referred to as a noninvasive bone biopsy because of the incredible resolution. This image shows the outer ring of cortical bone and the inner trabecular microarchitecture from which trabecular number, trabecular thickness and trabecular spacing are measured.



Nathan K. LeBrasseur, Ph.D.

throughout the life span,” says Dr. LeBrasseur.

The study found that muscle mass is associated with bone strength at particular places in the body. In women, relative ASM was associated with cortical thickness (CtTh) at load-bearing locations such as the femoral neck, lumbar spine and tibia (age- and physical activity-adjusted $r = 0.19-0.32$; all $p < 0.01$). Relative ASM was also associated with trabecular volumetric bone mineral density (vBMD) at the femoral neck and spine (all $p < 0.05$), and trabecular bone volume to tissue volume (BV/TV), number (TbN), thickness (TbTh), and separation (TbSp) at the radius (all $p \leq 0.05$), a nonload-bearing site.

In all men, relative ASM was associated with CtTh at all sites (age- and physical activity-adjusted $r = 0.17-0.28$; all $p < 0.01$). Associations between relative ASM and trabecular vBMD at the spine in men were lost after adjusting for age; however, relative ASM was associated with trabecular vBMD at the femoral neck and TbN and TbSp at the radius (all $p < 0.01$).

It’s well established that men tend to have higher muscle mass through life span, achieve higher muscle mass relative to their height earlier in life and maintain this relatively higher skeletal muscle mass as they age. According to Dr.

LeBrasseur, the Mayo team’s research findings might indicate that as they age, women dip below a critical threshold of muscle mass that may then predispose them for poor bone health and increase their risk of fall-related fractures in their hips and wrists.

“The question that then needs to be asked is this: If you had an intervention that increased muscle mass in women to a point above this theoretical threshold, would they then be protected from age-related bone changes like osteoporosis and fall-related fractures?” says Dr. LeBrasseur.

The Mayo team also investigated a panel of established and novel circulating factors associated with bone health that may be indicative of relative ASM and found that serum insulin-like growth factor (IGF) binding protein-2 (IGFBP-2) levels were the most robust negative predictors of relative ASM in both sexes.

“We found IGFBP-2, which has already been linked to osteoporotic fractures in men, is negatively associated with muscle mass in both sexes,” Dr. LeBrasseur says. “This finding could potentially be used to identify people who have low muscle mass and are at a particular risk of falls and associated fractures.”

International Studies Analyze Whether Feedback About Mobility and Exercise Improves Walking Outcomes Among Stroke Patients



Allen W. Brown, M.D.

Stroke is the most common diagnosis for which individuals are admitted to hospital-based rehabilitation programs. Two recent multicenter international trials in which Mayo Clinic participated have examined the impact of providing feedback about walking performance to stroke patients admitted to inpatient rehabilitation units.

The Stroke Inpatient Rehabilitation With Reinforcement of Walking Speed (SIRROWS) trial found that patients who received immediate verbal feedback about walking speed during inpatient rehabilitation showed clinically significant gains in walking speed. This single-blind, multicenter trial found that providing immediate feedback about walking speed during routine physical therapy helped patients increase walking speed by enough to permit unlimited, slow community ambulation at discharge from inpatient rehabilitation.

When the SIRROWS results were published, the authors suggested that the next phase of

research should examine the impact of providing even more feedback to patients during inpatient care and increasing the feedback provided during the first three to six months of outpatient rehabilitation. That recommendation became the basis of the Stroke Inpatient Rehabilitation Reinforcement of ACTivity trial (SIRRACT).

SIRRACT participants were recruited from 12 international and four American rehabilitation centers, including Mayo Clinic. Inclusion criteria included stroke within the past month requiring inpatient rehabilitation, residual hemiparesis, and the ability to walk at least five steps upon entering the study. Daily walking and other exercise were monitored by bilateral triaxial accelerometers on the ankles. Patient activity data were collected using a personal activity monitor (PAM). About the size of an average USB flash drive, the PAM contains a triaxial accelerometer that records data related to skills practice and provides outcome mea-

asures of daily activities and participation for analysis. This data also provides performance-related feedback to patients, which can boost their motivation to engage in activity. After inpatient sensor data were uploaded nightly to a central server, activity-recognition algorithms analyzed the data and returned a summary to the participants at each research site.

