

MRC-ARUK Centre for Musculoskeletal Ageing Research



Science & Wellness Afternoon: Unlocking the Secrets to Healthy Ageing

Paul Greenhaff, University of Nottingham

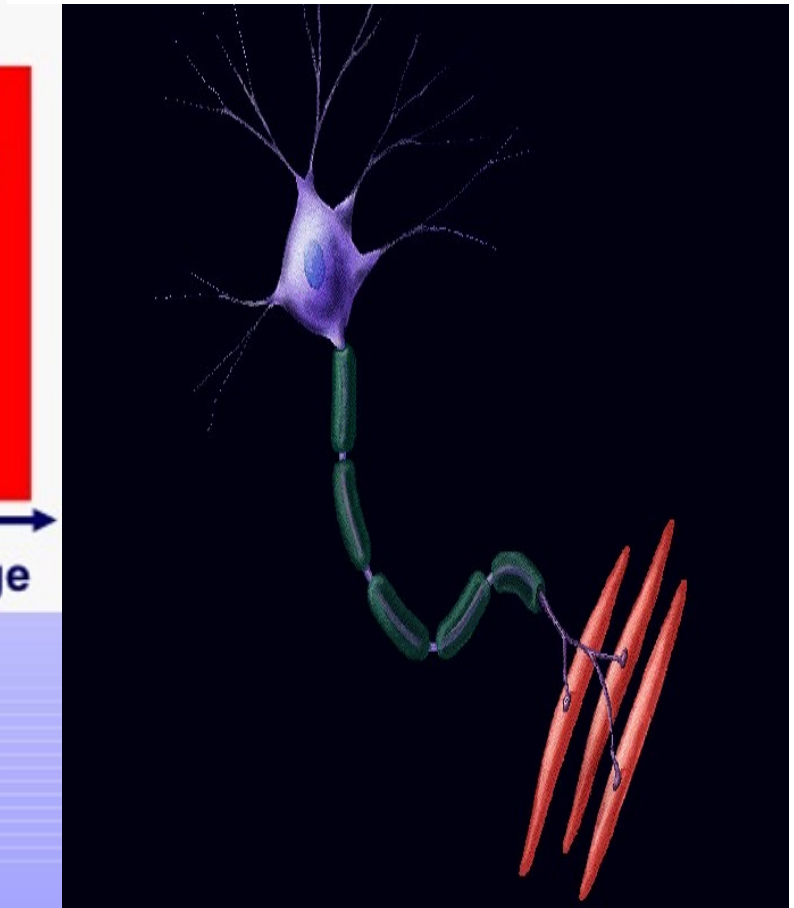
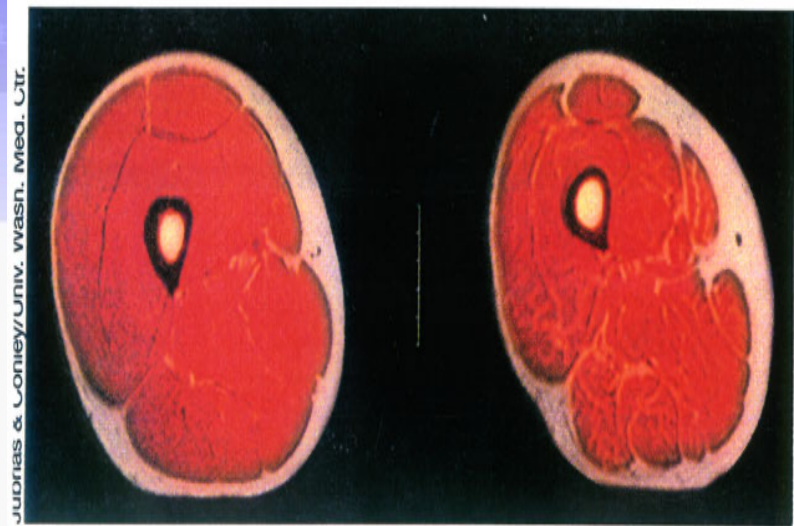
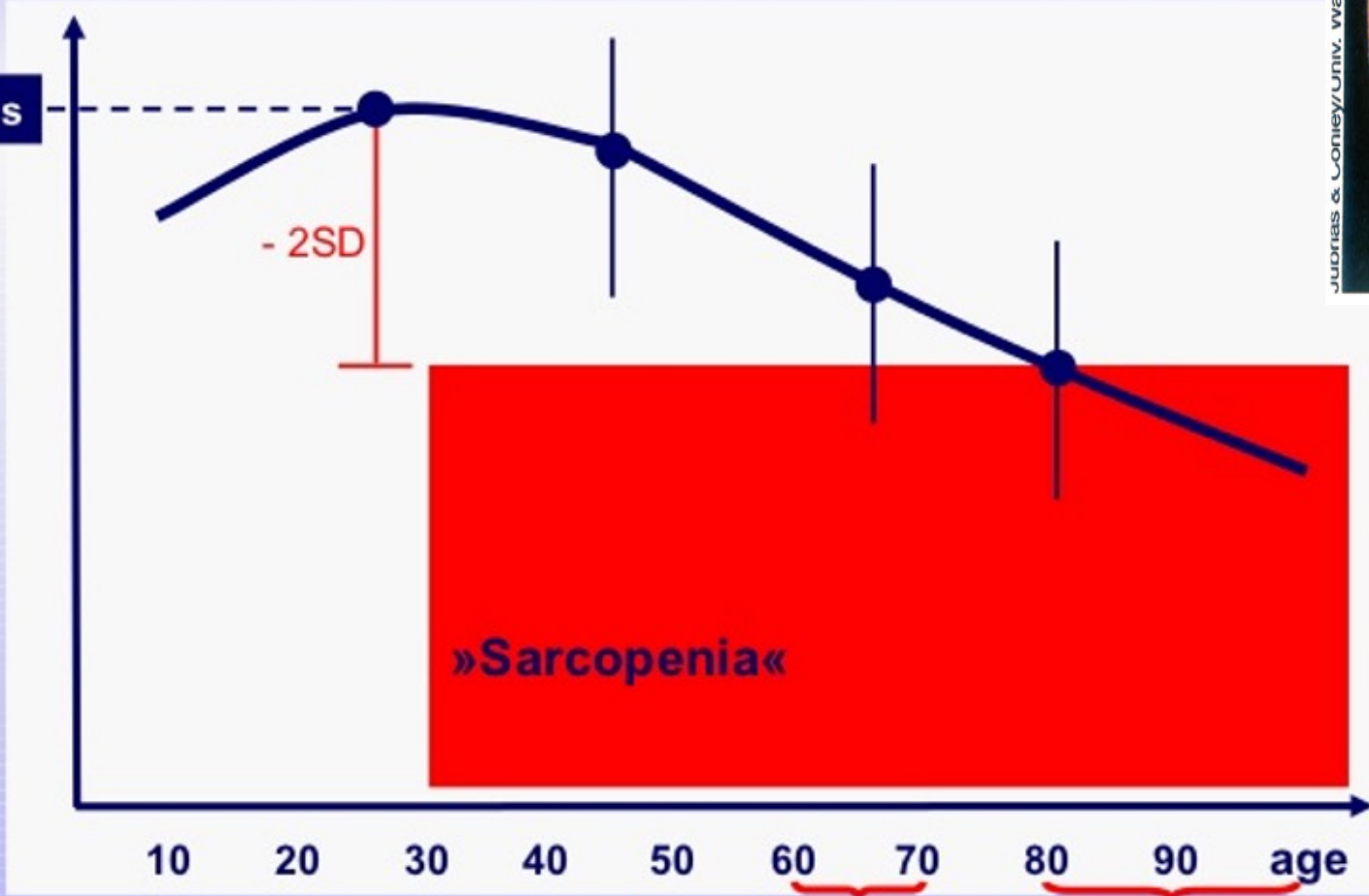
The Price of Inactivity: Understanding the Consequences of Not Moving

