

# Keeping active with a healthy diet

Dr Gladys Onambélé-Pearson

Institute for Biophysical & Clinical Research into Human Movement

# OLD AGE

by: Crates

These shrivelled sinews and this bending frame,  
The workmanship of Time's strong hand proclaim;  
Skilled to reverse whate'er the gods create,  
And make that crooked which they fashion straight.  
Hard choice for man, to die -- or else to be  
That tottering, wretched, wrinkled thing you see:  
Age then we all prefer; for age we pray,  
And travel on to life's last, lingering day;  
Then sinking slowly down from worse to worse,  
Find heaven's extorted boon our greatest curse.

# Physiological adaptations to ageing

- Ageing brings about a gradual decline in all physiological systems,
- This results in generalised weakness, loss of mobility as well as poor endurance and decreased functional balance

→ FRAILITY

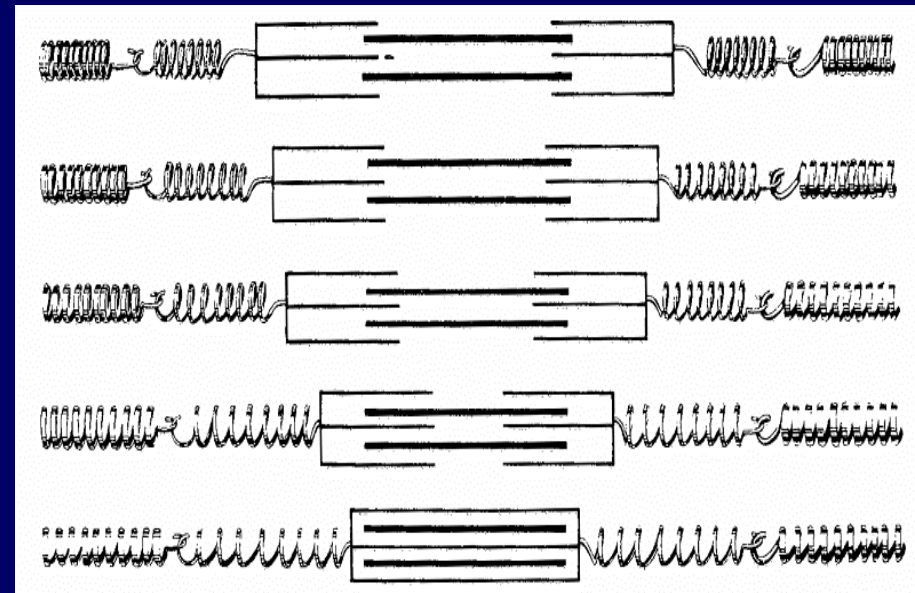
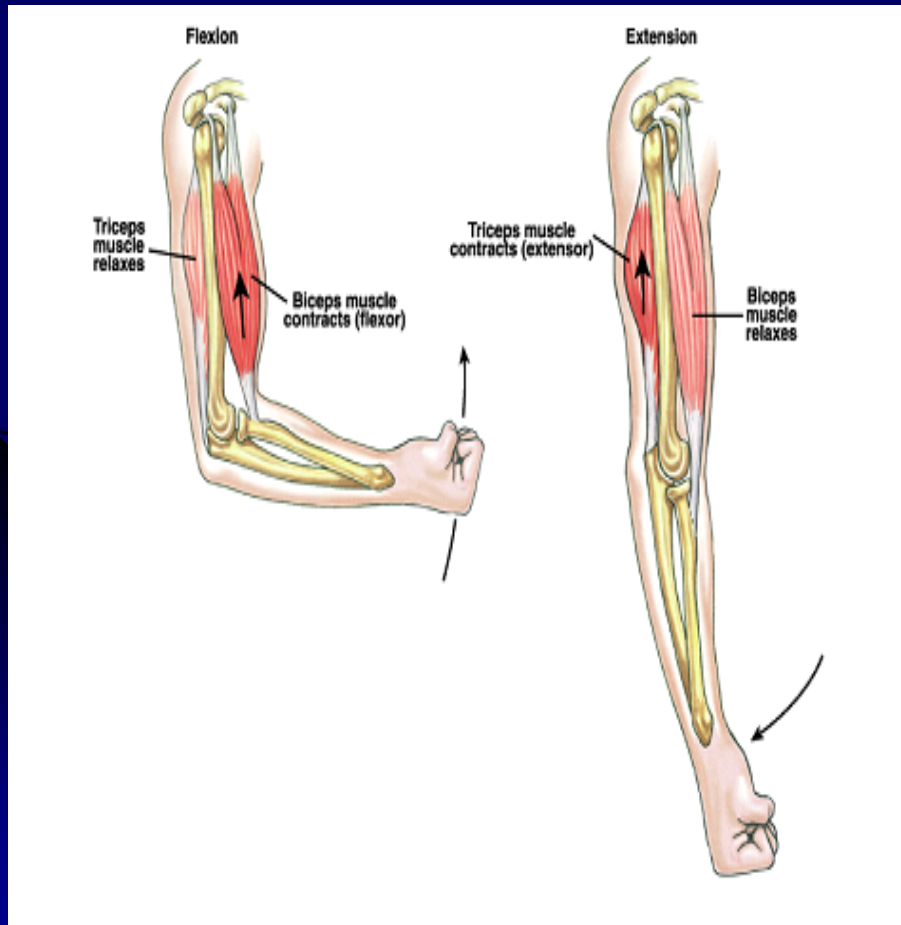
# Sarcopenia