SIRRACT compares the effects of two different levels of feedback about physical activity and walking performance provided during inpatient rehabilitation for stroke in 150 subjects. Participants were randomized to receive one of two levels of activity feedback. Primary outcome measures were the daily duration of walking practice, derived from the sensors, and a timed 15-meter walk at discharge by a blinded observer. The control group was told only how fast they walked in timed 10-meter walks on Monday, Wednesday and Friday. The experimental group received the same feedback as the control group, as well as information about distances walked, daily number of steps, time spent exercising and number of repetitions of leg movements.

According to Allen W. Brown, M.D., a physiatrist and director of brain rehabilitation research at Mayo Clinic, participating in international studies like SIRROWS and SIRRACT meshes well with Mayo Clinic's established clinical practice and research experience. Mayo's CARF-accredited inpatient rehabilitation program admits about 200 patients affected by stroke each year.

As researchers and clinicians await publication of the SIRRACT results, Dr. Brown observes that if a higher level of frequent, detailed feedback is shown to improve outcomes among stroke patients with disabilities, it might well change the way in which inpatient

Points to Remember

- Two recent international multicenter trials in which Mayo Clinic participated have examined the impact of providing feedback about walking performance to stroke patients admitted to inpatient rehabilitation units.
- The Stroke Inpatient Rehabilitation Reinforcement of Walking Speed (SIRROWS) trial found that patients who received immediate verbal feedback about walking speed during inpatient rehabilitation showed clinically significant gains in walking speed.
- The recently concluded Stroke Inpatient Rehabilitation Reinforcement of ACTivity trial (SIRRACT) compares the effects of two different levels of feedback about physical activity and walking performance provided during inpatient rehabilitation in 150 subjects.
- SIRRACT also illustrates a potentially significant role for the use of personal activity monitors in clinical research and in motivating patients to perform more exercise on their own and during formal therapy sessions.

rehabilitation care for stroke is delivered.

"SIRRACT might provide us with strong evidence to support a broader role for the use of personal activity monitors, both during and after inpatient rehabilitation," says Dr. Brown. "As the cost of these activity monitors decrease, this technology might also help us treat patients in rural areas more effectively."

Mayo Physicians Chosen for PM&R Leadership Roles

Kathryn A. Stolp, M.D., was recently named president-elect of the Association of Academic Physiatrists (AAP). Dr. Stolp has served on the AAP's board of trustees since 2010 and will assume the role of president on September 1, 2013.



Kurt M. Hoppe, M.D., is currently serving as president-elect of the American Academy of Physical Medicine and Rehabilitation (AAPM&R). Dr. Hoppe has held leadership positions in the AAPM&R since 2000.



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Mayo Clinic welcomes inquiries and referrals, and a request to a specific physician is not required to refer a patient.

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Resources

mayoclinic.org/medicalprofs

Clinical trials, CME, Grand Rounds,
scientific videos, and online referrals

Education Opportunities

2013 Brain Injury Conference

June 21, 2013, in Rochester, Minn.

This conference is designed to provide meaningful information that you can translate into your clinical practice and day-to-day life to better assist individuals living with the effects of acquired brain injury.

Contact: Call 800-545-0357 (toll-free) or 507-266-1007 or email cme@mayo.edu

Diagnostic and Interventional Musculoskeletal Ultrasound

June 27-29, 2013, in Rochester, Minn.

Offered in collaboration with the American Institute of Ultrasound in Medicine (AIUM), this course includes lectures, live demonstrations and hands-on experiences. The course is appropriate for clinicians at the beginner and intermediate-advanced levels who evaluate and treat patients with musculoskeletal and neurological diseases.

Contact: Email Danielle Delanko at ddelanko@aium.org or call 800-638-5352 (toll-free) or 301-498-4100

Ice Hockey Summit II: Action on Concussions

Oct. 8-9, 2013, in Rochester, Minn.

The prevalence and consequences of concussion at all levels of ice hockey are concerning. Reduction of concussion risk, as well as improved concussion diagnosis and management, requires a collaborative effort from medicine, psychology, sport science, coaching, engineering, officiating, manufacturing and community partners. This scientific program focuses on education and generates an evidence-based action plan designed to make a difference. Contact: Call 800-323-2688 (toll-free) or email cme@mayo.edu

23rd Annual Mayo Clinic Symposium on Sports Medicine

Nov. 8-9, 2013, in Rochester, Minn.

This program provides an integrated approach to the injured athlete and includes case presentations, lectures and video demonstrations. Health care professionals with an interest in sports medicine and athletic trainers will find this program appropriate. Contact: Call 800-323-2688 (toll-free) or email cme@mayo.edu

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