How far and how fast does the Grim Reaper walk?

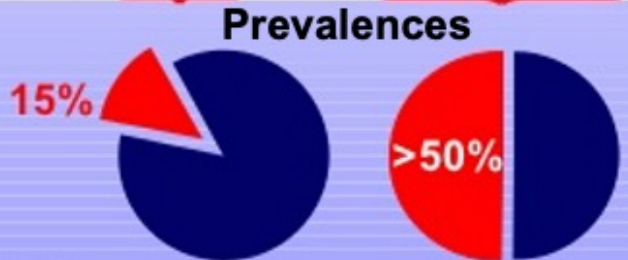


Loss of Muscle Mass with Age (2-3% per annum from ~40 years)

peak muscle mass

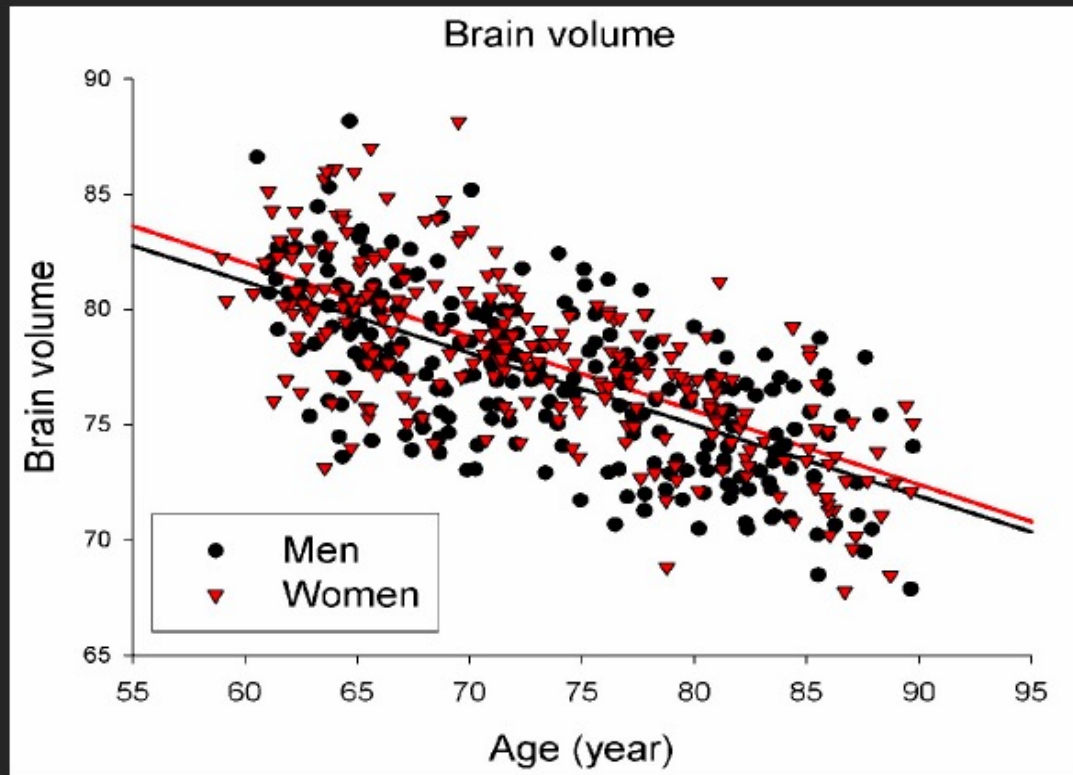


Sarcopenia defined as appendicular skeletal muscle mass being >2 standard deviations below the mean of a young reference group.

