

Title

Clarification of the differences in quadriceps muscle mass and muscle quality by age and sex in Japanese people.

Key Points

- In middle-aged and older Japanese community dwellers, thigh muscle quality and mass decline with age, with differences between men and women. In particular, men exhibited a quadratic accelerated age-related decline.
- Both the mass and quality of muscle play an important role in muscular exertion. Evaluation of both mass and quality can together provide a more accurate assessment of muscle conditions, particularly in the aged population.
- The results of this study can be applied to the establishment of a diagnostic method for sarcopenia using CT and other diagnostic devices in the future.

Summary

To investigate an accurate method of diagnosing sarcopenia, we focused on the mass and quality of the quadriceps muscle measured from computed tomography (CT) scans of the mid-thigh, and clarified the differences by sex and age and the relationship with knee extension strength. Our research results were published in the web version of the international scientific journal—*Journal of Cachexia, Sarcopenia and Muscle*—on May 19, 2021. Diagnosis of sarcopenia is currently based on a combination of measurement of muscle mass by dual-energy X-ray absorptiometry (DXA) or Bioelectrical Impedance Analysis (BIA) and measurement of muscle strength (grip strength) and physical function (walking speed). In recent years, the importance of assessing not only muscle mass, but also muscle quality has been highlighted. It is thought that fat accumulation inside and around the muscle and fibrosis reduce the quality of the muscle. An evaluation method using the density of CT images has been proposed to evaluate the quality of the muscle.

In this study, we found that both the mass and quality of muscle decline more rapidly in men than in women of older age, and that both mass and quality are related to knee extension strength. In addition, a detailed examination of the quadriceps muscle subdivided into four constituent muscles revealed differences between men and women in terms of the relationship between muscle and muscle strength.

It is expected that this information will lead to the establishment of a more accurate method of diagnosing sarcopenia using CT, its application in disease diagnosis in conjunction with other diagnostic equipment, and the development of exercise intervention that focus on muscles exhibiting

quality decline.

This research was supported by a Grant-in-Aid for Scientific Research from the Japan Society for the Promotion of Science (Principal Investigator: Yasumoto Matsui).

Research Background

In 2018, the European Working Group on Sarcopenia in Older People considered muscle quality and muscle mass as the parameters for sarcopenia diagnosis. Qualitative changes in skeletal muscle are caused by a reduction in type II fiber size, intramyocellular lipid, intramuscular and intermuscular fat accumulation, and muscle fibrosis. Imaging modalities, such as CT and magnetic resonance imaging, enable detailed cross-sectional assessments of muscle components and are useful in assessing muscle quality. Accordingly, although it is difficult to strictly distinguish between intramyocellular and extramyocellular lipids, researchers have attempted to evaluate thigh and abdominal muscle fat infiltration using CT values (CTVs) indicative of muscle attenuation. Considering that the volume of muscle mass loss that occurs with aging is twice as large in the lower extremities than in the upper extremities, age-related differences are more evident in the lower extremities. Moreover, reports have shown that the quadriceps muscle exhibits greater muscle mass loss with aging than the hamstrings and other posterior thigh muscles. As such, a detailed evaluation of age-related differences in quadriceps may lead to a reasonable assessment of age-related sarcopenic changes. Therefore, this study aimed to evaluate and describe the age- and sex-related differences in quadriceps muscle mass and quality and their relationships with knee extension strength (KES) using mid-thigh CT measurements, focusing on the entire quadriceps and its constituent muscles and adipose tissues, in community-dwelling middle-aged and older Japanese individuals.

Research Results

The National Institute for Longevity Sciences-Longitudinal Study of Aging (NILS-LSA) is a longitudinal study on age-related differences among randomly selected middle-aged and older community dwellers aged ≥ 40 years from resident registrations. Cross-sectional data from 520 Japanese individuals (273 men and 247 women, mean age: 63.1 ± 10.6 years) were analyzed. The participants underwent a single-slice CT examination of the right mid-thigh. The cross-sectional areas (CSAs) and CTVs from the CT images were analyzed using a dedicated software. The CSAs were evaluated as a measure of muscle and intermuscular fat mass, and CTVs were evaluated as a measure of muscle quality, reflecting the intramuscular fat and intramyocellular lipids. The four constituent muscles, intermuscular adipose tissue, and the entire quadriceps area (total quadriceps muscles + intermuscular adipose tissue) were assessed (Figure 1). The analysis was conducted using the

participants' characteristics and measurements related to sarcopenia, including grip strength, KES, and total body muscle mass as measured by DXA. Because there have not been any simultaneous reports of CSA and CTV of the quadriceps muscle by sex and age in the Japanese population, we have described the unadjusted data in detail. All CSAs and most CTVs were found to be higher in men than in women, but the rectus femoris CTV showed no difference between men and women and was characterized differently from the others. Both entire quadriceps CSA and CTV showed a quadratic decline at older ages in men, while in women the decline was linear, suggesting that the degree of influence of age on muscles is different in men and women (Figure 2). Because the quadriceps femoris is the muscle that plays the largest role in knee extension, we assessed its relationship with KES. Both the CSA and CTV of the total quadriceps muscles were found to be independently related to KES. When the four constituent muscles were further divided and examined in detail, it was found that the relationship between KES and the constituent muscles differed between men and women. As the vastus medialis CTV in women only showed a relationship with muscle strength, the relationship differed not only in CSA, which represents muscle mass, but also in CTV, which represents muscle quality, depending on the constituent muscle.