# Is sarcopenia the sole responsible factor?

- **Activation capacity**
- **Single muscle fiber properties**
- **Whole muscle internal architecture**
- **Tendon mechanical properties**

# Muscles work jointly with tendons



# Ageing affects tendons

...but inconsistency of results:

- 1) Ageing makes tendons stiffer
- 2) Ageing makes tendons more extensible
- 3) Ageing has no effect

**Maturation  $\neq$  Ageing !**

**Also stiffening of joints with ageing often mistaken for tendon stiffening**

However, the *in vivo* interactions between human muscles and tendons in relation to ageing has never been studied before

# Study Aims

- Investigate the *in vivo* effects of ageing not only on muscles but also on tendons
- Assess the physiological relevance of these changes to whole body function in relation to frailty in old age

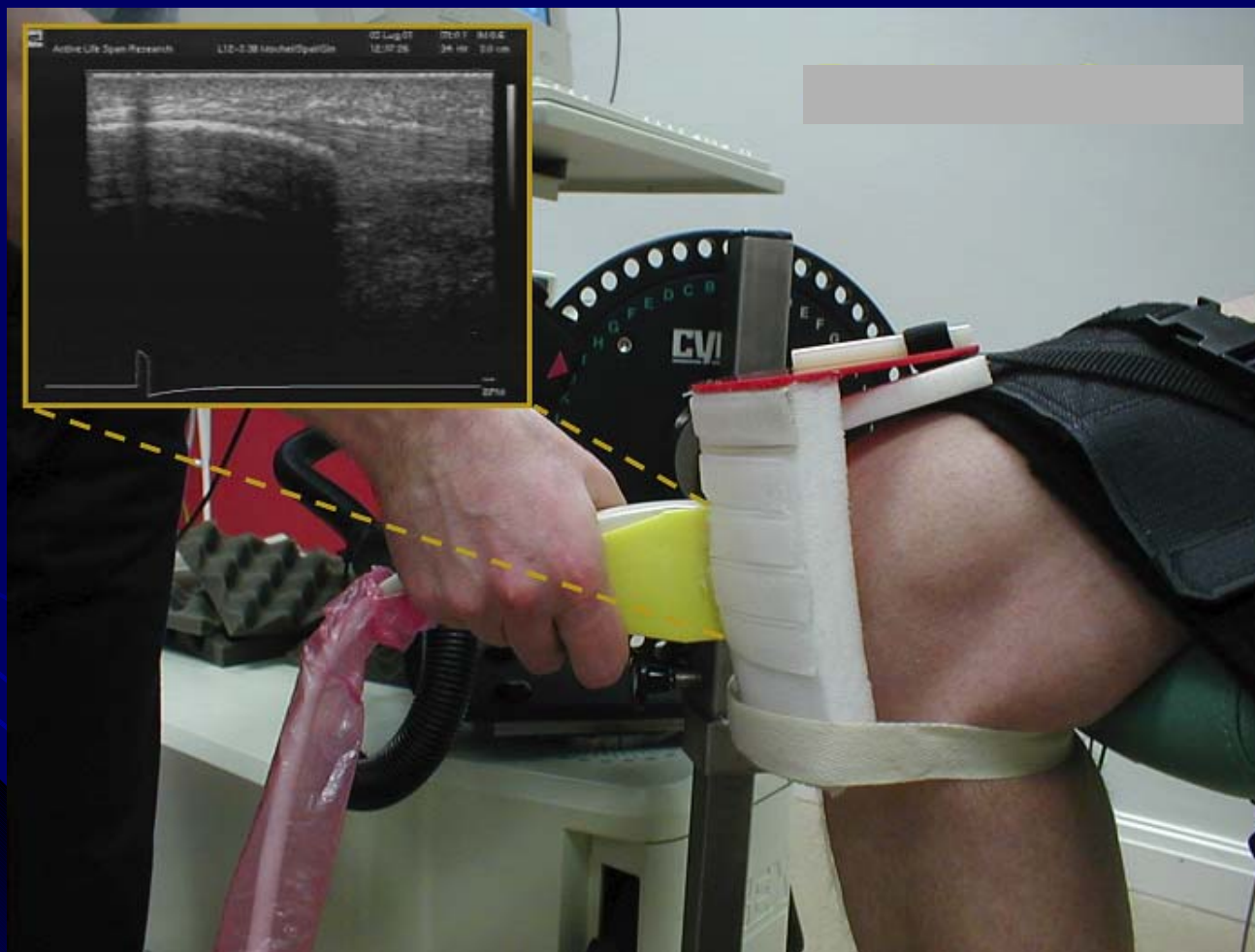
# Research focus

- **Activation capacity:** by electrical stimulation
- **Muscle size and architecture:** by ultrasound and MRI
- **Tendon properties:** by ultrasound & dynamometry
- **Balance ability:** via force platform outputs
- **Stairs & chairs negotiation:** via motion analysis
- **Functional ability tests:** using time-related performances

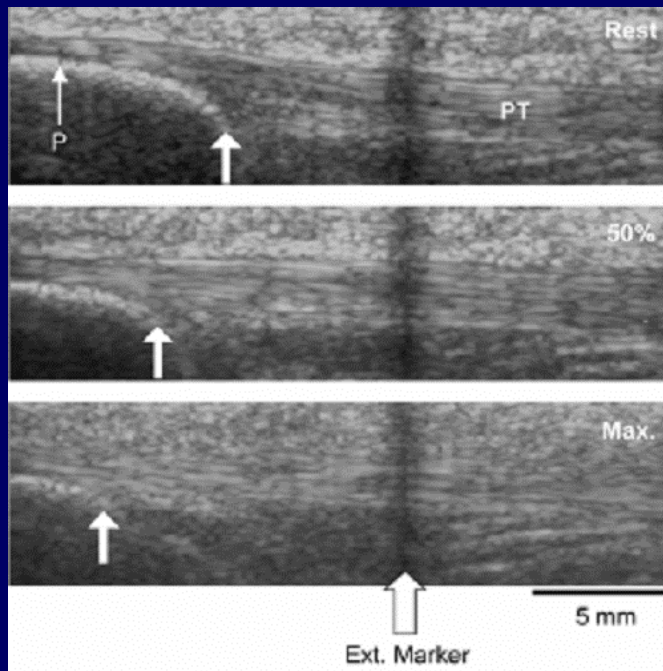
# Study design

- **Cross-sectional comparison of data from three age groups:  
Young, Middle-aged and Older**
- **Quantification of the relation between muscle & tendon characteristics and whole body performance**

