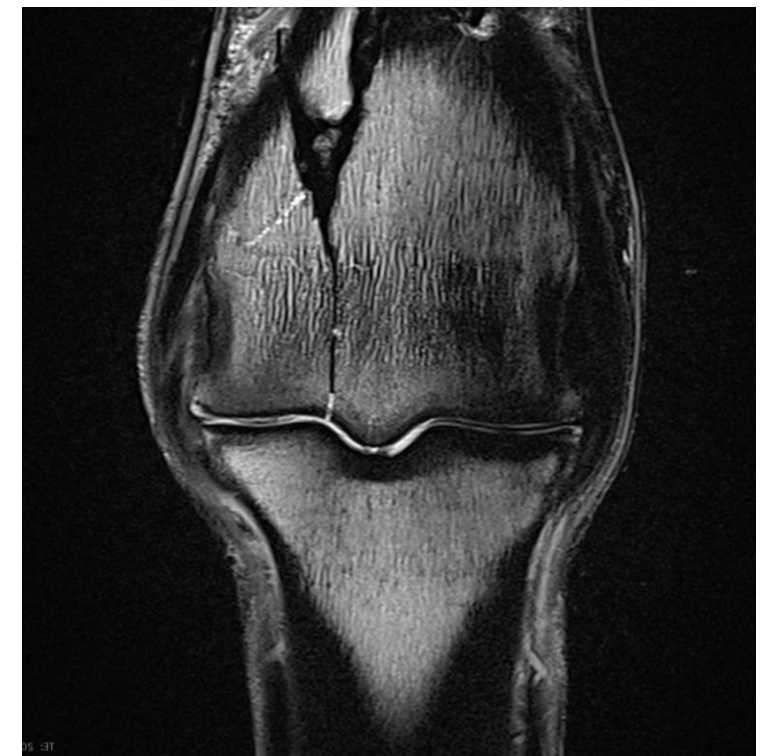


# Proton magnetic resonance spectroscopy of the distal metacarpus or metatarsus in Thoroughbred racehorses with and without catastrophic fractures

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## Introduction

- Fractures of the **third metacarpal or metatarsal bone (MC/MTIII)** are common in Thoroughbred racehorses
- Advanced imaging** of the equine MC/MTIII has failed to conclusively **predict** which limbs will **fracture** and which will not
- Bone mineral density (BMD)** and **bone marrow adiposity** - useful biomarkers in humans
- Magnetic Resonance Spectroscopy (MRS)** - advanced imaging technique used alongside MRI
  - Provides information on molecular composition of tissue
  - Spectrum of hydrogen protons** at a single location (voxel or ROI)
- Gold standard for quantification of **bone marrow adipose tissue** (Karampinos et al. 2018)
- Inverse relationship between **bone marrow adiposity** and **BMD** in humans
- Increase** in bone marrow fat content in several diseases including **osteoporosis**
- Decrease** in bone marrow fat content in professional football players and runners (Wang et al. 2021; Belavy et al. 2018)



## Aims

To quantify the **fat content (FC)** for the equine MC/MTIII and compare with CT-derived **BMD**

### Hypotheses

- FC **decreases** with an **increase** in BMD in the trained racehorse
- Horses with fractures have a **lower** bone marrow FC than horses without fractures

## Methods

- Cadaver limbs from Thoroughbred racehorses in training with and without fractures were recruited.
- 3T MRI Scanner (MAGNETOM Skyra; Siemens Healthineers)
  - Knee coil
- Structural images
  - Sclerosis grade (0-3) by consensus
- Single Voxel Magnetic Resonance Spectroscopy
  - STEAM sequence (TE 20 ms, TR 4000 ms, 70 averages)
  - ROI (1cm<sup>3</sup>) placed at 3 sites within bone
  - Spectra analysed to fit water peak and 6 fat peaks (Figure 1)
- Helical 64-slice CT scanner (Somatom Definition AS; Siemens Healthineers)
  - Sclerosis grade (0-3) by consensus
  - Mean BMD calculated at same 3 sites within bone (Woods et al. 2021) (Figure 2)
- Analysis for association between BMD and FC
  - Spearman rank correlations, Kruskal Wallis test, Mann-Whitney test

