



# **Muskelmassa och fysisk funktion vid åldrande:**

## **Effekterna av fysisk aktivitet och hälsosam kost**

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Demens  
Rörelseförmåga

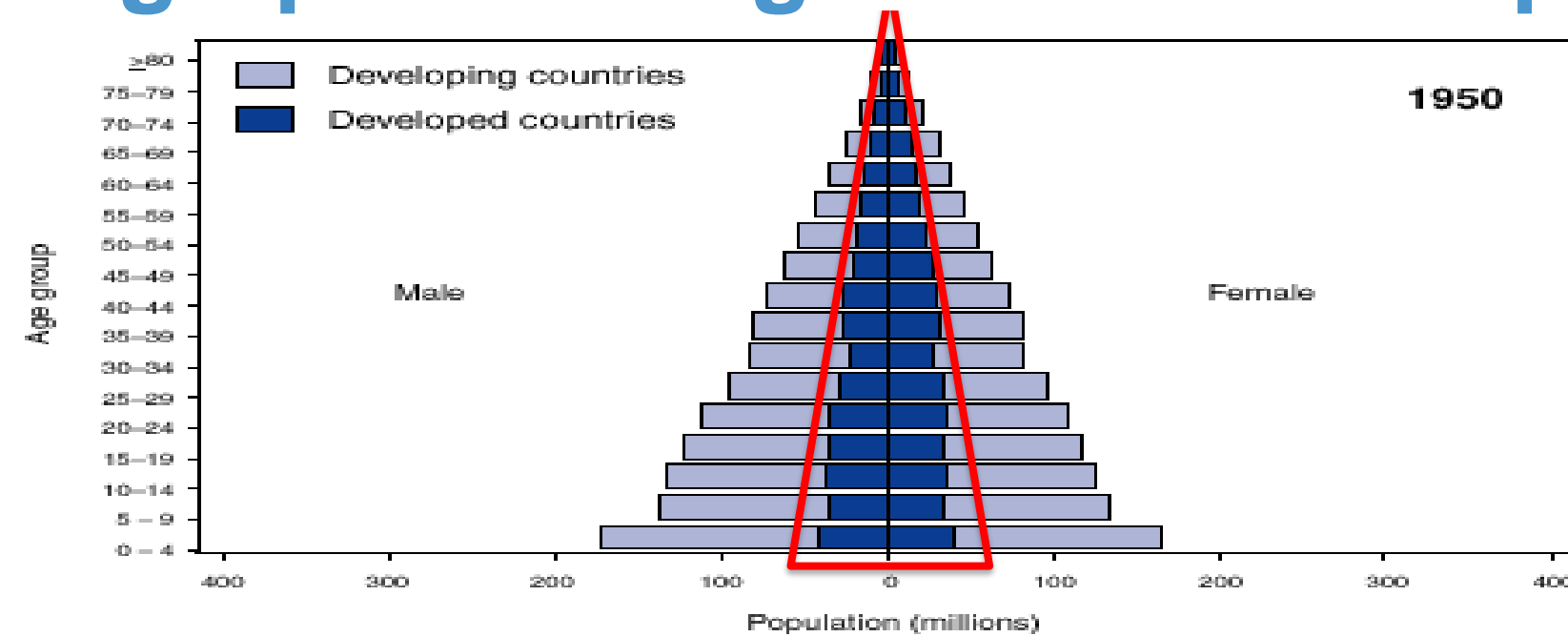




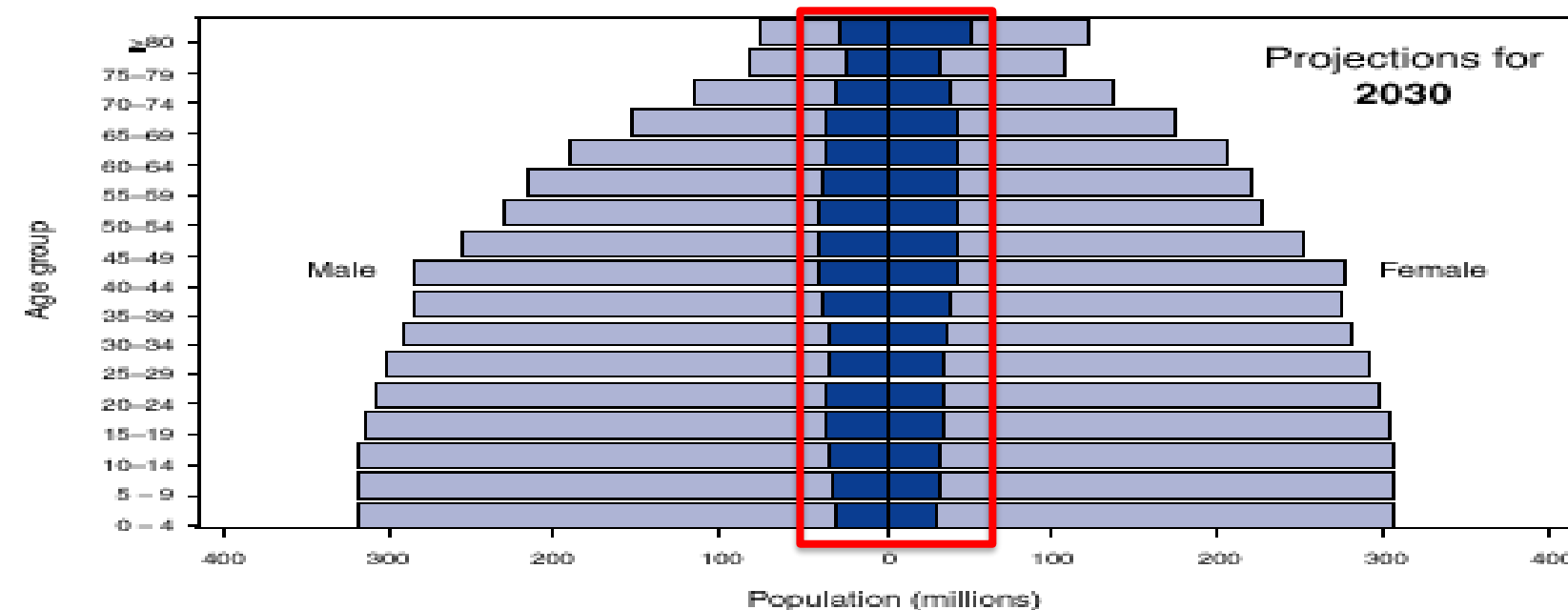
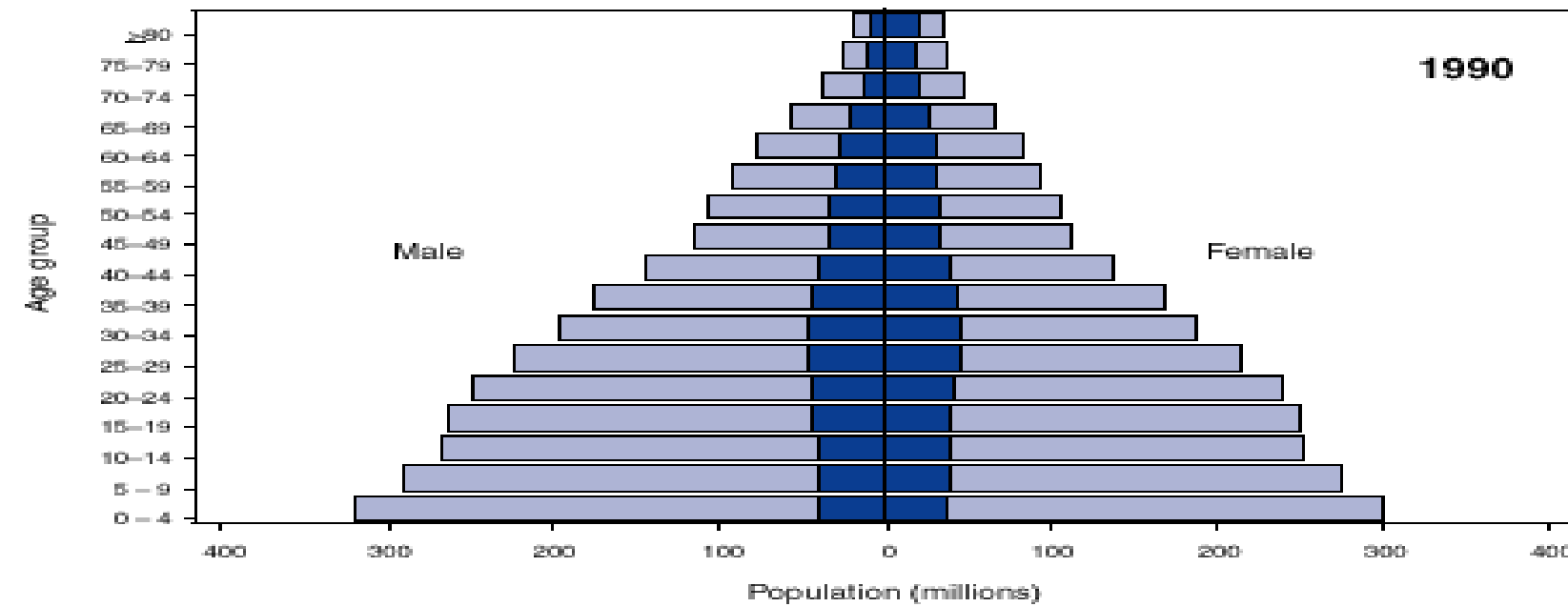