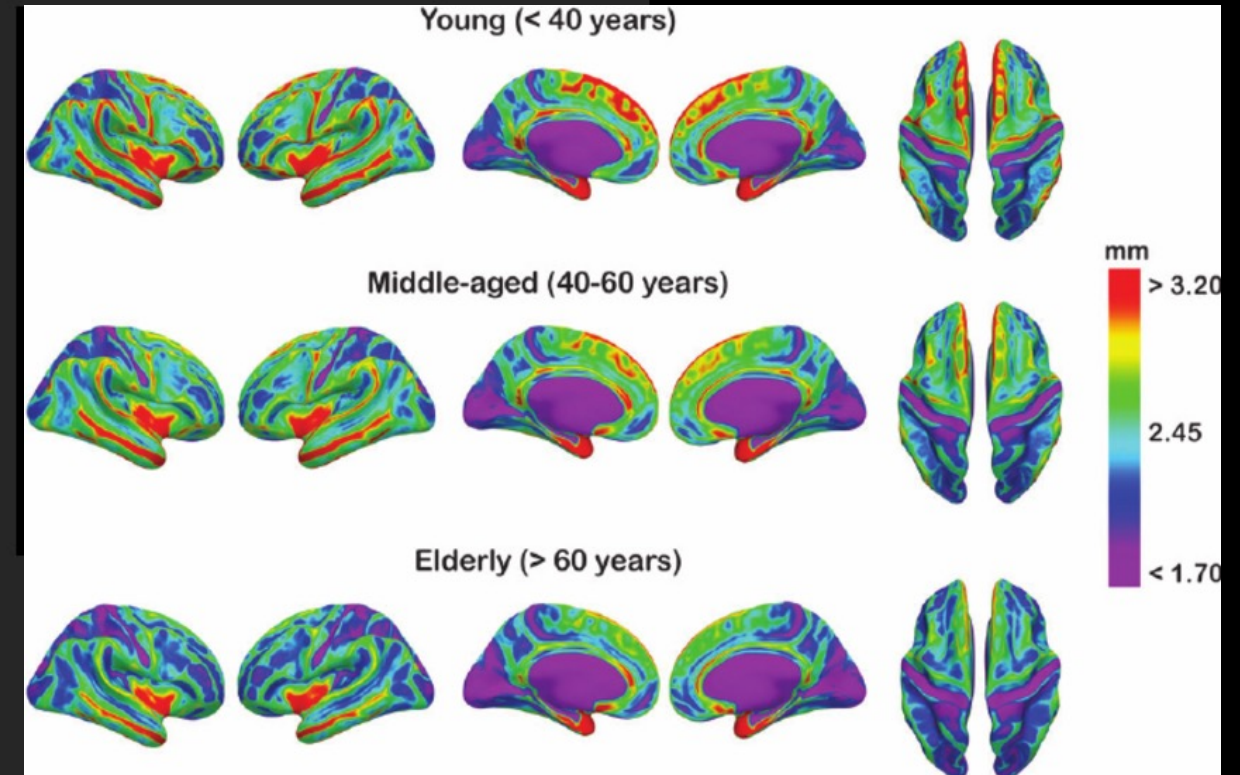


Brain Volume & Cortical Thickness

References values derived from normal aging population



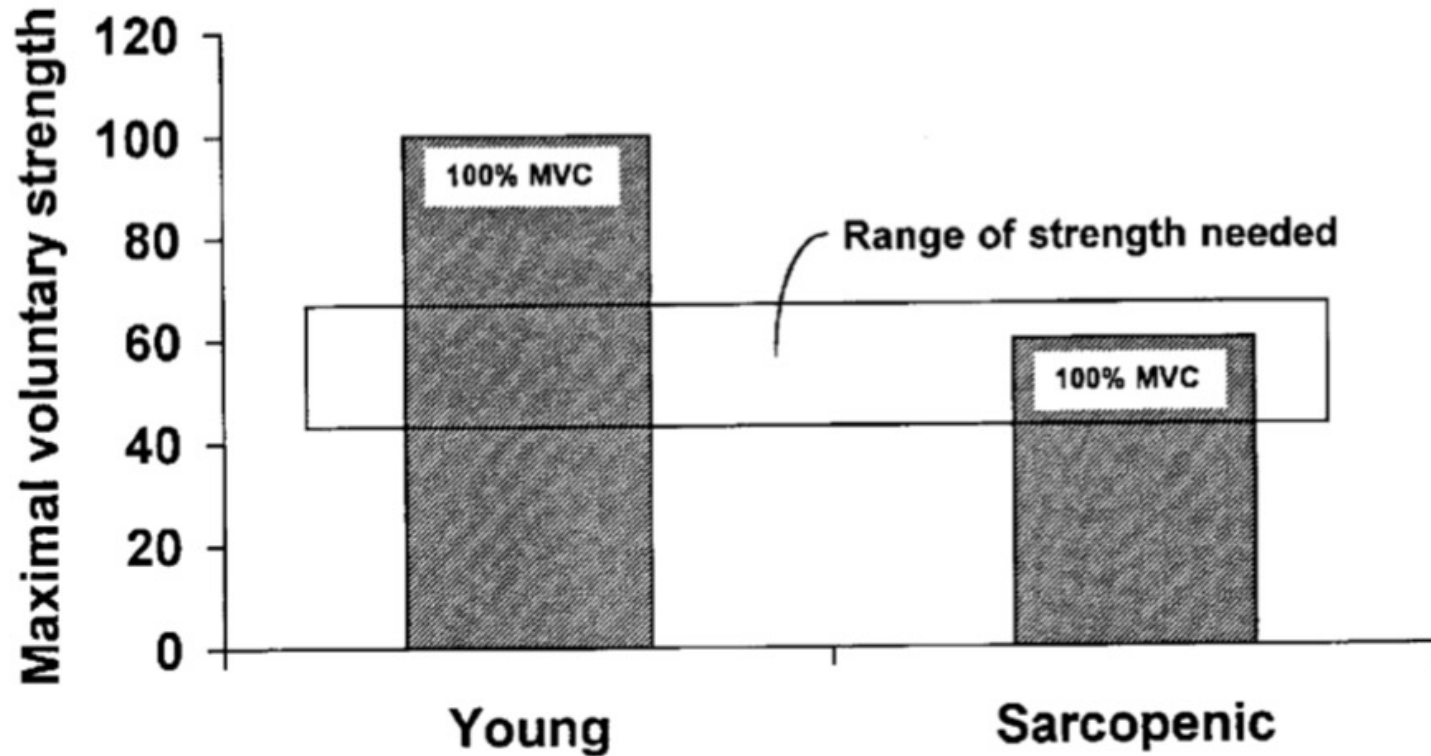
Ikram et al., Neurobiol of Aging 2008



Fjell et al. February 2009 Cerebral Cortex 19(9):2001-12

Loss of strength with ageing

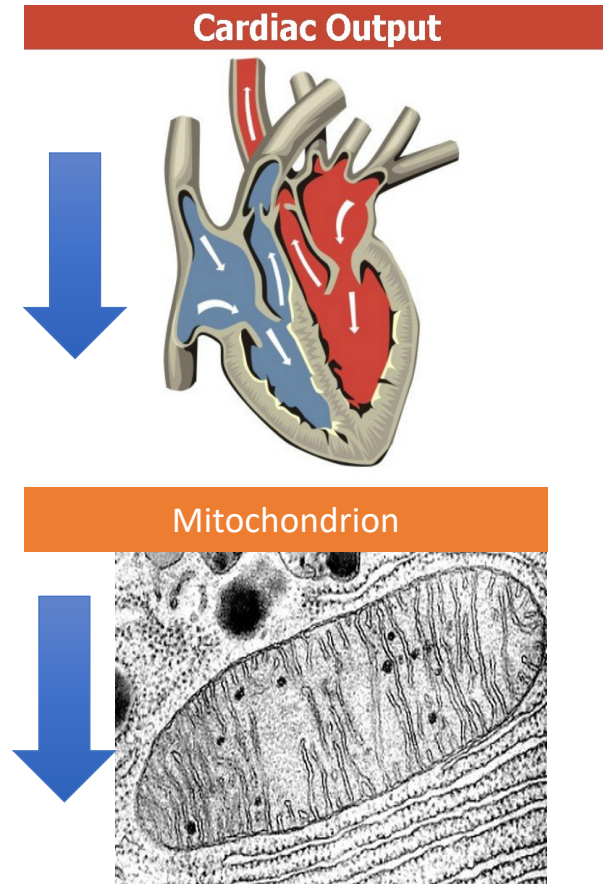
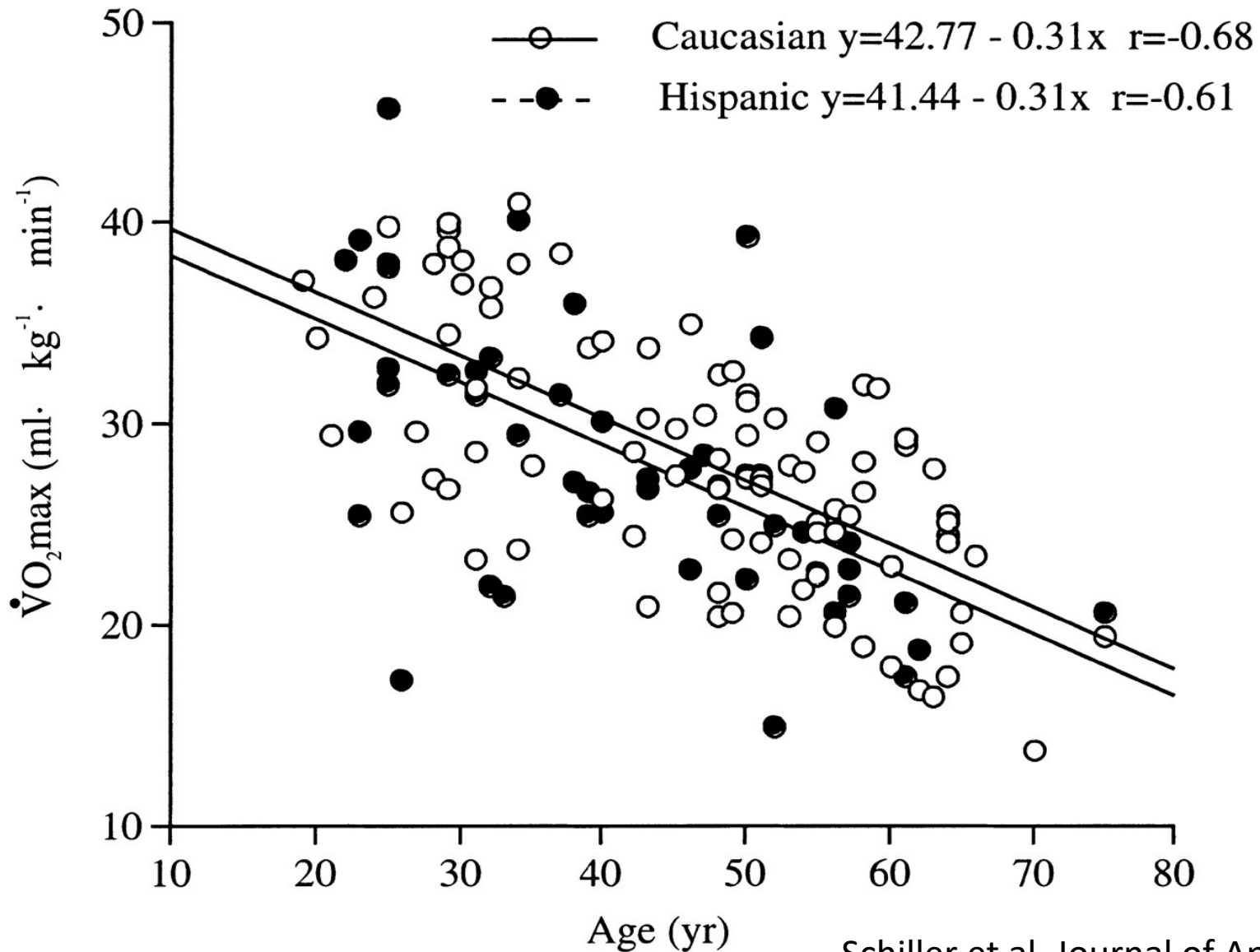
Frontera and Meredith, Exercise rehabilitation of the elderly. In: Rehabilitation of the