# Experimental set-up



# In vivo Imaging



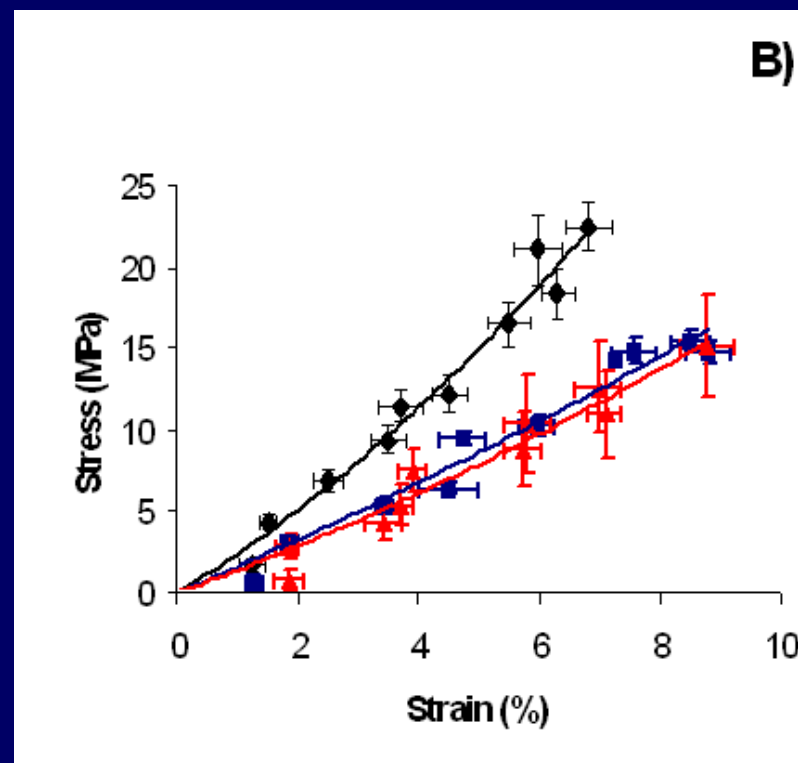
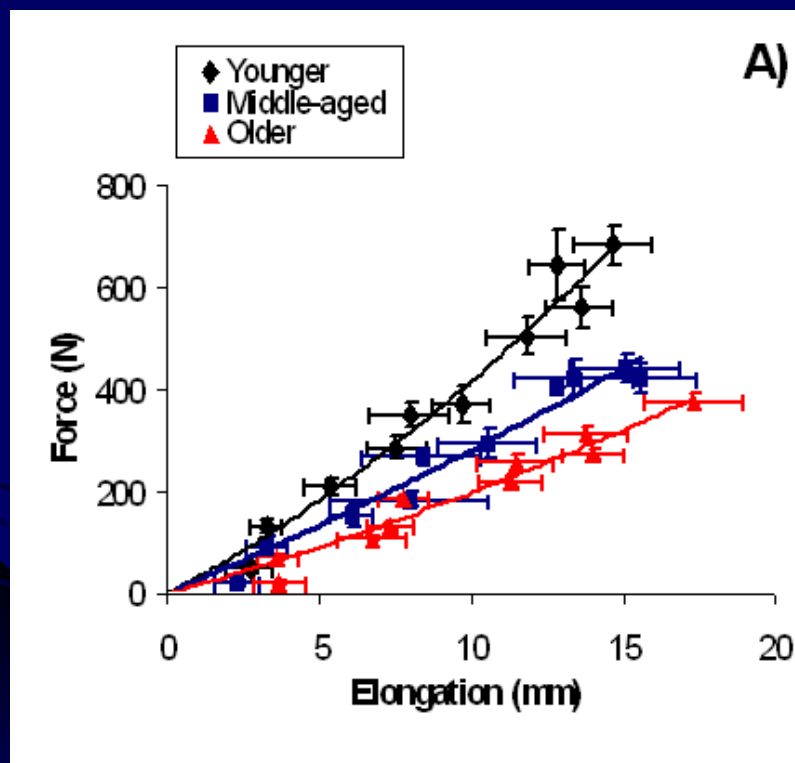
MRI - Moment arm