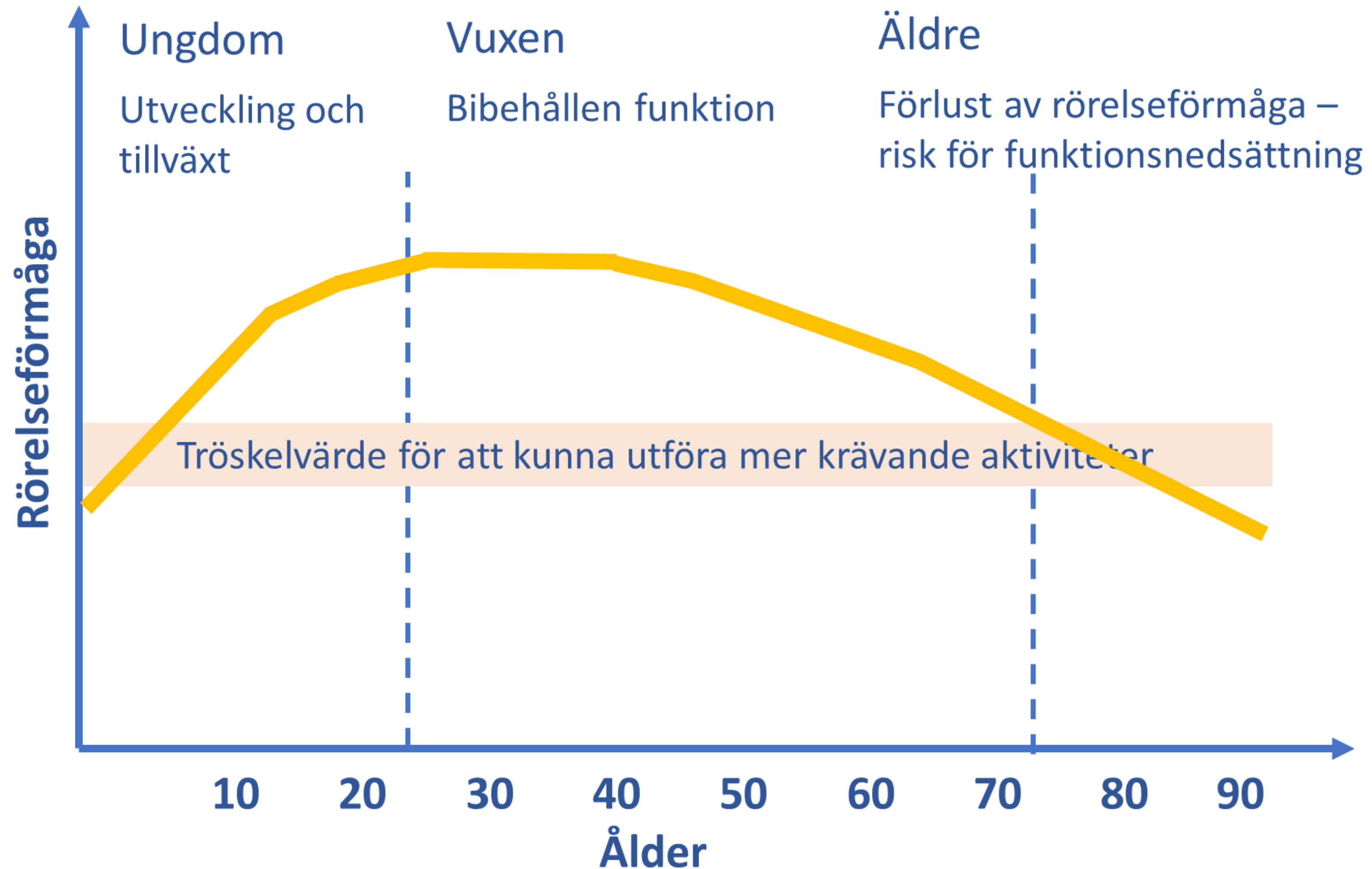


# Major demographic change is the developed world



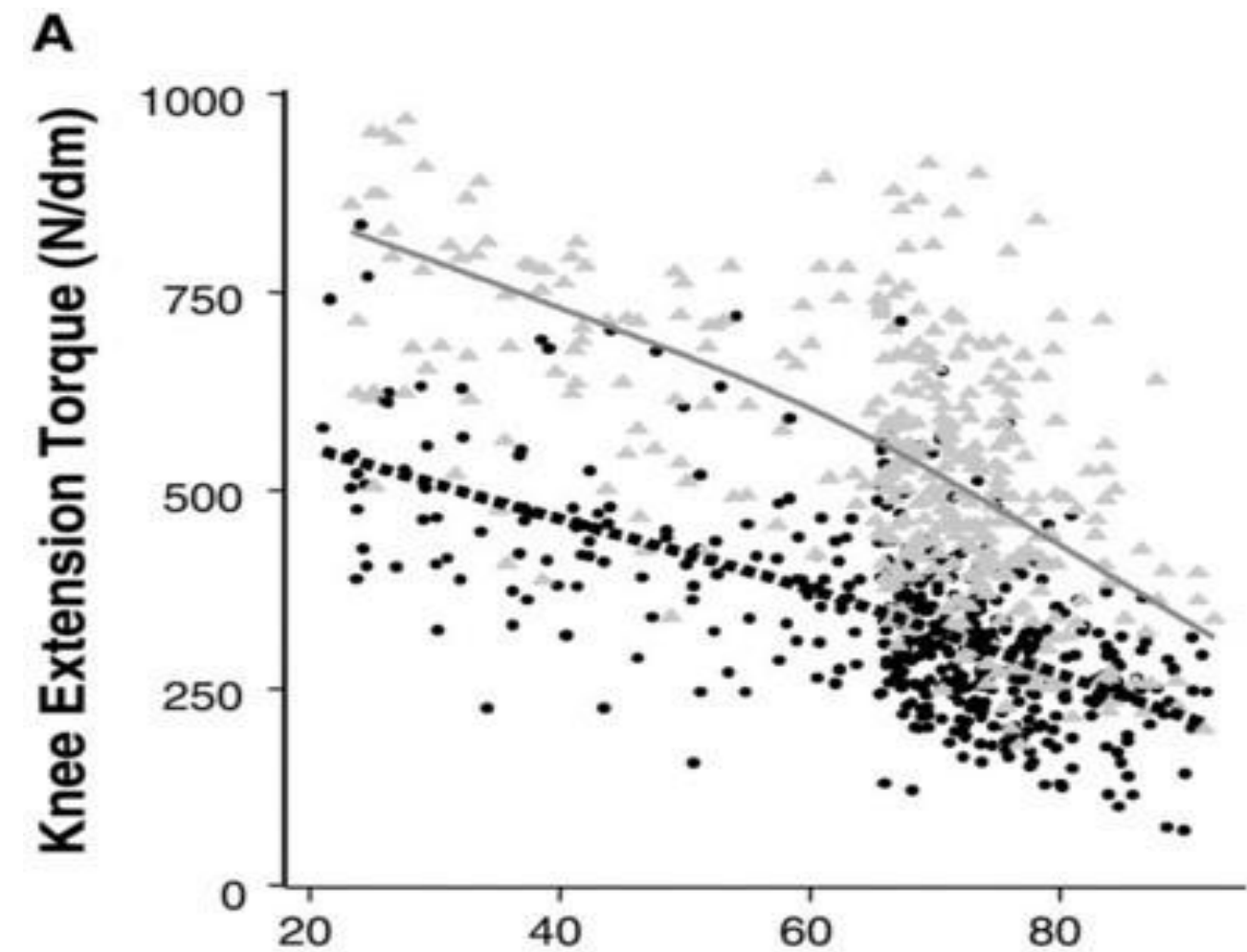
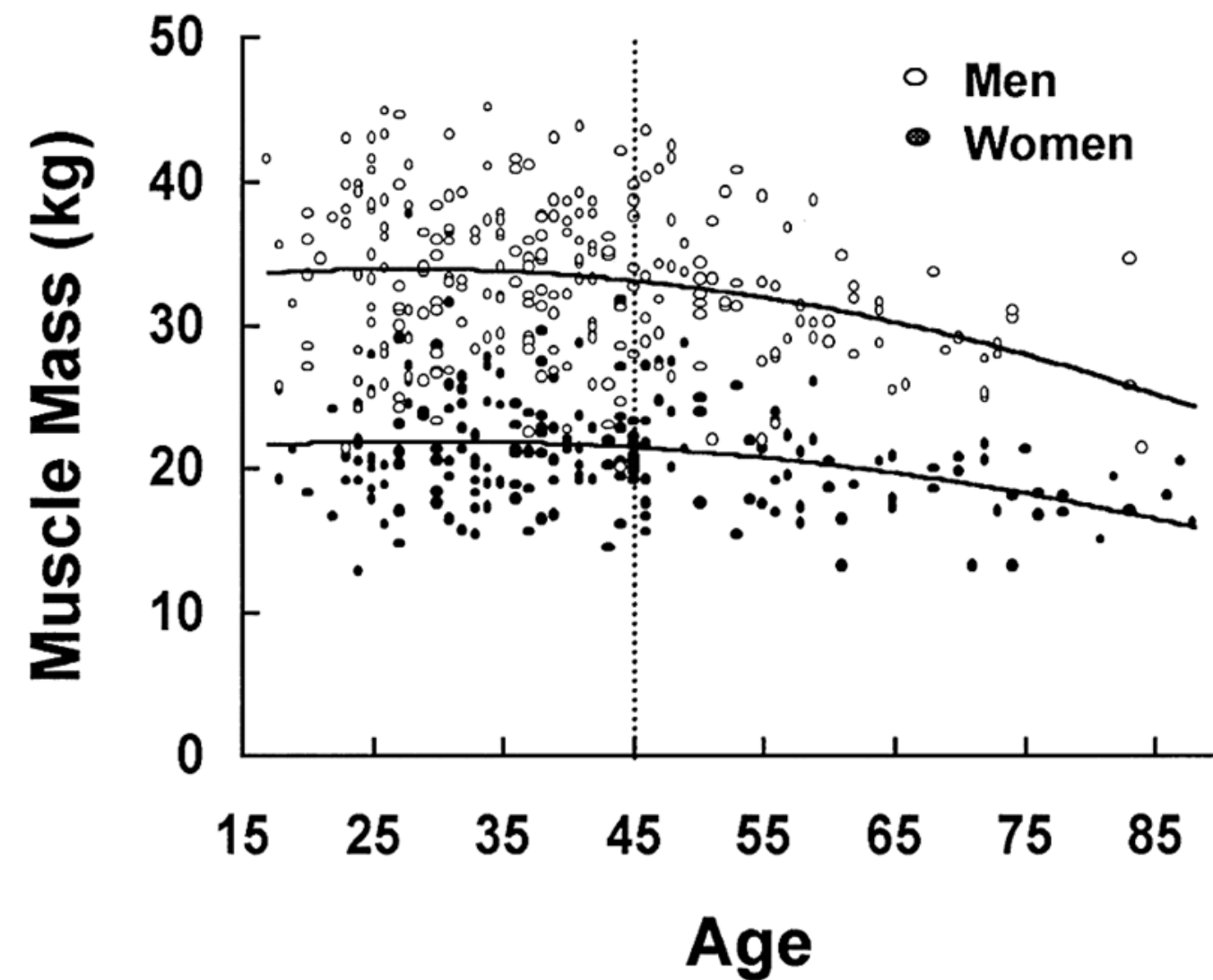
Half of all the children in countries such as Sweden, born in the year 2000 or later will be 100 year or older!!