Aging and Elderly Patient, ed. G Felsenthal, S Garrison & FU Steinberg, 1995, pp 35-45. Baltimore, MD: Williams & Wilkins.



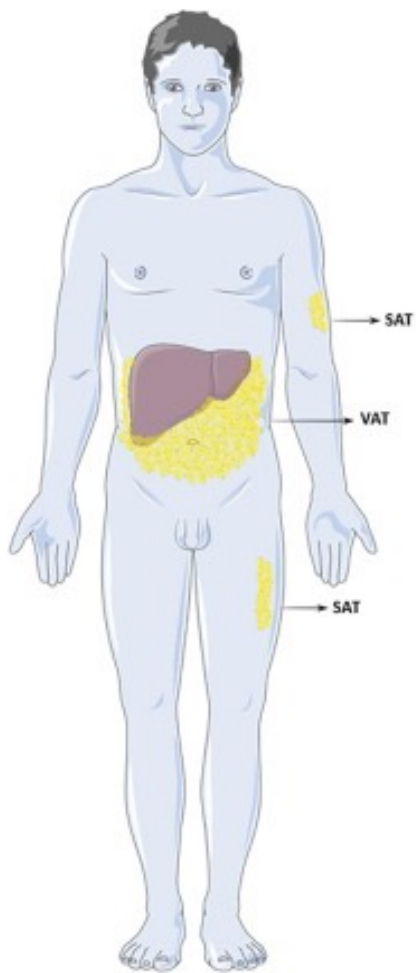
Effect of loss of strength on the ability to perform an action such as rising from a chair, for a young, healthy adult (left) and for a sarcopenic older person of the same body weight (right).

MVC = maximal voluntary contraction. Actions that exceed MVC cannot be performed. Baltimore, MD: Williams & Wilkins.