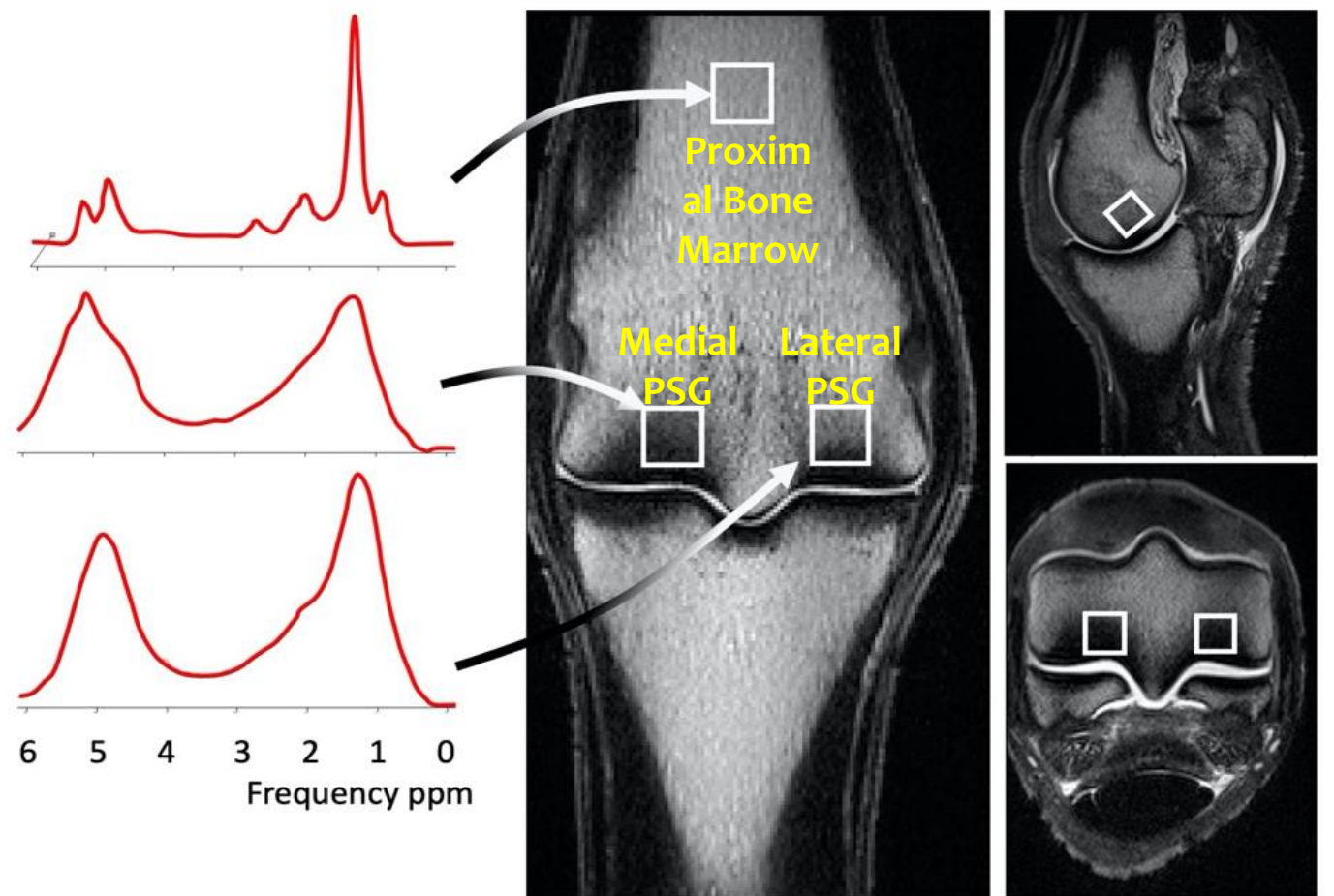


Figure 1: T1w images showing MRS voxel positioning and example spectra for the lateral, condyle, medial condyle and centre of the distal diaphysis of the third metatarsus.