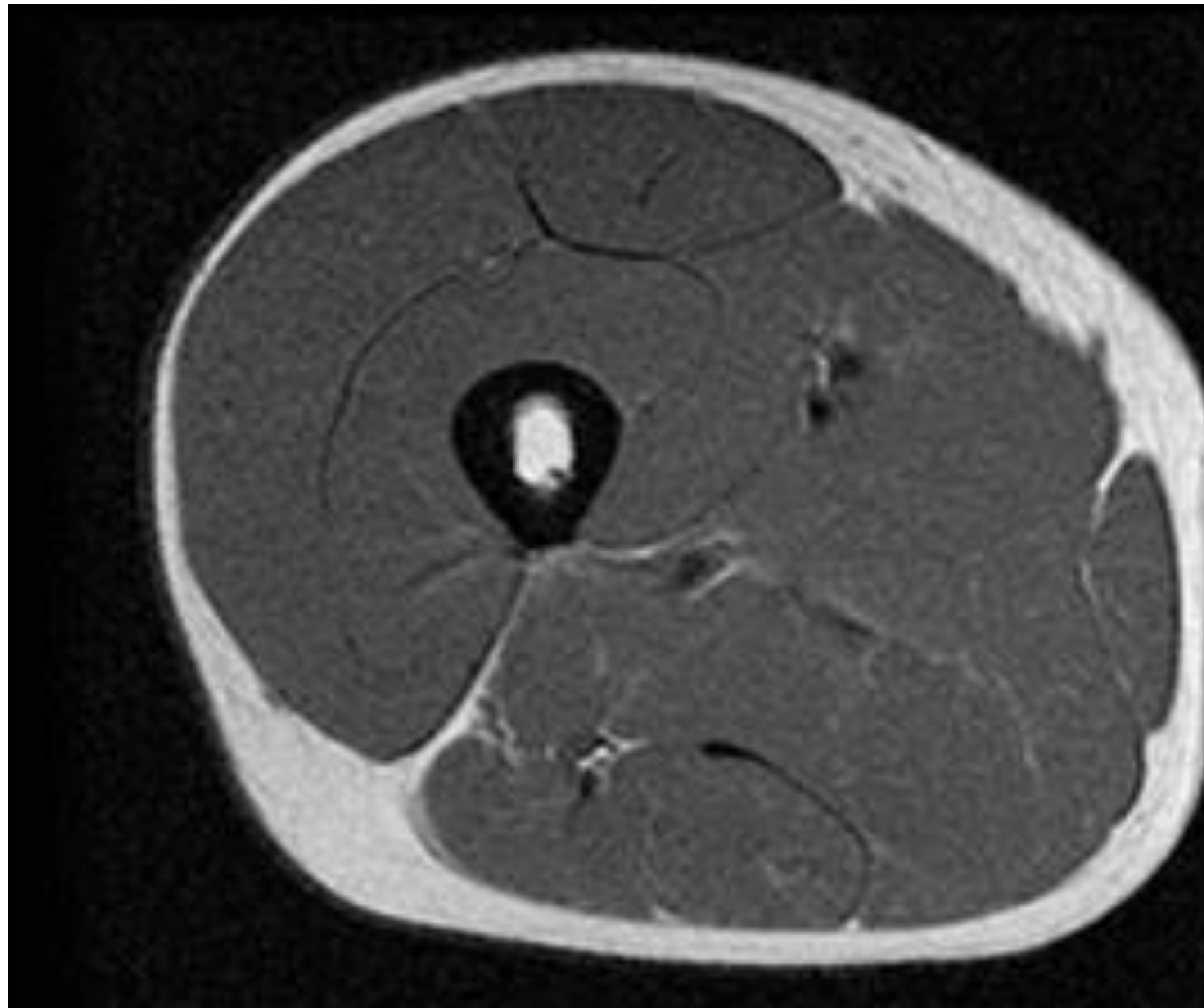




# Ageing and physical function

## Muscle mass and muscle strength



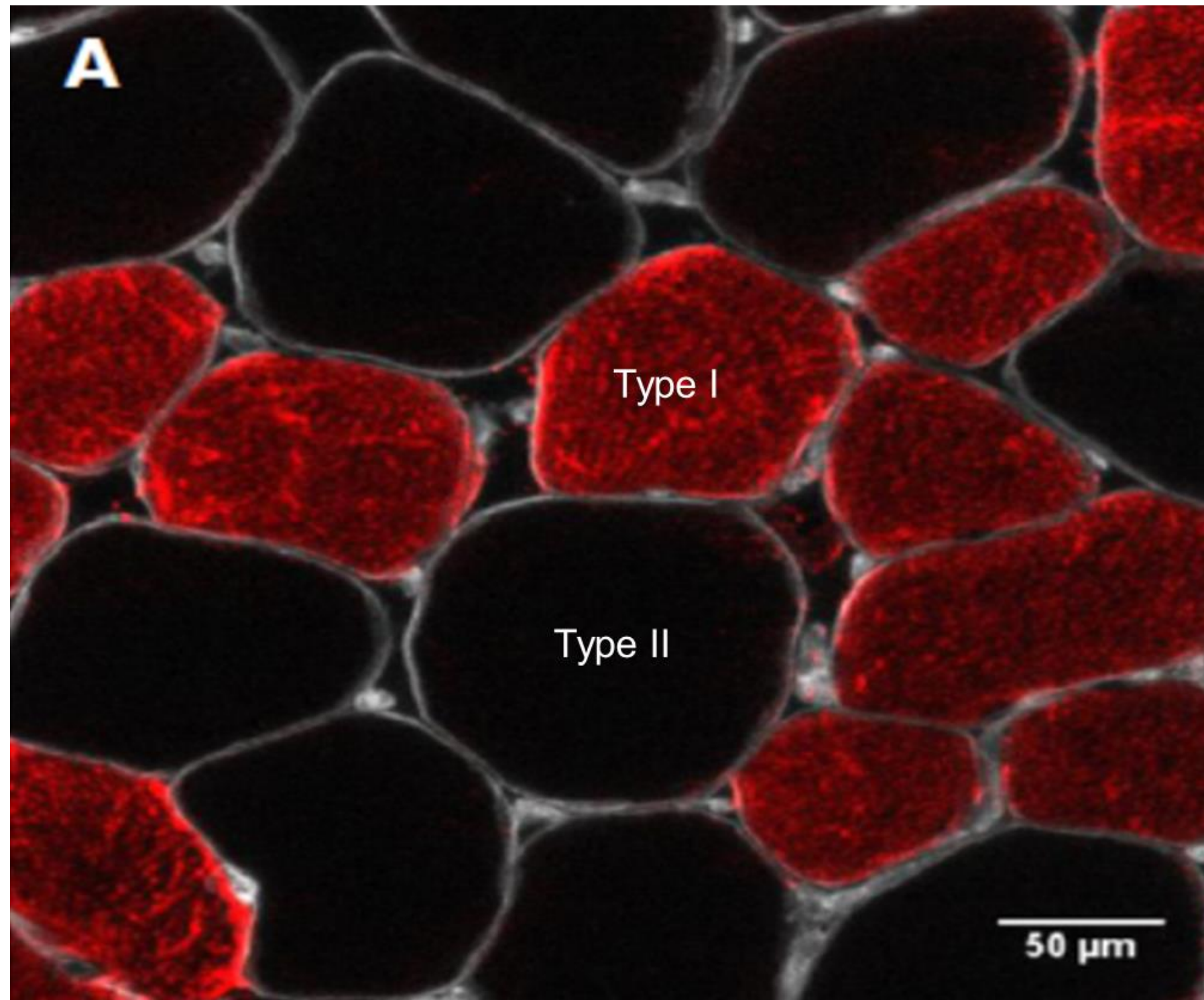


**Sedentary young individual (25 yrs.)**

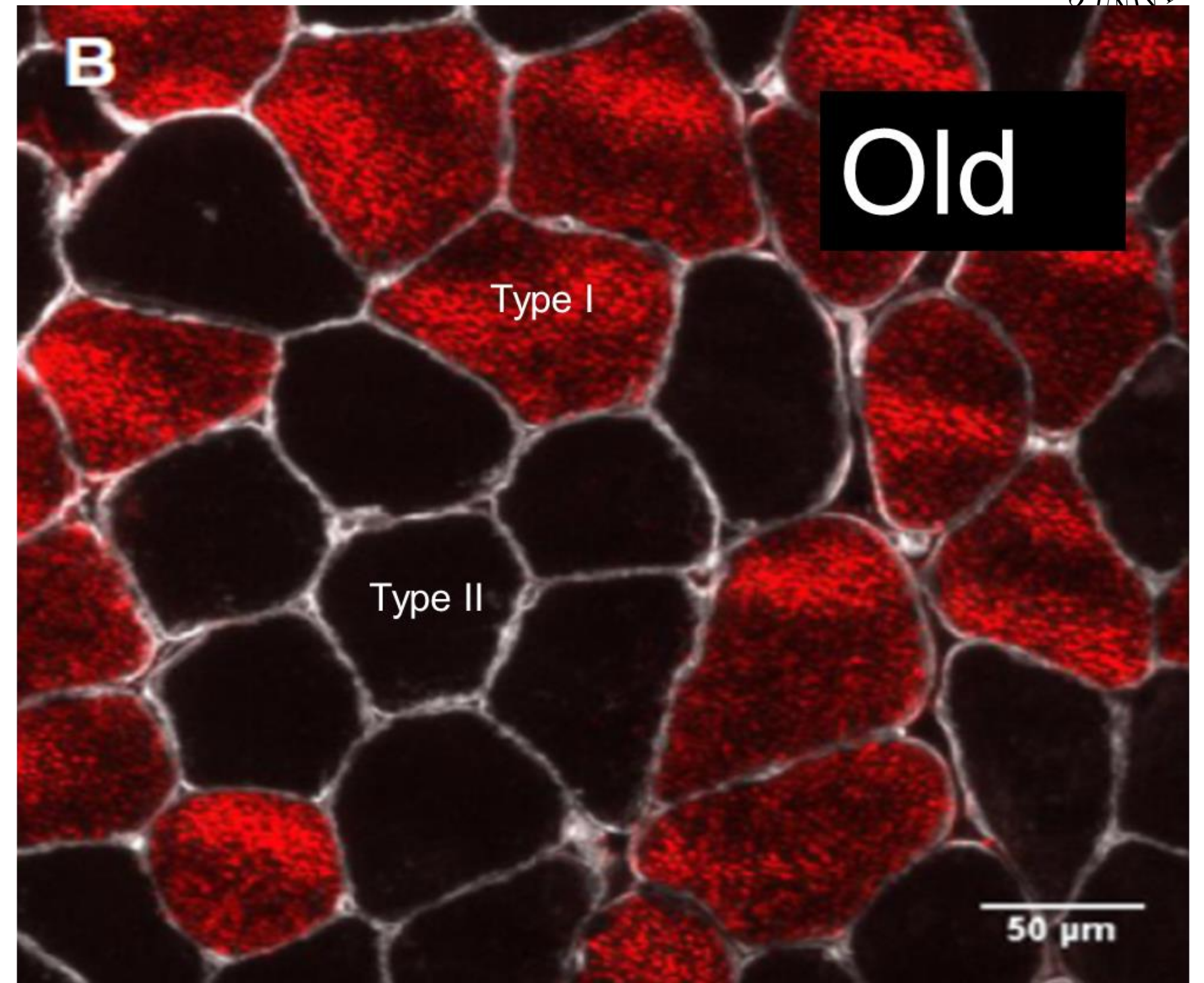


**Sedentary old individual (65 yrs.)**





25 yr

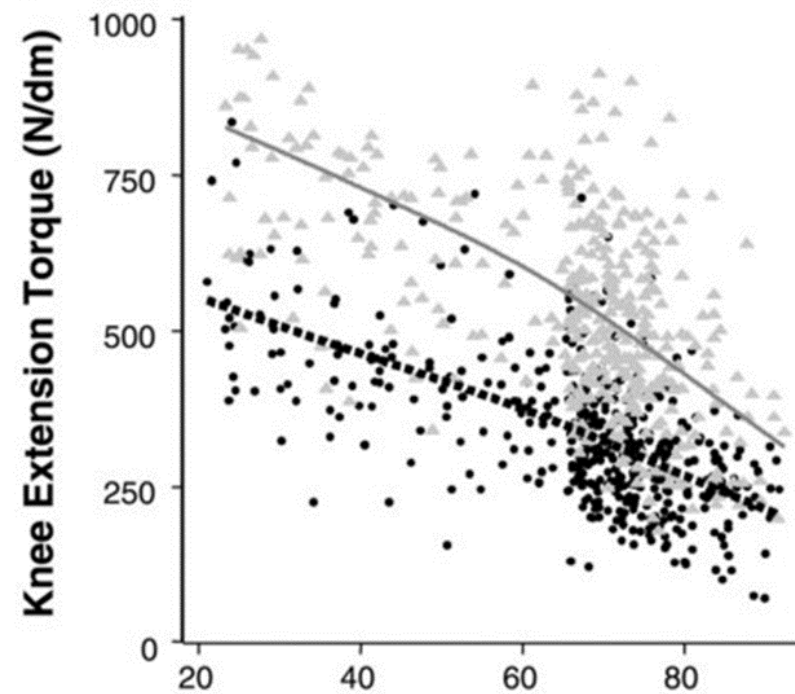


65 yr

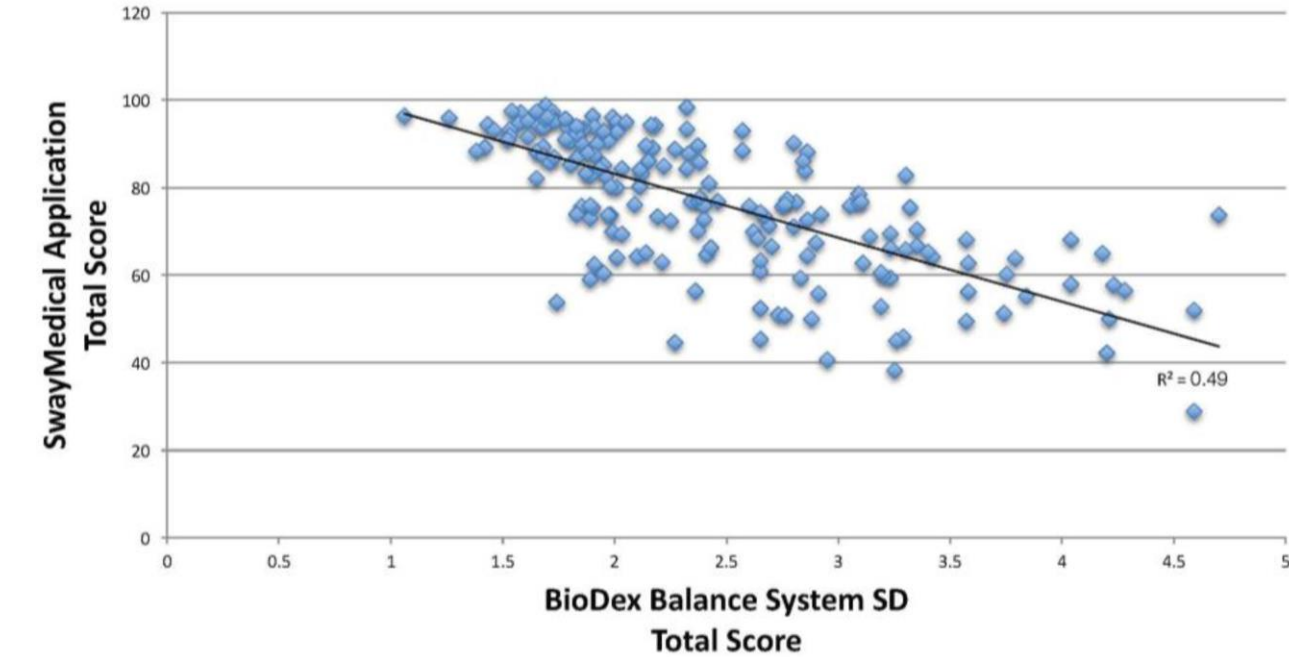


# Reduced physical capacity – reduced physical function

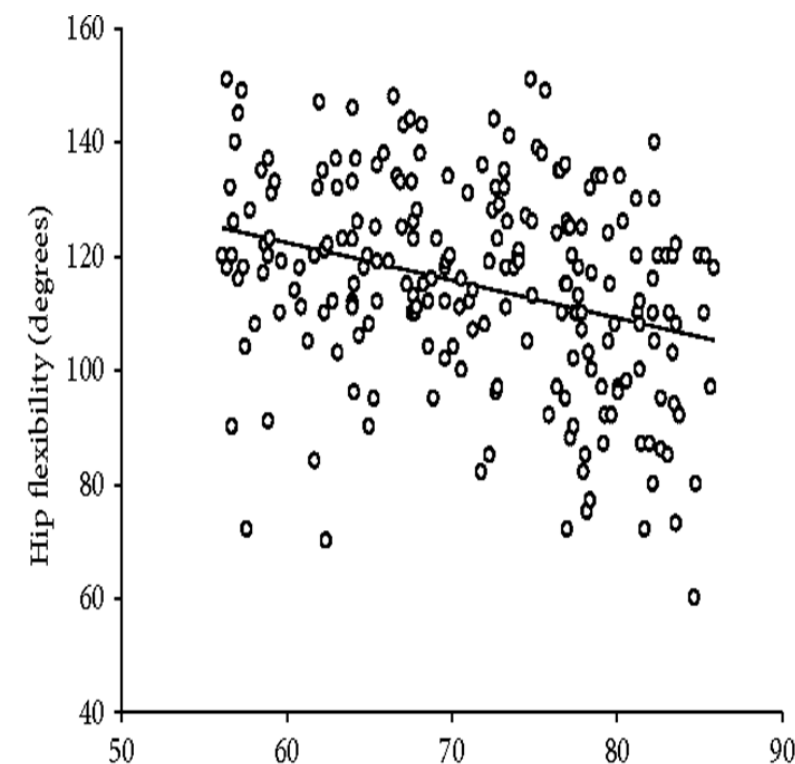
## Muscle strenght



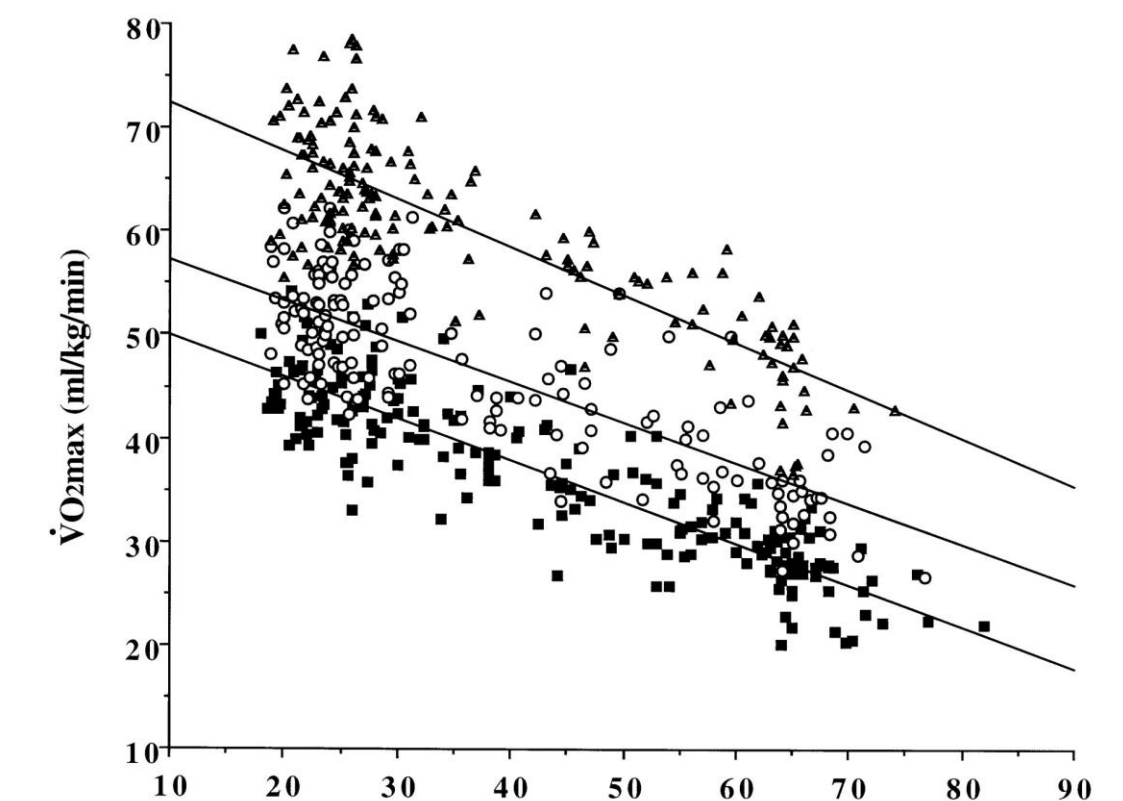
## Balance



## Flexibility



## Aerobic capacity



Proctor et al., 2005

Stathokostas et al., 2013

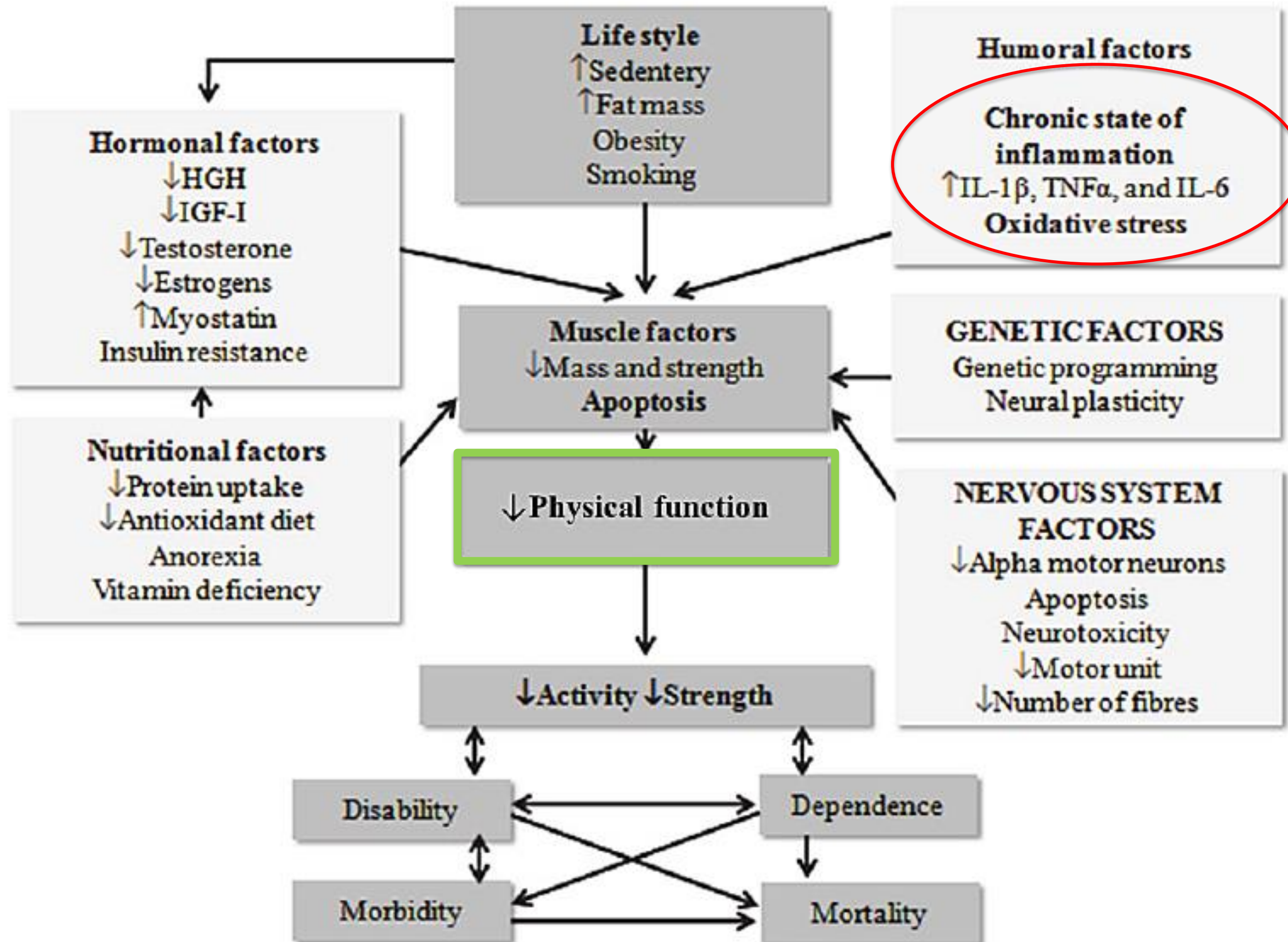
Wilson et al., 2010

Hawkins et al., 2002



- These deteriorations take place also among healthy and physical active elderly
- Older women are especially vulnerable given a general lower physical function and a higher prevalence of disability compared to men





# How do we maintained physical function and thereby promote a healthy aging?

Habitually physical  
activity (PA) level

Resistance training