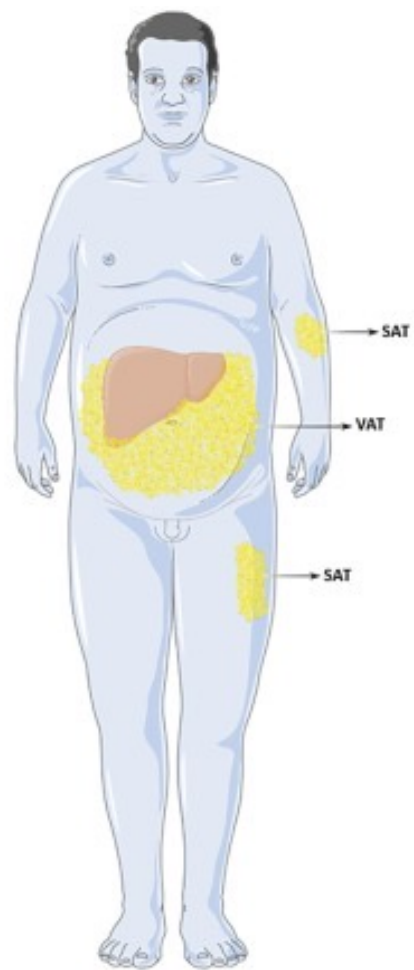
Loss of Cardiovascular and Muscle Quality



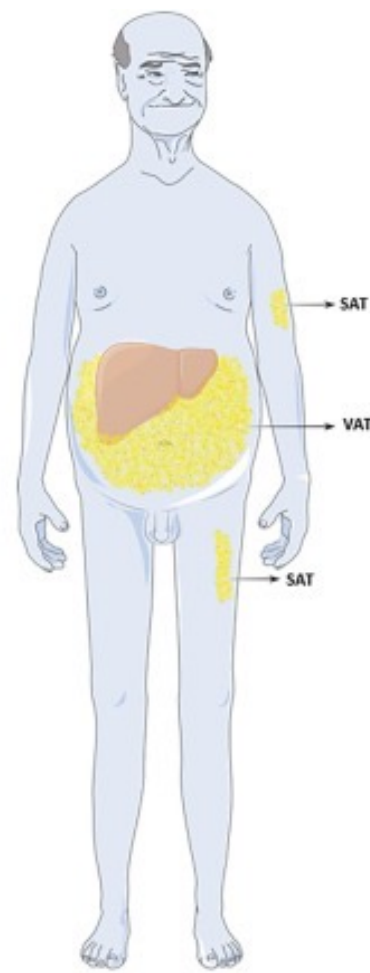
Increasing Adiposity



Young /Lean
status



Obesity



Aging

Physiological Ageing?

HOWEVER.....

most of these physiological features of ageing appear to be also major features of inactivity

You can make a young person physiologically age simply by making them inactive.



Question: Is age related physiological decline as much a function of inactivity as ageing phenomena per se?

FACTSHEET 5

Physical activity guidelines for

OLDER ADULTS (65+ YEARS)



50% of EU population are reportedly failing to meet physical activity guidelines

1. Older adults who participate in any amount of physical activity gain some health benefits, including maintenance of good physical and cognitive function. Some physical activity is better than none, and more physical activity provides greater health benefits.
2. Older adults should aim to be active daily. Over a week, activity should add up to at least 150 minutes (2½ hours) of moderate intensity activity in bouts of 10 minutes or more – one way to approach this is to do 30 minutes on at least 5 days a week.
3. For those who are already regularly active at moderate intensity, comparable benefits can be achieved through 75 minutes of vigorous intensity activity spread across the week or a combination of moderate and vigorous activity.
4. Older adults should also undertake physical activity to improve muscle strength on at least two days a week.
5. Older adults at risk of falls should incorporate physical activity to improve balance and co-ordination on at least two days a week.
6. All older adults should minimise the amount of time spent being sedentary (sitting) for extended periods.

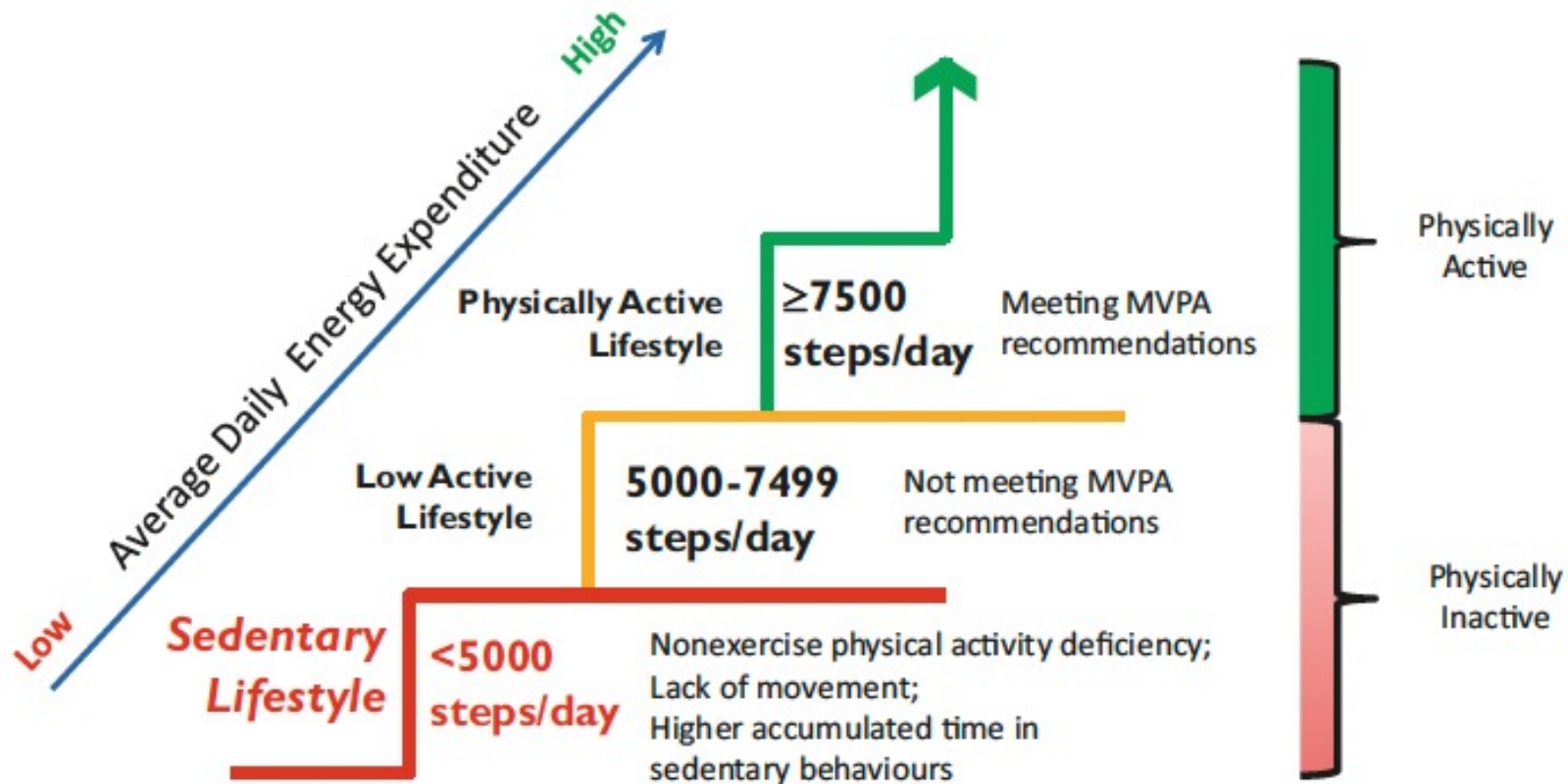
Appl. Physiol. Nutr. Metab. 38: 100–114 (2013)

