Data-driven resistance training against muscular atrophy

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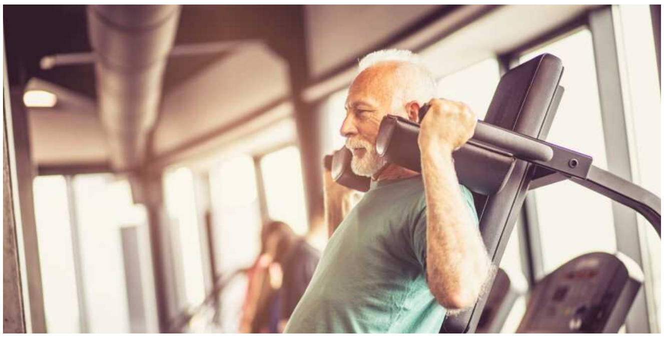

Rightly known as medicine: Resistance exercise is the most important measure against muscular atrophy. Credit: Mladen Zivkovic/iStock

Muscles play a critical role in life. Skeletal muscle mass alone accounts for up to 40 percent of our body mass. Muscles turn chemical energy into mechanical energy and generate the power with which we breathe and move. Muscles also serve as a reservoir for carbohydrates, proteins and fatty acids, and contribute significantly to our metabolism and energy balance.

However, muscle mass unfortunately declines continuously from the age of 40. This age-related muscular atrophy—sarcopenia—comprises about 6 percent over ten years. By the age of 80, a person will thus have lost about a third of their maximum muscle mass. Physical performance reduces significantly and quality of life drops.

Resistance training is medicine

It is generally understood that physical activity can stimulate muscle growth. Resistance training is thus the key measure to counteract the negative effects of sarcopenia. However, what exactly targeted muscle training is and how it can optimally achieve its purpose is largely unknown.

"This is because resistance training is not mapped accurately enough in practice, so it is difficult to draw conclusions about muscle growth," says Claudio Viecelli, Ph.D. student at ETH's Institute of Molecular Systems Biology under Professor Ernst Hafen.

Viecelli aims to close this gap. For his dissertation, the molecular and muscle biologist worked with colleagues from Zurich University of Applied Sciences (ZHAW) and Kieser Training AG to develop an impressively simple method: it uses acceleration sensors in conventional smartphones to record resistance training variables on devices in a high temporal resolution. The researchers discussd their method in the specialist journal *PLOS ONE*.

Wanted: time under tension

Until now, the activity carried out with a weight during a resistance exercise session has usually been logged in terms of sets and repetitions. However, such training data is insufficiently comparable and thus sub-optimal when it comes to examining the effects of training on muscle growth. The temporal patterns of resistance training are relevant to muscle plasticity.

The description figures required have been known theoretically for a long time. These include the "single repetition," which consists of lifting and lowering the load; then the "contraction-phase specific time," which indicates the time the muscle is under tension during the lifting and lowering; and finally the "total time-under-tension"—this quantifies how long the muscles were under tension during an exercise.

From acceleration to contraction

So far, there has been no suitable method of recording these values reliably in the gym. "It would require several stop watches or even several assistants—but this is hardly practical. This is why this information is usually missing in training logs and scientific publications," explains Viecelli, who himself is a resistance training enthusiast. While searching for a solution, he came up with the idea of using a smartphone as a digital analysis tool.

In order to test this idea, Viecelli examined the training exercises of 22 test subjects on nine pieces of resistance equipment at the ASVZ Sport Center Irchel. He attached the smartphone to the weight stack in order to record the acceleration during the exercise. A specifically programmed app then logged the sensor data. Viecelli was able to determine the contraction times from these acceleration profiles. He then used video recordings as a comparison to demonstrate that the method is sufficiently precise and works reliably.

Towards digitalised resistance training facilities

The new analysis method enables resistance exercises to be mapped much more accurately and allows the relevant comparative figures to be recorded in a standardized manner. This makes it possible to quantify resistance exercise as a stimulus for muscle building and to identify training-induced changes in muscle physiology using comparative studies. This could help to counteract age-related sarcopenia and its after-effects.

The method is primarily intended for research purposes. However, Viecelli believes that everyone may be able to use this tool in future to record data independently on their smartphones. This would allow them, for example, to better tailor their training programs to their individual needs.

Such user data will also be interesting for scientific purposes. Viecelli's vision is a digitalised resistance exercise laboratory with a wide range of training data that can be correlated with users' body composition. "Our goal is to develop personalized training strategies to efficiently and effectively increase muscle mass and strength," says the molecular and muscle biologist.

More information: Claudio Viecelli et al. Using smartphone accelerometer data to obtain scientific mechanical-biological descriptors of resistance exercise training, *PLOS ONE* (2020). DOI: 10.1371/journal.pone.0235156

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