Diet





# Research gaps

- Physical activity (PA) have been suggested to have important influences on physical function (PF) and muscle mass (MM) at old age.
- However:

It is unknown whether the influence of PA on PF is due to present or past PA behaviours

It is also debated if sedentary behaviour has an detrimental effect on PF regardless of PA behaviour

Whether type of occupation (sedentary vs. physical active ) moderate the association between past PA and PF/MM at old age is unclear

# Study I: Present PA

Healthy older women (65-70 yrs.)

Present PA behaviour: Accelerometers

Past PA behaviour: Historical Adulthood Physical Activity Questionnaire

- Exercise habits
- Sufficient validity to rank individuals according to their past PA behavior when compared to objective assessed PA (Besson et al., 2010)

Body composition inc muscle mass (DEXA)

Physical function

Aerobic capacity – 6 minute walk test

Explosive leg strength – Squat jump

Balance – Single-leg-stance

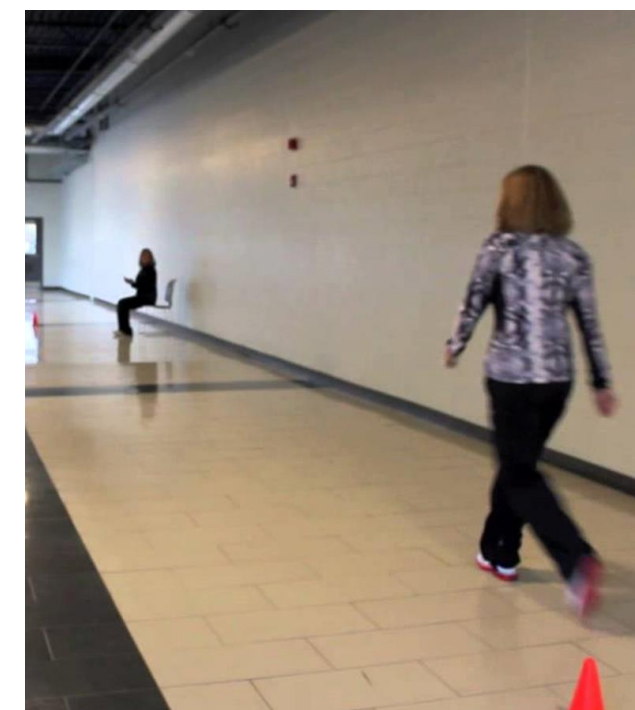
Calculated z-values for each test: aggregated functional z-score