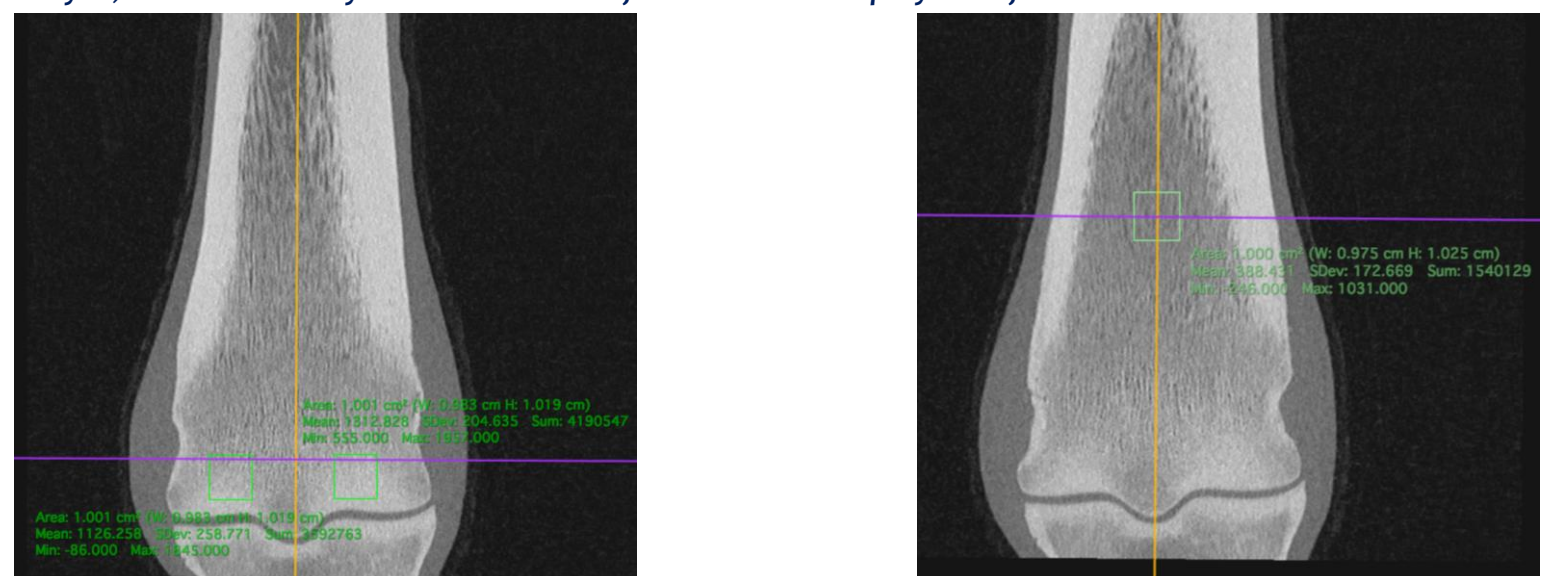


Figure 2: Dorsal CT images showing voxel positioning for the lateral, condyle, medial condyle and centre of the distal diaphysis of the third metatarsus.

## Results

- Eighteen limbs** from 10 different horses were included
- Median age of **9 years** (range: 3-11 years)
- Limbs were divided into **2 groups**; limbs from horses **with** clinical stress fractures (N=9) and limbs **without** clinical stress fractures (N=9)
- Significantly reduced fat content was identified in the proximal marrow of fracture cases (Figure 3)
- A negative correlation was identified between fat content and BMD at all locations (Figure 4)