[dx.doi.org/10.1139/apnm-2012-0235](https://doi.org/10.1139/apnm-2012-0235)

A step-defined sedentary lifestyle index: <5000 steps/day

Catrine Tudor-Locke, Cora L. Craig, John P. Thyfault, and John C. Spence

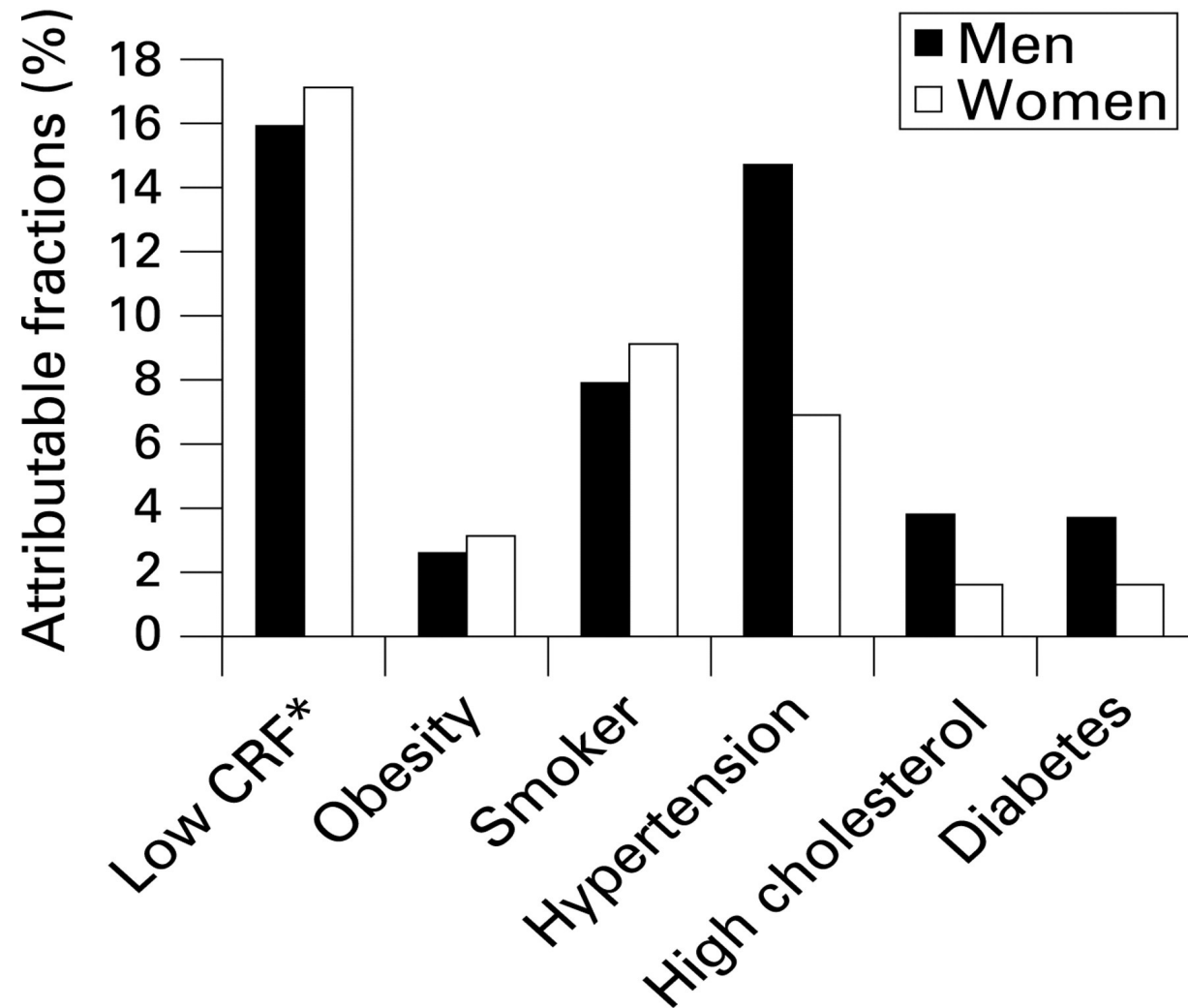
Fig. 1. Step-defined sedentary lifestyle index for adults. MVPA, moderate-to-vigorous physical activity.



Although few alternative values have been considered, the continued use of <5000 steps/day as a step-defined sedentary lifestyle index for adults is appropriate for researchers and practitioners and for communicating with the general public.

What's the significance of being inactive?

Blair Br J Sports Med 2009, 43: 1: 1-2



Attributable fractions (%) for all cause deaths in 40,842 (3333 deaths) men and 12,943 (491 deaths) women in the Aerobics Center Longitudinal Study.

The attributable fractions are adjusted for age and each other item in the figure.

*** = cardiorespiratory fitness determined by a maximal exercise test on a treadmill.**

Evidence from Public Health Epidemiology –

Meta-analysis | [Published: 14 August 2012](#)

Sedentary time in adults and the association with diabetes, cardiovascular disease and death: systematic review and meta-analysis

[E. G. Wilmot](#), [C. L. Edwardson](#), [F. A. Achana](#), [M. J. Davies](#), [T. Gorely](#), [L. J. Gray](#), [K. Khunti](#), [T. Yates](#) ✉ & [S. J. H. Biddle](#)

[Diabetologia](#) 55, 2895–2905 (2012) | [Cite this article](#)

Sedentary time is associated with an increased risk of diabetes, cardiovascular disease and cardiovascular and all-cause mortality; the strength of the association is most consistent for diabetes.