ORIGINAL ARTICLE

WILEY

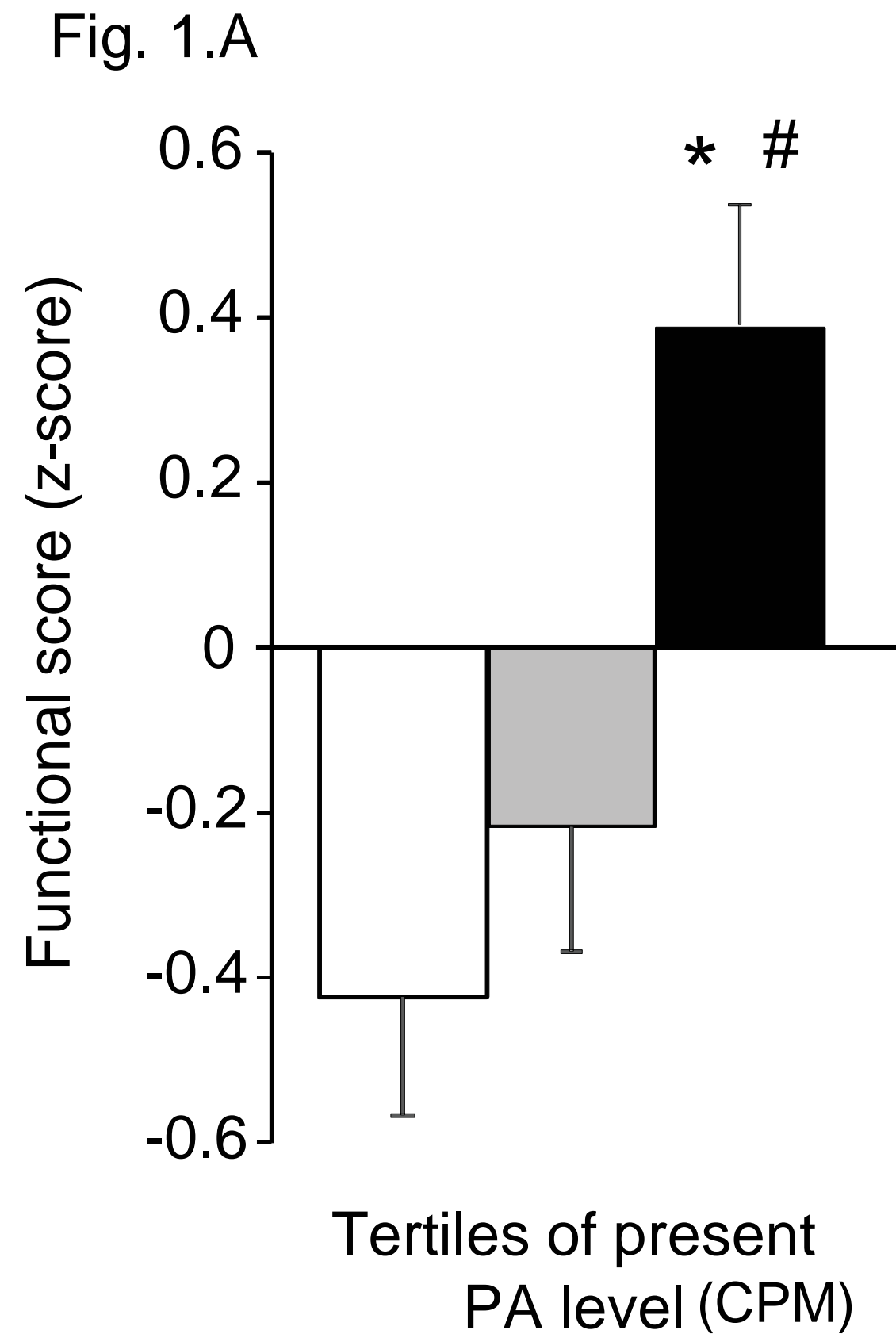
## Physical function in older adults: Impacts of past and present physical activity behaviors

Peter Edholm | Andreas Nilsson  | Fawzi Kadi



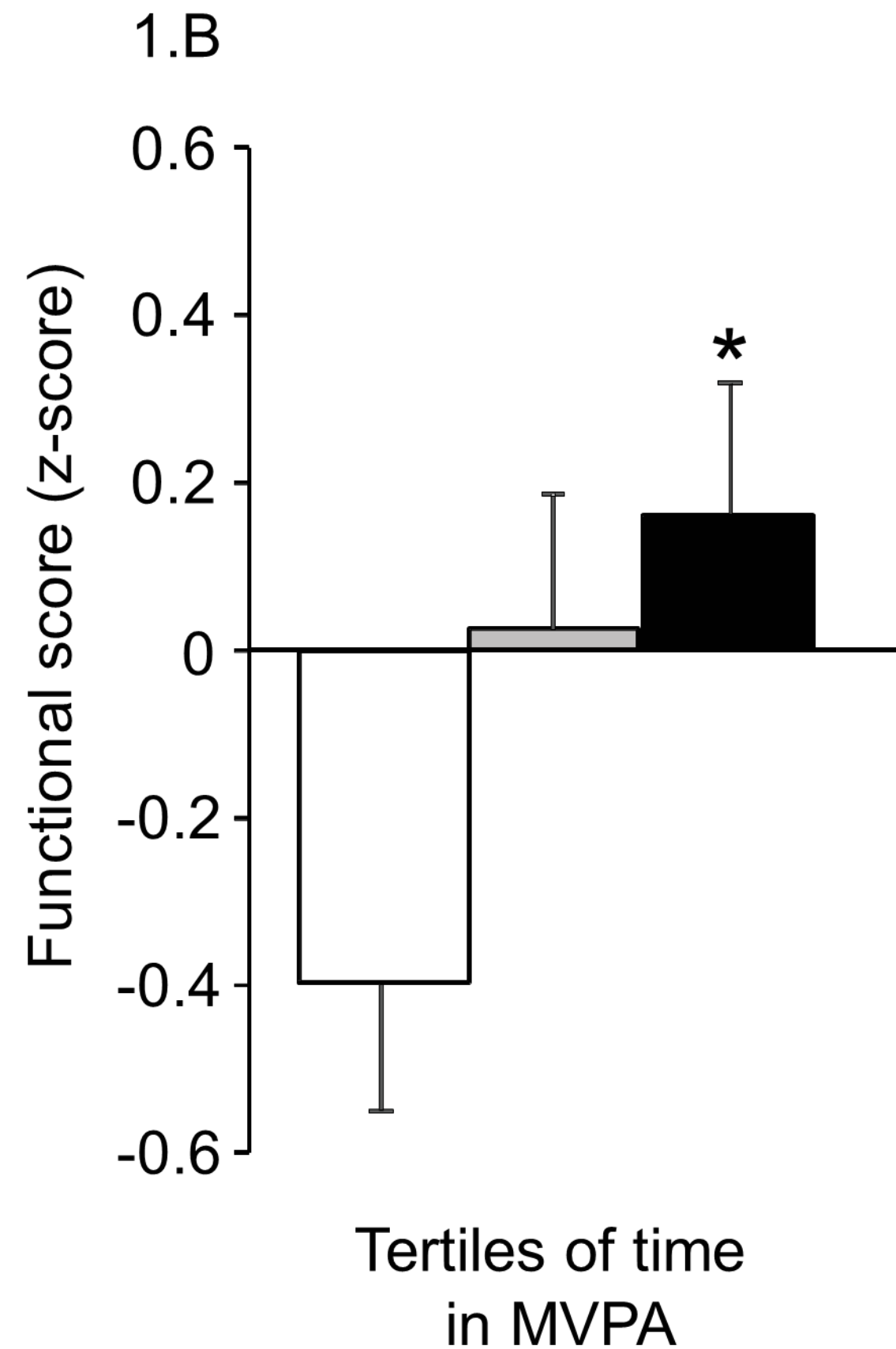


# Present PA behaviour



Remained after adjustment  
of past PA behaviour

# Present PA behaviour

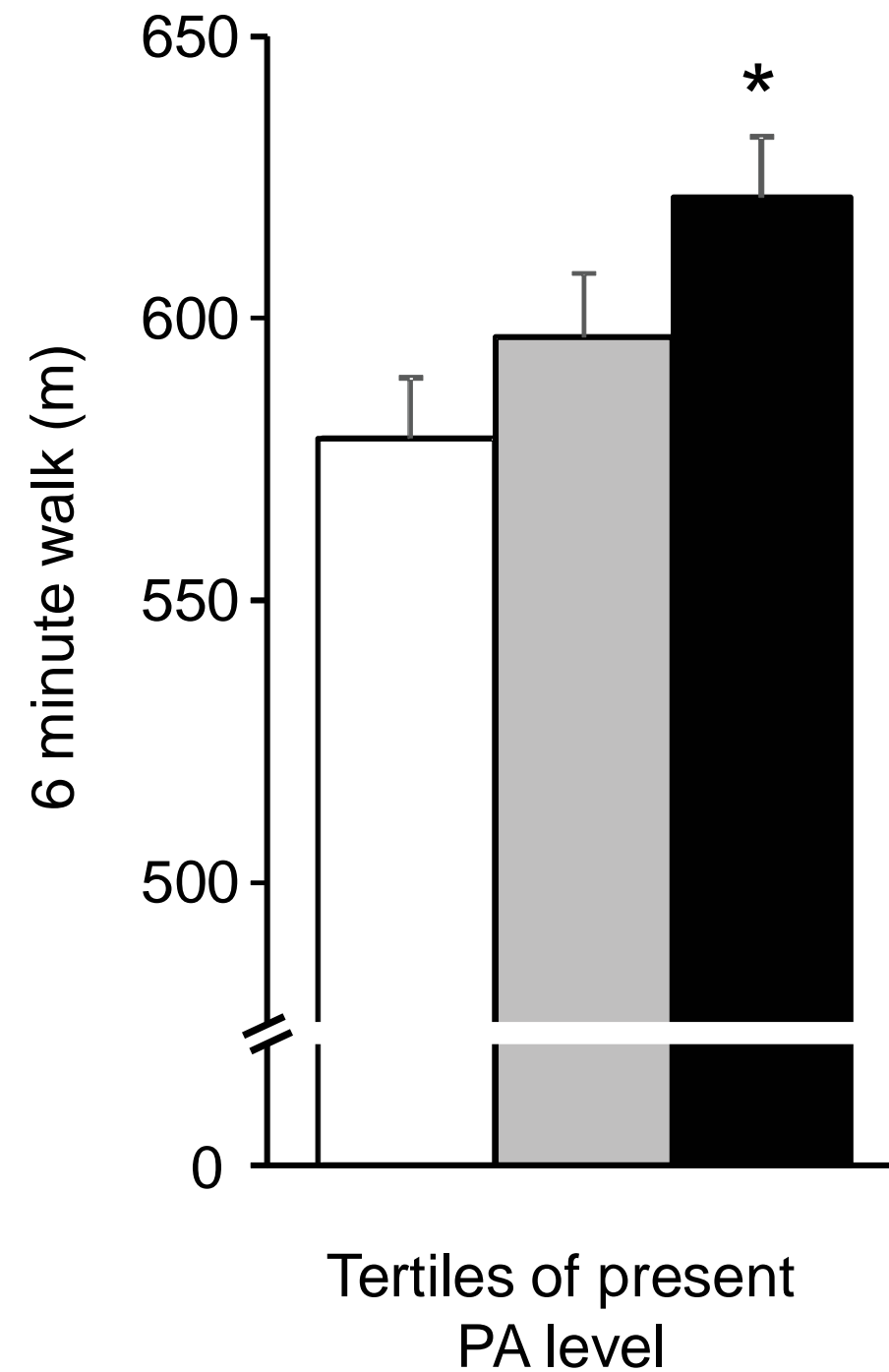


No such effect was seen for time in light PA or sedentary behaviour

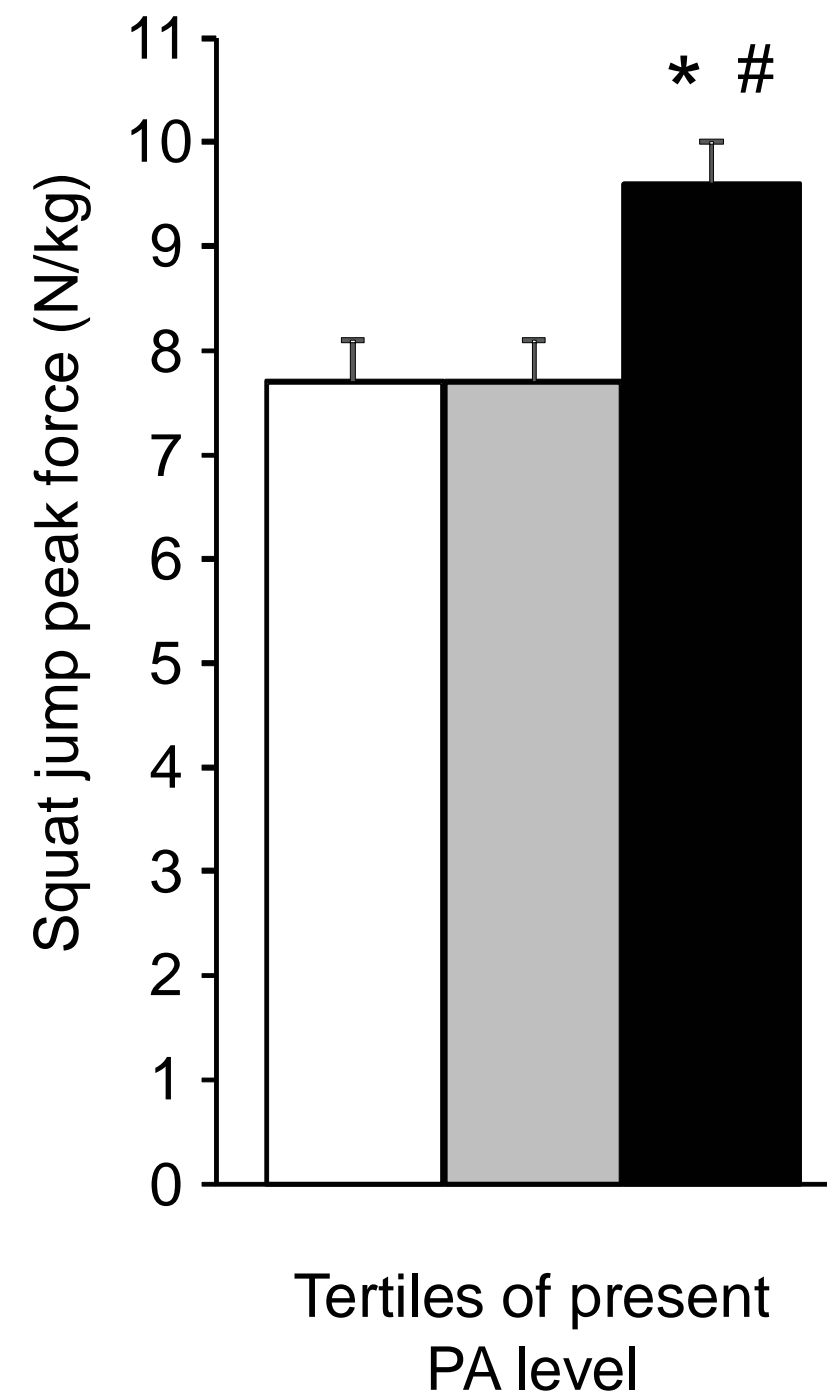


# Present PA behaviour

Fig. 2.A



2.B



But not balance....

