Cycling helps preserve muscle mass and composition: A Quantitative MRI study

Anna Di Laura[1], Johann Henckel, Martin A Belzunce, Alister Hart
[1]Royal National Orthopaedic Hospital NHS Trust

INTRODUCTION:

Muscle loss or sarcopenia is the progressive decrease in muscle mass and strength during aging. Although it is primarily a disease of the elderly, its development may be associated with conditions that are not exclusively seen in older individuals. Low levels of physical activity have been linked with increased levels of muscle fat infiltration and progressive muscle weakness. Therefore, physical activity and a healthy lifestyle are crucial factors for delaying and reducing its effects. Two important markers for muscle health are muscle volume and intramuscular fat (IMF) content, as they have been associated with loss of strength and mobility. These biomarkers can be quantitatively assessed with magnetic resonance imaging (MRI) and computational tools that allow the study of individual muscles.

We aimed to better understand the benefits of cycling on muscle health by means of 3D quantitative MRI.

Our primary objective was to quantify IMF content, volume and lean volume of the gluteal muscles of middle-ages cyclists. Our secondary objective was to compare the biomarkers to those of physically inactive individuals.

METHODS:

This was a cross-sectional study involving two matched groups of middle-aged adults that underwent pelvic MRI. The first group consisted of physically inactive (PI) men that were ready to start the Couch to 5K (Cto5K) programme, a running plan for absolute beginners. The inclusion criteria for this group was less than 1 hour of physical exercise per week. The second group consisted of trained cyclists that had cycled more than 7000 km in the previous year. Common inclusion criteria for both groups was absence of injuries and other health problems, no contraindication to MRI and ages of 30-65 years old. A total of 57 subjects were recruited. 29 for the physically inactive group and 28 for the cyclists group.

Four gluteal/hip muscles were considered to assess the overall muscle health as they are essential for keeping an active lifestyle and are involved in a wide range of physical activities. These are gluteus maximus (GMAX), gluteus medius (GMED), gluteus minimus (GMIN) and tensor fasciae latae (TFL). For each muscle, we used a validated in-house software tool to comput three MRI-based muscle health metrics: intramuscular fat (IMF) content, volume and lean volume, Figure 1. Both volume and lean volume measurements were normalized by the lean body mass (LBM) of each subject. All the MRI scans were cropped at the tip of the lesser trochanter (LT) to avoid volume differences due to FOV mismatches.

We compared the FF, volume and lean volume of the two groups using a Kruskal-Wallis test for not normally distributed samples. In addition, we performed univariate and multiple regression analyses to determine the associations of BMI and cycling (categorical variable) with FF and volume.

RESULTS:

The PI group had a higher BMI (median 28.7 kg/m2; $p<0.01$) and higher lean body mass (median LBM 64.9 kg; $p<0.01$) than the cyclists group (median BMI 23.7 kg/m2, median LBM 60.2 kg).

We found that the cyclists group had lower levels of fat infiltration for the four muscles under analysis compared to the PI group, and had a larger GMAX muscle after normalizing the volume by the lean body mass. The FF values of the cyclists were lower for GMAX ($p<0.01$), GMIN ($p<0.01$), GMED ($p<0.01$) and TFL ($p<0.01$).

Significant univariate correlations were found between muscle FF and BMI ($R2= 0.589$, $p<0.01$ for GMAX; $R2= 0.541$, $p<0.01$ for GMED; $R2= 0.190$, $p<0.01$ for GMIN; and $R2= 0.490$, $p<0.01$ for TFL). Significant correlations were also found between muscle FF and the PI/Cyclists categorical variable ($R2= 0.377$, $p<0.01$ for GMAX; $R2= 0.453$, $p<0.01$ for GMED; $R2= 0.134$, $p<0.01$ for GMIN; and $R2= 0.182$, $p<0.01$ for TFL), Figure 2.

The normalized volume was larger for the cyclists than for the PI group only for GMAX ($p<0.01$), while the normalized lean volume was larger for the cyclists for GMAX ($p<0.01$) and GMED ($p=0.02$).

DISCUSSION AND CONCLUSION:

A sedentary lifestyle has a considerable impact on muscle health, in particular muscle composition.

The findings of this study show that the degradation of muscle composition in middle-aged sedentary adults is higher to that of cyclists, indicating that this sport activity is effective in delaying the ageing process and helping preserve muscle mass and composition.

This study is the first study to compare cyclists and sedentary individuals and generates quantitative data to support the benefits of a healthy over a sedentary lifestyle providing robust evidence for future comparative studies.

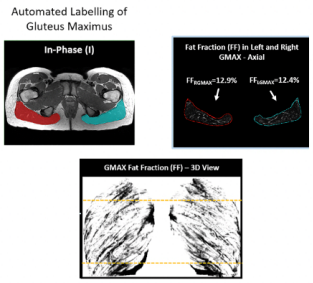

Figure 1: FF measurement of GMAX. An automated tool is used to label the in-phase Dixon data (left image). FF of right and left GMAX are estimated by masking the FF image with the labels (middle image). On the right, a 3D view of the FF in both gluteus maximus is shown where a dark signal indicates fat content.

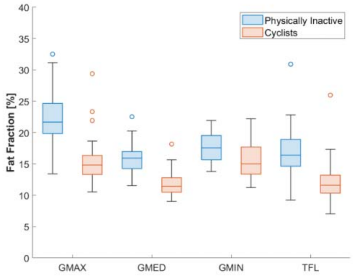

Figure 2: Boxplots of FF values of GMAX, MED , MIN and TFL muscles for each group. Median and interquartile ranges are reported. The outliers are plotted individually.