Amount of time spent in sedentary behaviors and cause-specific mortality in US adults

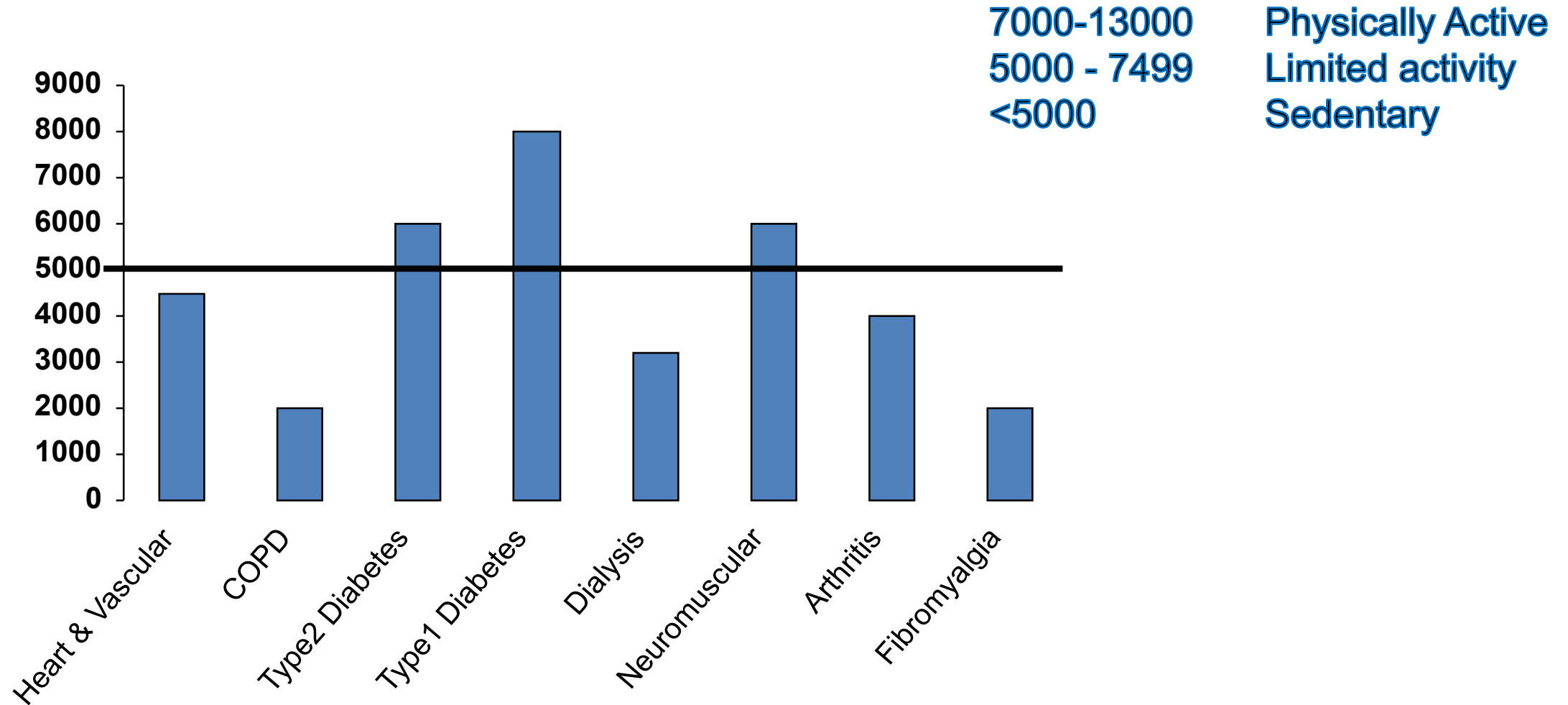
[Charles E Matthews](#) ✉, [Stephanie M George](#), [Steven C Moore](#), [Heather R Bowles](#), [Aaron Blair](#), [Yikyung Park](#), [Richard P Troiano](#), [Albert Hollenbeck](#), [Arthur Schatzkin](#)

The American Journal of Clinical Nutrition, Volume 95, Issue 2, February 2012, Pages 437–445,
<https://doi.org/10.3945/ajcn.111.019620>

Examined 240,819 adults (aged 50–71 y) who did not report any cancer, cardiovascular disease, or respiratory disease at baseline. Mortality was ascertained over 8.5 y. Time spent in sedentary behaviours was positively associated with mortality

Inactivity in chronic disease



Physical activity (daily step count) chronic disease



How far does the Grim Reaper walk?

ARTICLES | [VOLUME 7, ISSUE 3, E219-E228, MARCH 01, 2022](#)

Daily steps and all-cause mortality: a meta-analysis of 15 international cohorts

[Amanda E Paluch, PhD](#)   • [Shivangi Bajpai, MS](#) • [Prof David R Bassett, PhD](#) • [Prof Mercedes R Carnethon, PhD](#) • [Prof Ulf Ekelund, PhD](#) • [Prof Kelly R Evenson, PhD](#) • et al. [Show all authors](#)

[Open Access](#) • Published: March, 2022 • DOI: [https://doi.org/10.1016/S2468-2667\(21\)00302-9](https://doi.org/10.1016/S2468-2667(21)00302-9) •

Fifteen studies, of which seven were published and eight were unpublished, with study start dates between 1999 and 2018. The total sample included 47,471 adults, among whom there were 3013 deaths (10.1 per 1000 participant-years) over a median follow-up of 7.1 years ([IQR 4.3–9.9]; total sum of follow-up across studies was 297,837 person-years).