# What are the implications?

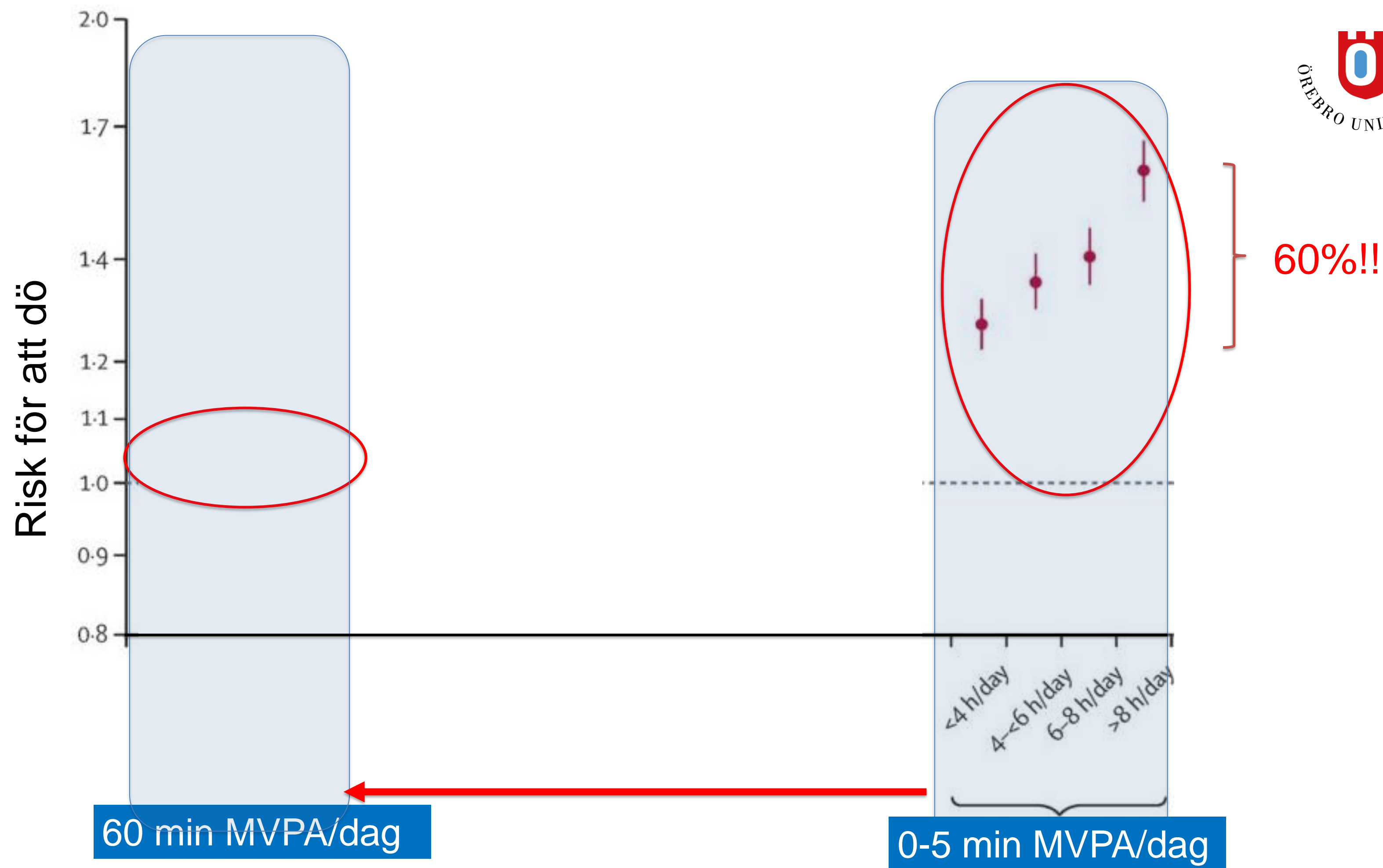
Here we show for the first time that present PA behaviors are related to physical function at old age, regardless of participants past PA behavior

Thus, our findings provide scientific support for the popular quote that *“it’s never too late to start exercising”*.

Specific balance training should be suggested even to well functioning and physically active older women in order to maintain physical function

The detrimental effects of a low PA level on physical function are primarily driven by insufficient amounts of MVPA rather than excessive amounts of sedentary time.





# Study II: Past PA behaviours

Healthy older women (65-70 yrs.)

Present PA behaviour: Accelerometers

Past PA behaviour: Historical Adulthood Physical Activity Questionnaire

- 35 to 65 yrs of age
- Early middle age (35-50 yrs), late middle age (50-65 yrs)
- Participants were classified as past physical active or inactive base (>150 min of MVPA/week = 600 METmin)

Body composition inc muscle mass (DEXA)

Physical function

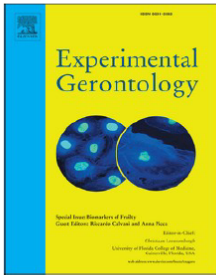
- Aerobic capacity – Åstrand test
- Leg strength – Isometric knee extension



Contents lists available at [ScienceDirect](#)

Experimental Gerontology

journal homepage: [www.elsevier.com/locate/expgero](http://www.elsevier.com/locate/expgero)



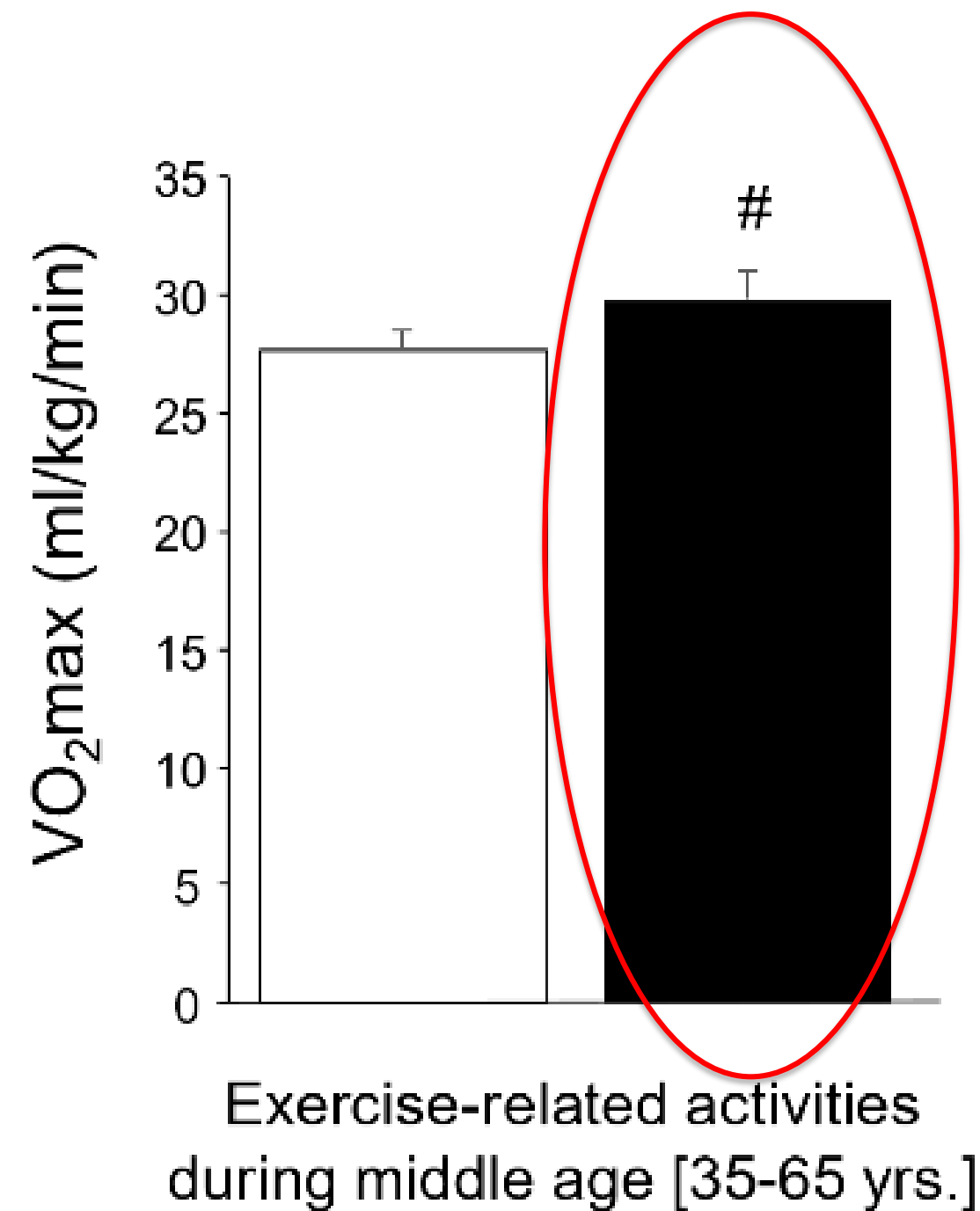
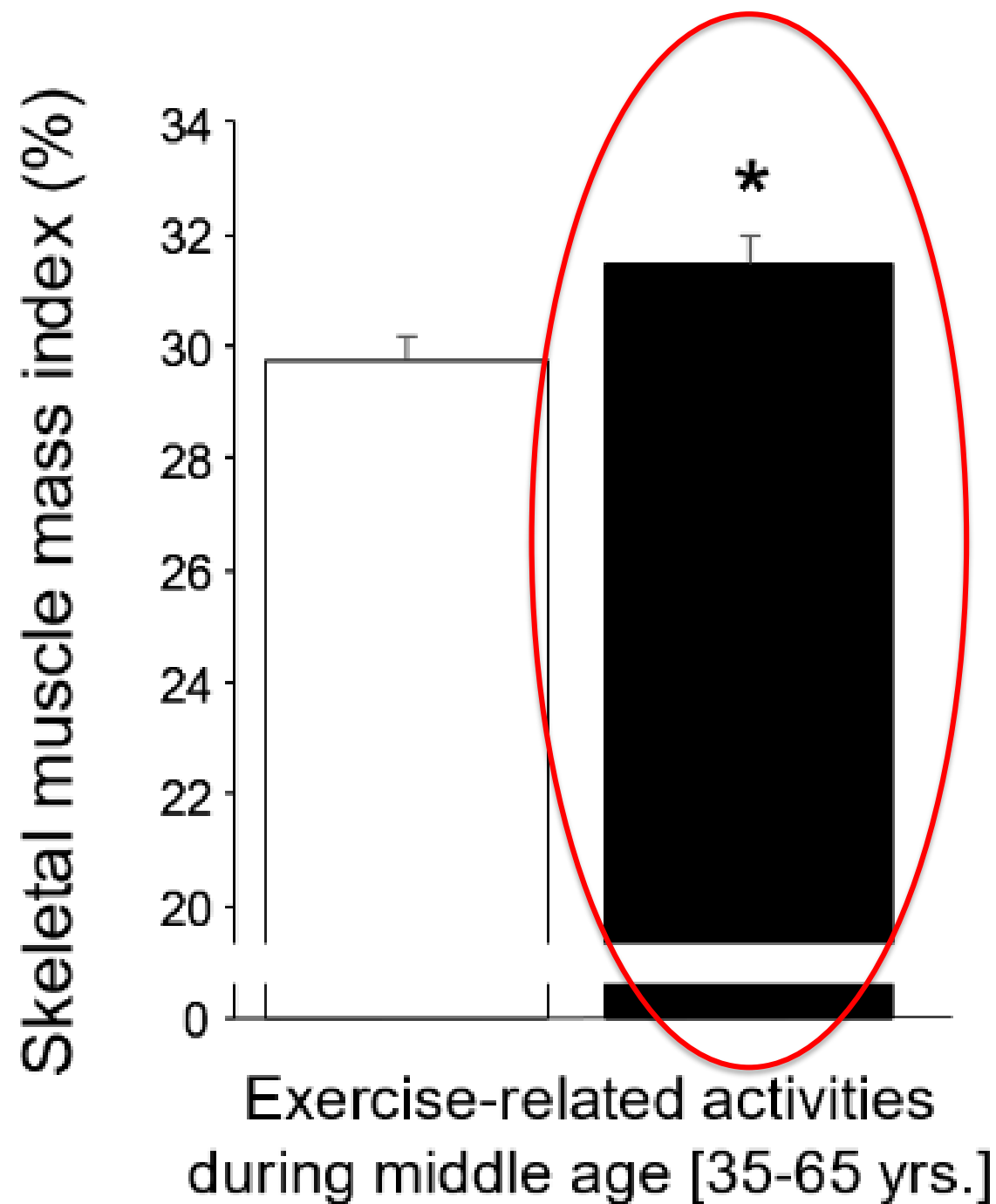
Muscle mass and aerobic capacity in older women: Impact of regular exercise at middle age