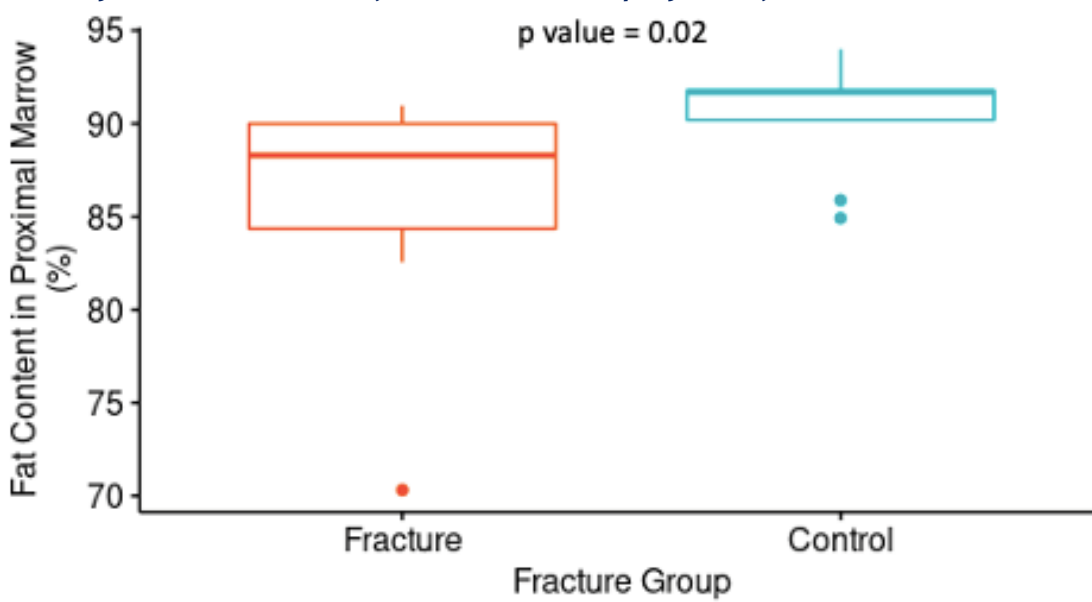


Figure 3: Box plot showing the median percentage FC in the bone marrow of the distal diaphysis in horses with fractures (88%) compared to controls (91%) (p=0.02).