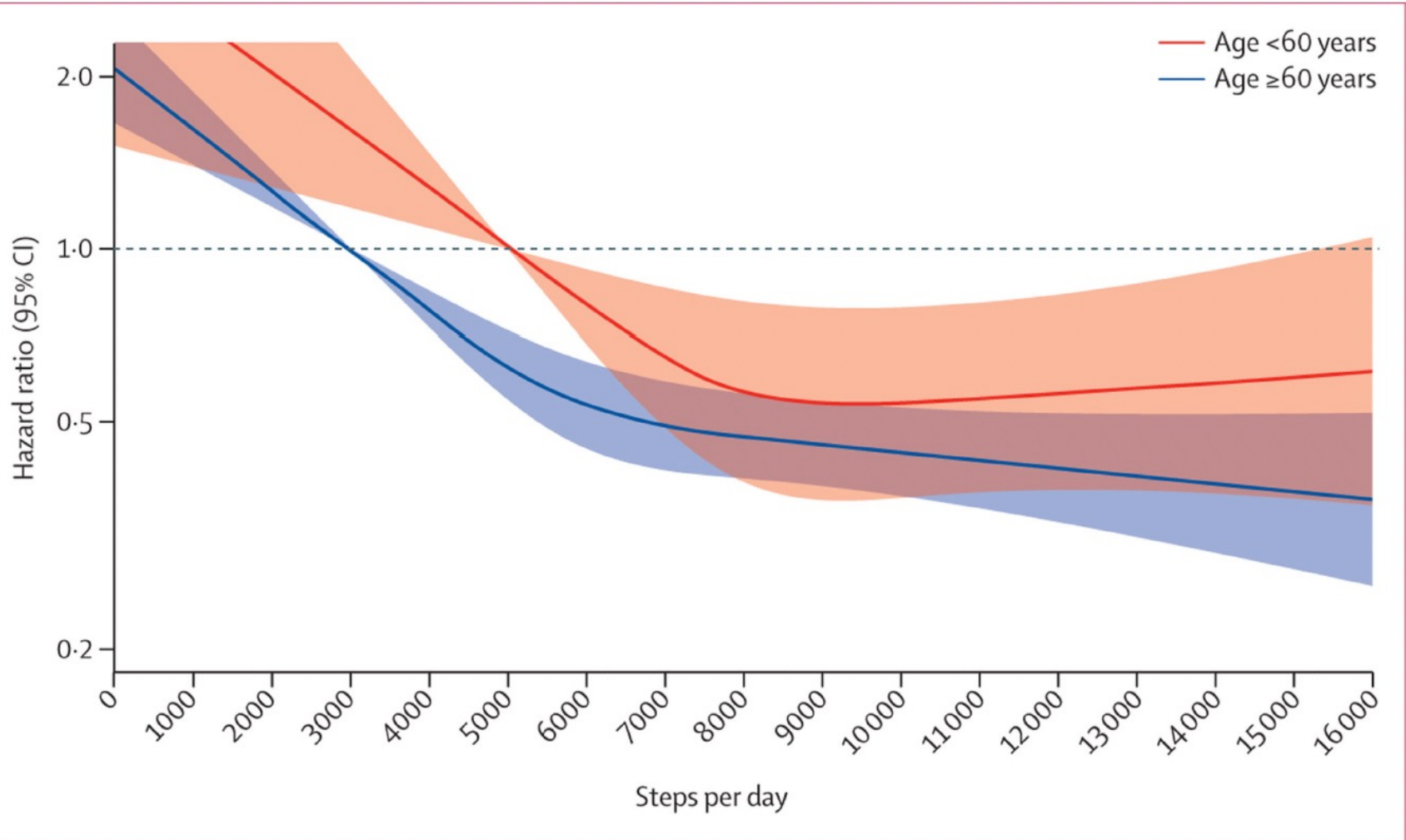


Figure 3: Dose-response association between steps per day and all-cause mortality, by age group
 Thick lines indicate hazard ratio estimates, with shaded areas showing 95% CIs. Reference set at the median of the medians in the lowest quartile group (age ≥ 60 years = 3000 steps per day and < 60 years = 5000 steps per day). Model is adjusted for age, accelerometer wear time, race and ethnicity (if applicable), sex (if applicable), education or income, body-mass index, and study-specific variables for lifestyle, chronic conditions or risk factors, and general health status. $p_{\text{interaction}}=0.012$ by age group. 14 studies included in spline analysis, excluded Baltimore Longitudinal Study of Aging.¹⁹ The y-axis is on a log scale.

How far does the Grim Reaper walk?

Age and step count relationship with all-cause mortality

Progressively decreasing risk of mortality among **adults aged 60 years and older with increasing number of steps per day until 6000–8000 steps per day** and among **adults younger than 60 years until 8000–10 000 steps per day.**

Conclusion

Taking more steps per day was associated with a progressively lower risk of all-cause mortality, up to a level that varied by age.



How fast does the Grim Reaper walk?

1705 men aged 70 or more participating in CHAMP (Concord Health and Ageing in Men Project) followed for a mean of 59.3 months.

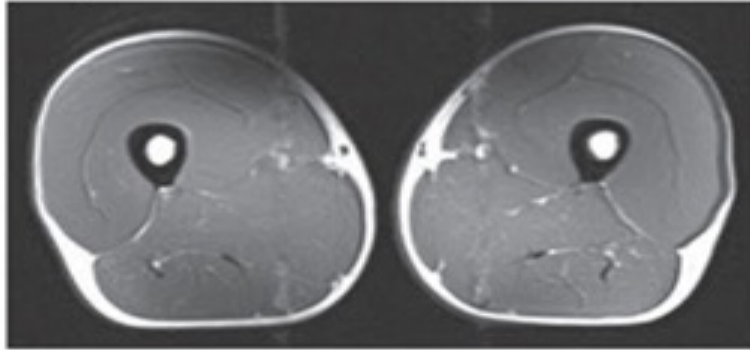
The mean walking speed was 0.88 (range 0.15-1.60) m/s.

Survival analysis showed that **older men who walked faster than 0.82 m/s (about 2 miles per hour) were 1.23 times less likely to die (95% confidence interval 1.10 to 1.37) than those who walked slower.**

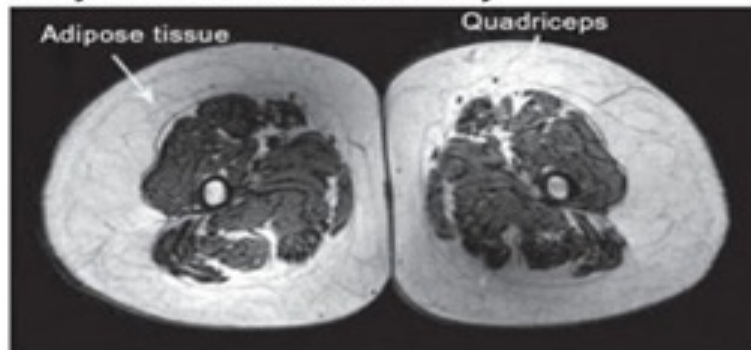
When a walking speed of 1.36 m/s (about 3 miles per hour) or greater was achieved risk of death was almost eliminated.

Wroblewski, A., et. al. Chronic Exercise Preserves Lean Muscle Mass in Masters Athletes. The Physician and Sports medicine. 39, 2011.

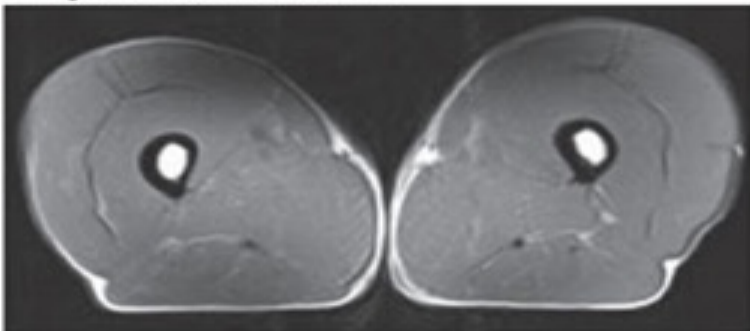
40 year old triathlete



74 year old and sedentary



74 year old triathlete:



Physical inactivity is likely to be the primary driver of poor health span and chronic disease progression.



But how much physical activity is needed? Epidemiological evidence suggests:

The Grim Reaper's maximum daily walking distance is 6,000 to 8,000 steps per day if you are an adult over 60 years of age.

The Grim Reaper's maximum walking speed is 1.36 m/s (about 3 miles per hour) a person over 70 years of age.