Peter Edholm, Jort Veen, Fawzi Kadi, Andreas Nilsson\*



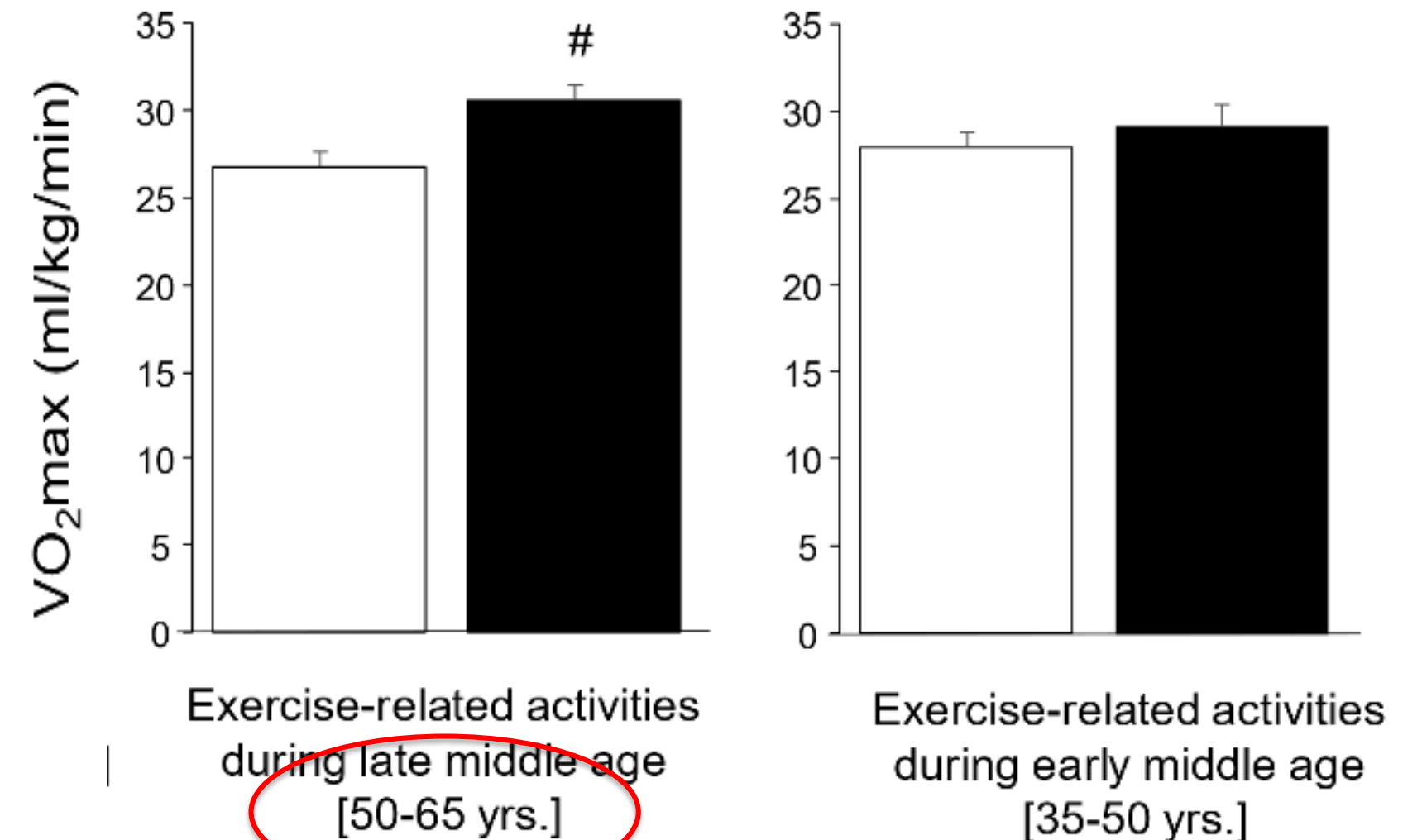
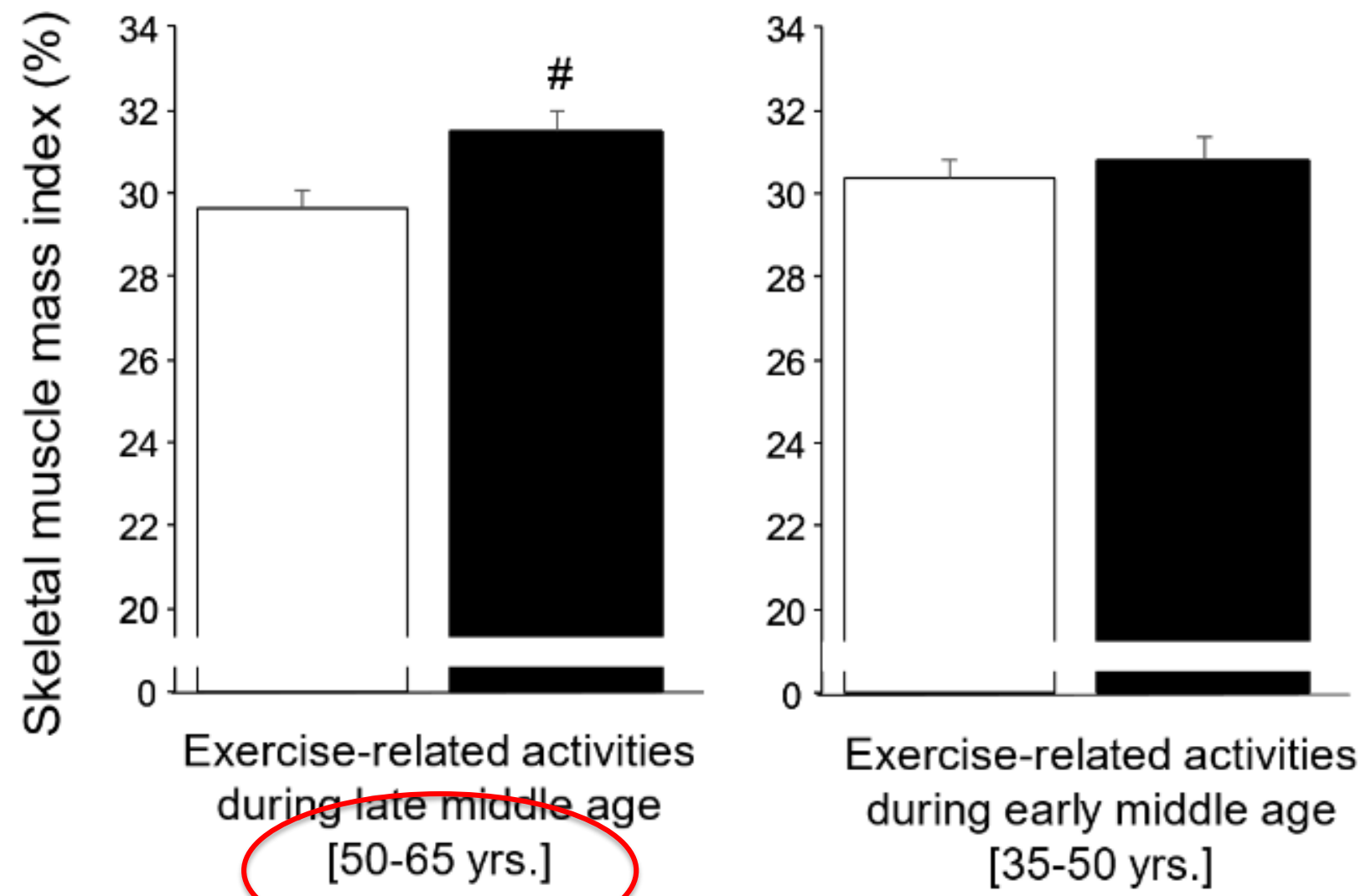


## PA behaviour during middle age [35-65]



Remind after  
adjustment for both  
present PA behaviour  
and previous occupation

# PA behaviour during early [35-50] vs. late [50-65] middle age





# What are the implications?

The study highlight the importance of engaging in exercise-related activities during middle age years in order to promote benefits on muscle mass and aerobic fitness at old age

An PA level > 600 METmin per week (in line with current PA recommendations) is sufficient to induce such benefits.

As type of occupation (physical demand) at middle age did not alter these benefits, our results highlights the importance of leisure-time exercise habits

So both past and present PA behaviours are important for maintained muscle mass and physical function!

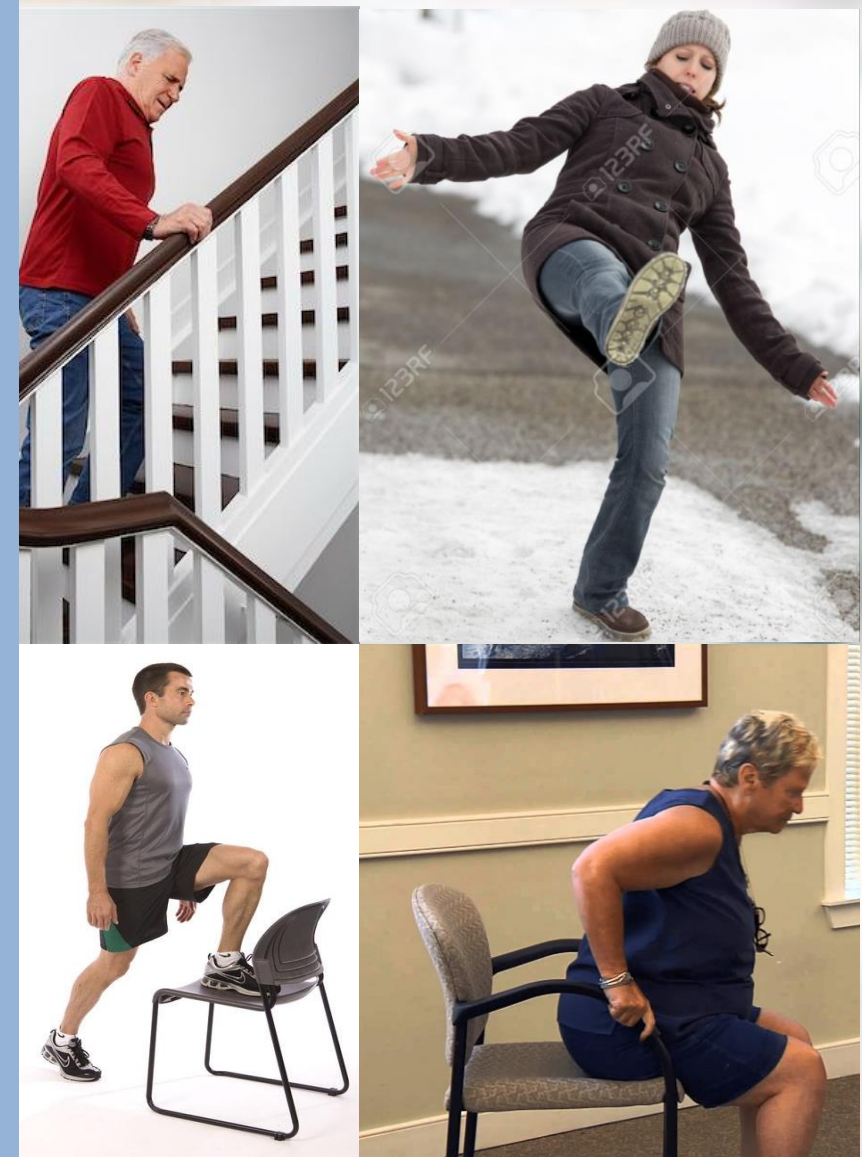
But, what if we wish to increase muscle mass and physical function?