MRI – Muscle cross-sectional area

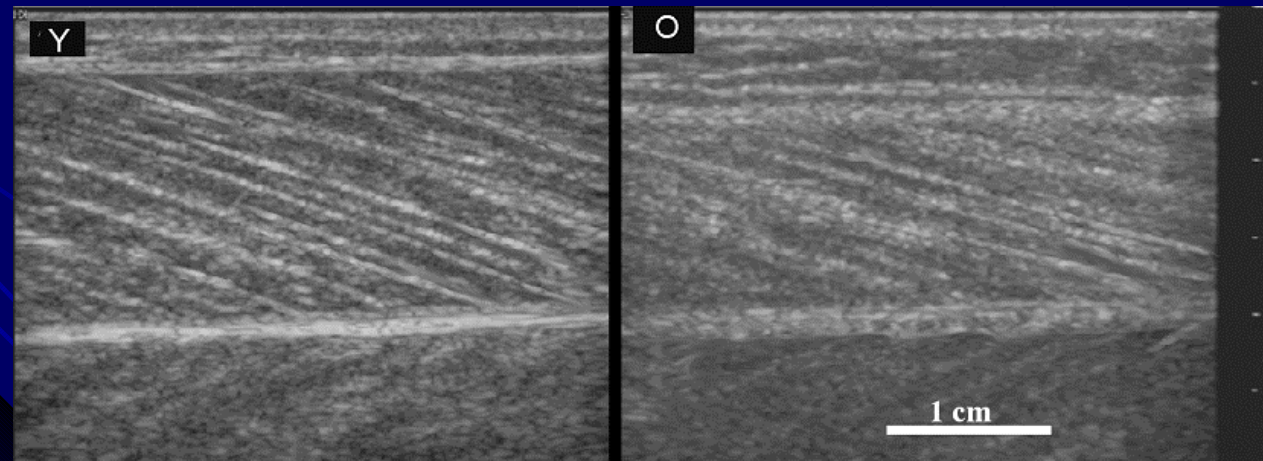
Images of tendon displacement during ramped contractions

# Effect of ageing on tendons



# Effects of ageing on muscle architecture

- Ageing makes muscles not only smaller but also shorter



# Whole body function testing



# Impairment in whole body performance

1. Postural Balance ✓
2. Stair negotiation capacity ✓
3. Sit-to-stand transitions ✓
4. Walking ✓

# Recap

- 1. Muscle weakness in ageing is not only due to sarcopenia and neural activity changes ...**
- 2. ....but also to changes in muscle architecture and in tendon mechanical properties**
- 3. The above alterations are associated with impairment in whole body performance**
- 4. Rehabilitation and even prevention is therefore key**

# Is exercise effective at reversing the deteriorating effect of ageing on the skeletal-muscle-tendon complex?



The beneficial effects of resistance training as a means of delaying age-related sarcopenia and associated problems have been demonstrated.



Outcomes include positive effects on muscle strength, power and cross-sectional area, alterations in fibre type, reductions in body fat, increased tendon stiffness, increased neural activation capacity and improved functional ability



# Future directions



- From observation we know that muscles can get better with appropriate loading
- *However in spite of the obvious advantages* there appears to be an obligatory loss in muscle strength/power with ageing
- *The mechanism of response to training interventions is not clearly understood.* This would be necessary to help optimise regimes
- *Need to disentangle the effects of ageing from those of disuse.* i.e. when identifying biological markers of 'ageing' we need to account for the influence of lifestyle (nutritional status or genetic background for instance)

# Future directions Ctnnd...



## Nutritional interventions

- **OBJECTIVES:** The SPARC funded will elucidate appropriate nutritional/exercise interventions targeted specifically at individuals aged 65+
- **METHODS:** Assessment of functional, physiological and hormonal profiles in 65+, as well as determining any link with psychometric measures of quality of life.
- **INTERVENTIONS:** Nutritional advise, Exercise, timed protein plus carbohydrate supplementation

# Acknowledgements



- Study participants
- Research team: Prof M. Narici, Prof C. Maganaris, Prof A. Minetti, Prof C. Stewart, Dr K. Tipton
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Old age isn't so bad when  
you consider the  
alternative.

--Maurice Chevalier