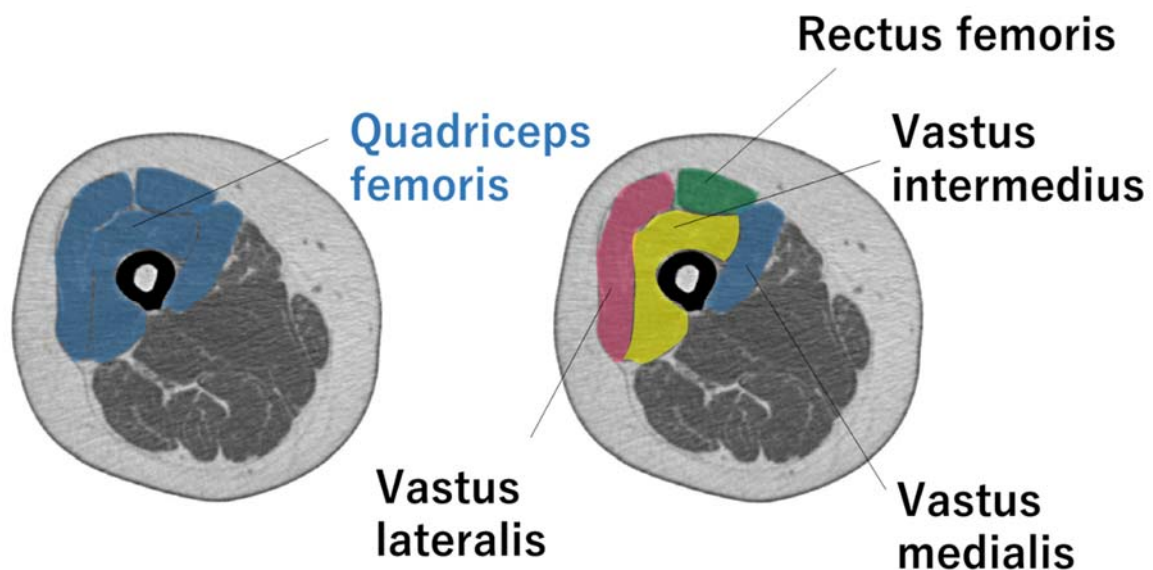


Figure 1: CT image of the quadriceps muscle

*The color tone has been reversed from the normal CT image.

The white area represents fat and the black area represents muscle.

The CT values (density of the image) evaluates the quality of the muscle. The cross-sectional area of

the muscle was used to evaluate muscle mass.

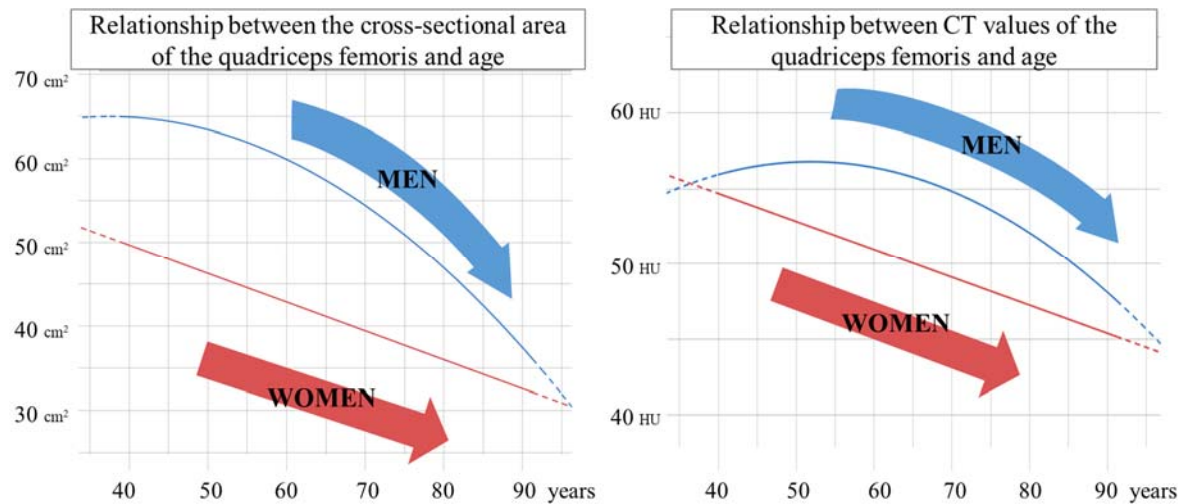


Figure 2: Relationship between age and the cross-sectional area of the quadriceps muscle according to sex, and the relationship between age and CT values.

Regarding the quadriceps muscle, men have a sharply lower muscle cross-sectional area (muscle mass) and CT values (muscle quality) as they get older than women.

However, since this is a cross-sectional study, it is not clear whether an individual's cross-sectional area and CT values will decrease, as indicated by this graph.

Research Summary and Future Perspective

Now that we have published the measurements related to CT of the quadriceps muscle, according to sex and age, they can be used as reference values for Japanese individuals. Therefore, evaluation of the CT of the mid-thigh using the same method can be used to assess the age level of the muscle condition. However, since this is a cross-sectional study, it is hoped that longitudinal studies that follow the same individuals for a longer period of time could be performed to confirm true quadriceps muscle changes with age. As more data are accumulated and refined in the future, it is expected that CT will be increasingly utilized as a diagnostic method for sarcopenia. In addition, it is expected that CT evaluation will enable the objective extraction of poor-quality muscles and tailor-made exercise therapy according to each individual's condition.

Publication

Journal of Cachexia, Sarcopenia and Muscle

Differences in the mass and quality of the quadriceps with age and sex, and their relationship with knee extension strength

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DOI: 10.1002/jcsm.12715

Japanese ver.

https://www.med.nagoya-u.ac.jp/medical_J/research/pdf/Jou_CA_Sar_Mus_210608.pdf