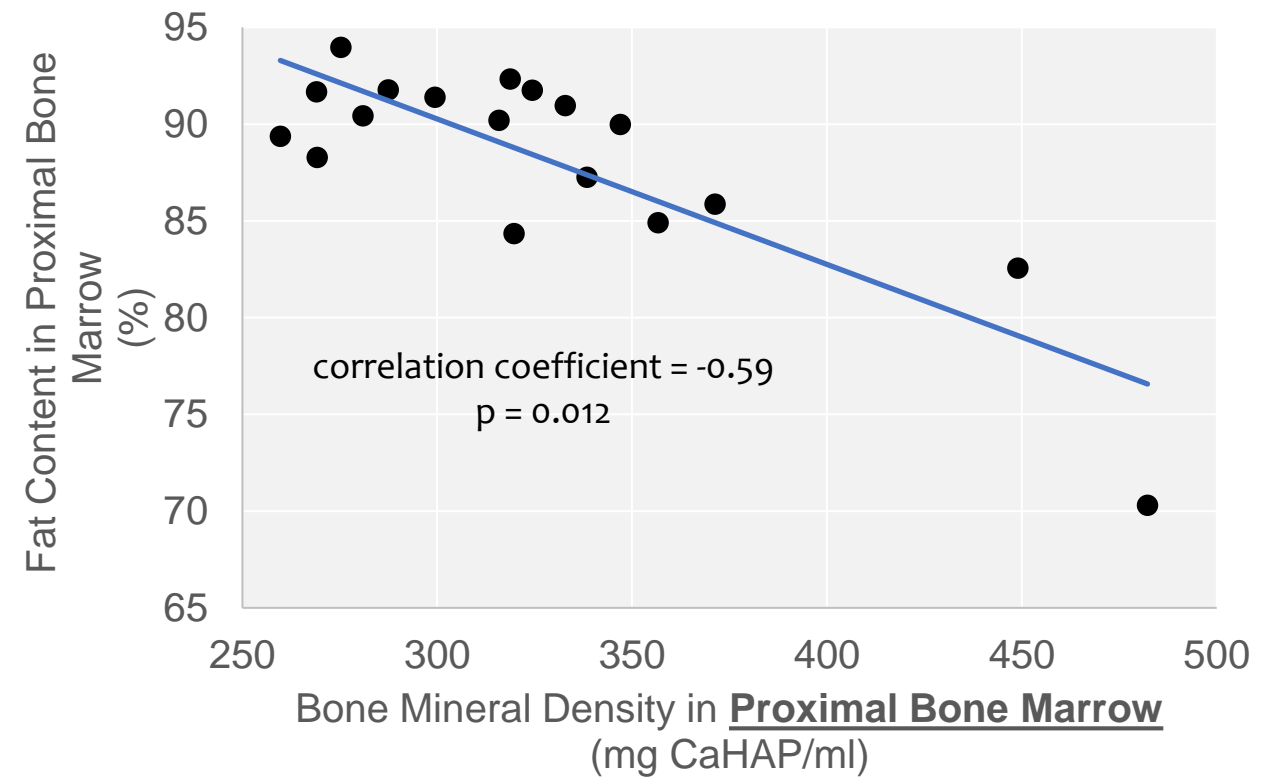
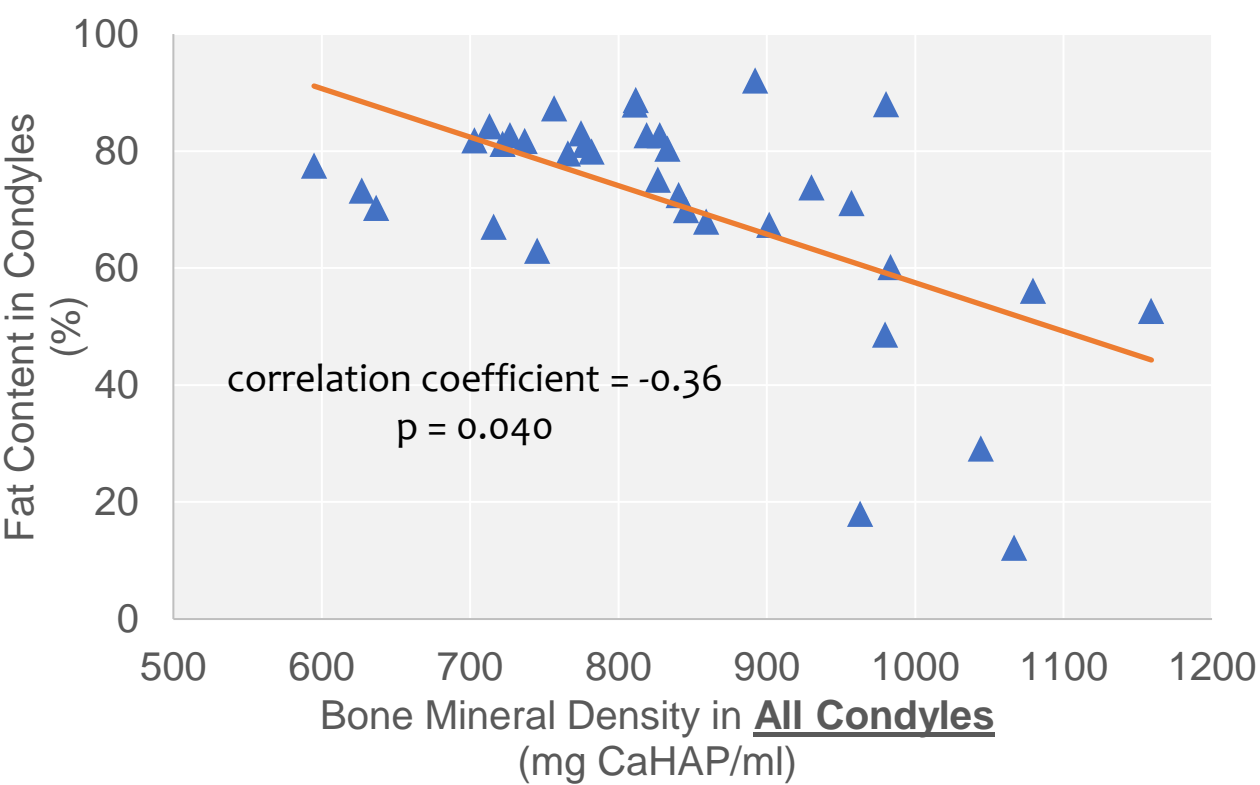


Figure 4: Scatter plots showing a significant negative correlation between the mean bone mineral density and fat content in all metacarpal/metatarsal condyles (left) and the proximal bone marrow (right).

## Conclusion

- Proton magnetic resonance spectroscopy** can be performed in the equine metacarpal/tarsal bone
- Potential to provide further information on the **role of marrow adipose tissue** in bone health