# Resistance training

- Resistance training (RT) is the most effective training method if one wish to increase muscle mass and strength.
- In older adults RT:
  - ↑ Maximal muscle strength
  - ↑ ↔ **Muscle mass** (Hanson, 2001, Kosek 2006, Vincent 2002).
  - ↑ ↔ **Explosive capacity** (Frontera 1988, Häkkinen 1998, Skelton 1995)

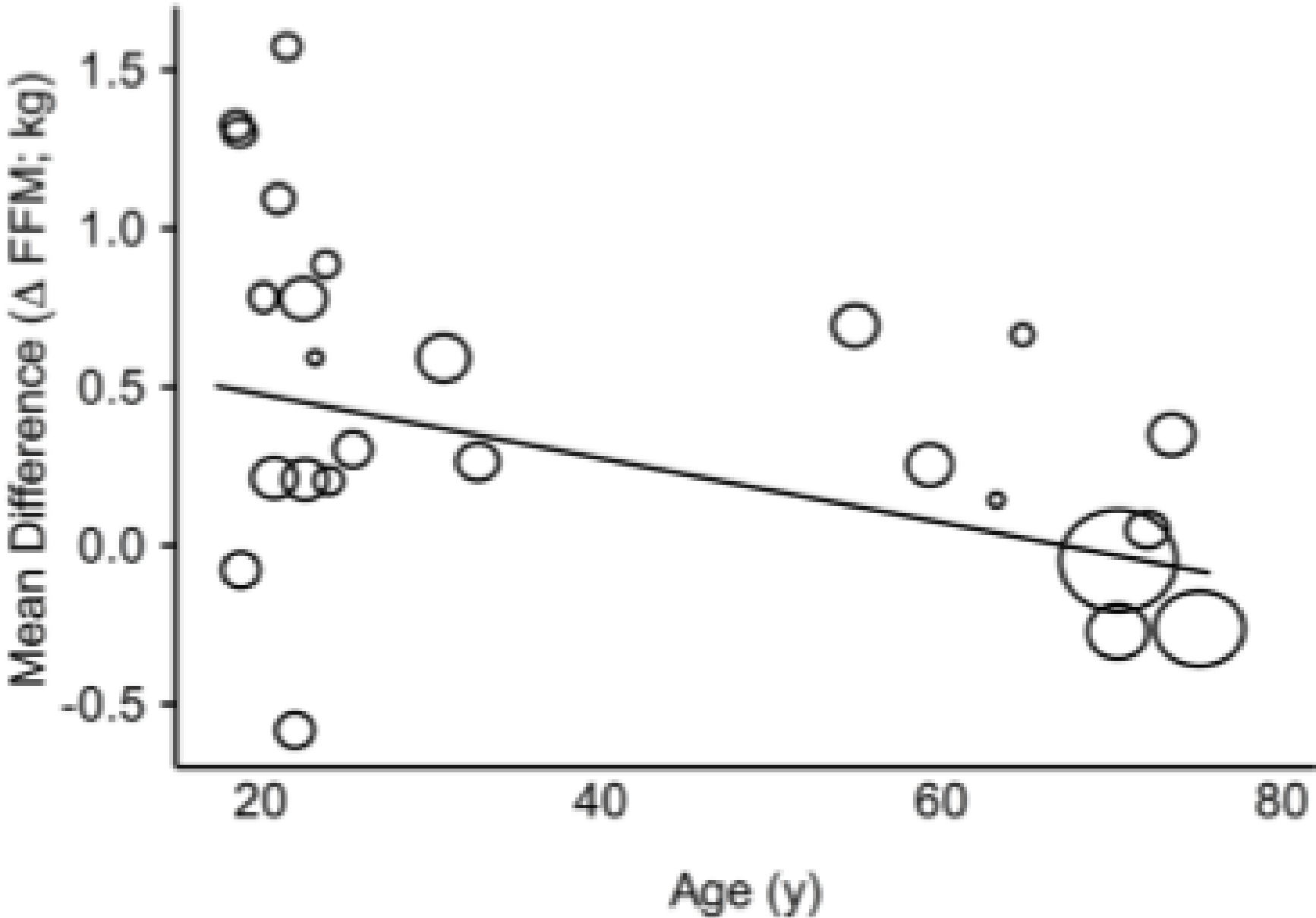
Especially common in healthy older women.....  
In older adults there is a blunted anabolic response....  
Chronic systemic inflammation in older adults



Diet is impo



N
Protein intake
Relative protein
Total energy
Carbohydrate
Fat, % of energy
Protein, % of energy
Body composition
Weight, kg
Height, cm
BMI, kg·m <sup>-2</sup>
SMI, % B
Objective Physical Activity
VO <sub>2</sub> max
Isometric
Self-Reported
BW, Body weight
c g·kg <sup>-1</sup> c



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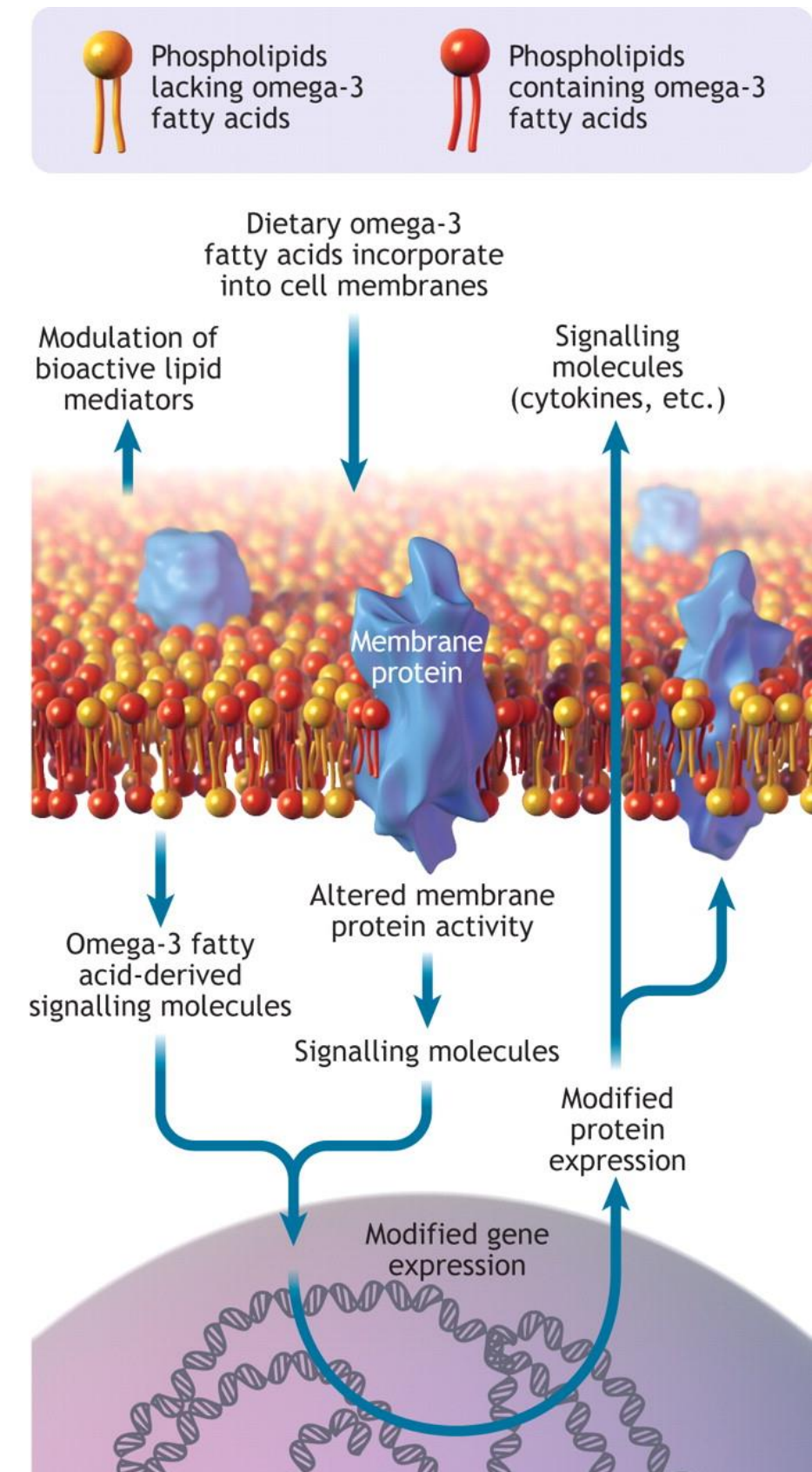
**Figure 4** Random-effects univariate meta-regression between age and the mean difference in fat-free mass (FFM) between groups. Each circle represents a study and the size of the circle reflects the influence of that study on the model (inversely proportionate to the SE of that study). The regression prediction is represented by the solid line (−0.01 kg (−0.02, −0.00), p=0.02).



# Diet is important... Omega 3 PUFA

## PUFA; (omega 3 and 6)

- Omega-6 PUFA (AA), mediate cellular inflammatory
- Omega-3 PUFA (EPA; DHA) counteract inflammatory effects of AA
  - Omega-6/3 ratio, contribute to the regulation of inflammation
- High intake of omega 3 (Mediterranean diet/fatty fish/fish-oil)
  - reduced systemic inflammation (Rees et al., 2019)
  - increased muscle protein synthesis rate (mTOR) (Smith 2011)
  - slows the normal decline in muscle mass strength in older (Smith 2015).
  - NSAID+RT = larger gains in muscle mass in old BUT not young (Trape 2011)





## Research gaps

- Does a high intake of omega-3 PUFA enhance RT induce adaptations in older adults?
- In that case, is this due to reduced chronic inflammation?

# Study III + VI

Äldre hälsosamma kvinnor (65-70 år)

3 grupper (20st/grupp)

Kontroll (KON)

Styrketräning (ST)

Styrketräning + hälsosam diet (ST+HD)

Styrketräning (ST och ST+HD):

Gym, 2 gånger i veckan, 6 månader

~ 12 repetitioner x 3 gånger (85% 1RM)

Progressiv/Instruktörer

Hälsosam diet (ST+HD):

Nordiska kostrekommendationerna

Rik på omega-3 fettsyror (Lax/Makrill, rapsolja, valnötter, linolja)

Dietist, recept, inköpslistor, sammankomster med matlagning



# STUDY III

## Inflammation and muscle mass

Influence of combined resistance training and healthy diet on muscle mass in healthy elderly women: a randomized controlled trial

Emelie Strandberg,<sup>1</sup> Peter Edholm,<sup>1</sup> Elodie Ponsot,<sup>1</sup> Britta Wåhlin-Larsson,<sup>1</sup> Erik Hellmén,<sup>1</sup> Andreas Nilsson,<sup>1</sup> Peter Engfeldt,<sup>1</sup> Tommy Cederholm,<sup>2</sup> Ulf Risérus,<sup>2</sup> and Fawzi Kadi<sup>1</sup>

<sup>1</sup>School of Health and Medical Science, Örebro University, Örebro, Sweden; and <sup>2</sup>Department of Public Health and Caring Science, Clinical Nutrition and Metabolism, Uppsala University, Uppsala, Sweden

### Dietary intake (E%) in RT+HD

- SFA: ↓  $13.7 \pm 3.2$  to  $9.7 \pm 1.5$
- MUFA: ↑  $11.9 \pm 2.2$  to  $14.4 \pm 1.6$
- PUFA: ↑  $5.1 \pm 1.3$  to  $9.0 \pm 2.1$
- n-6/n-3: ↓  $3.1 \pm 1.3$  to  $1.8 \pm 0.6$

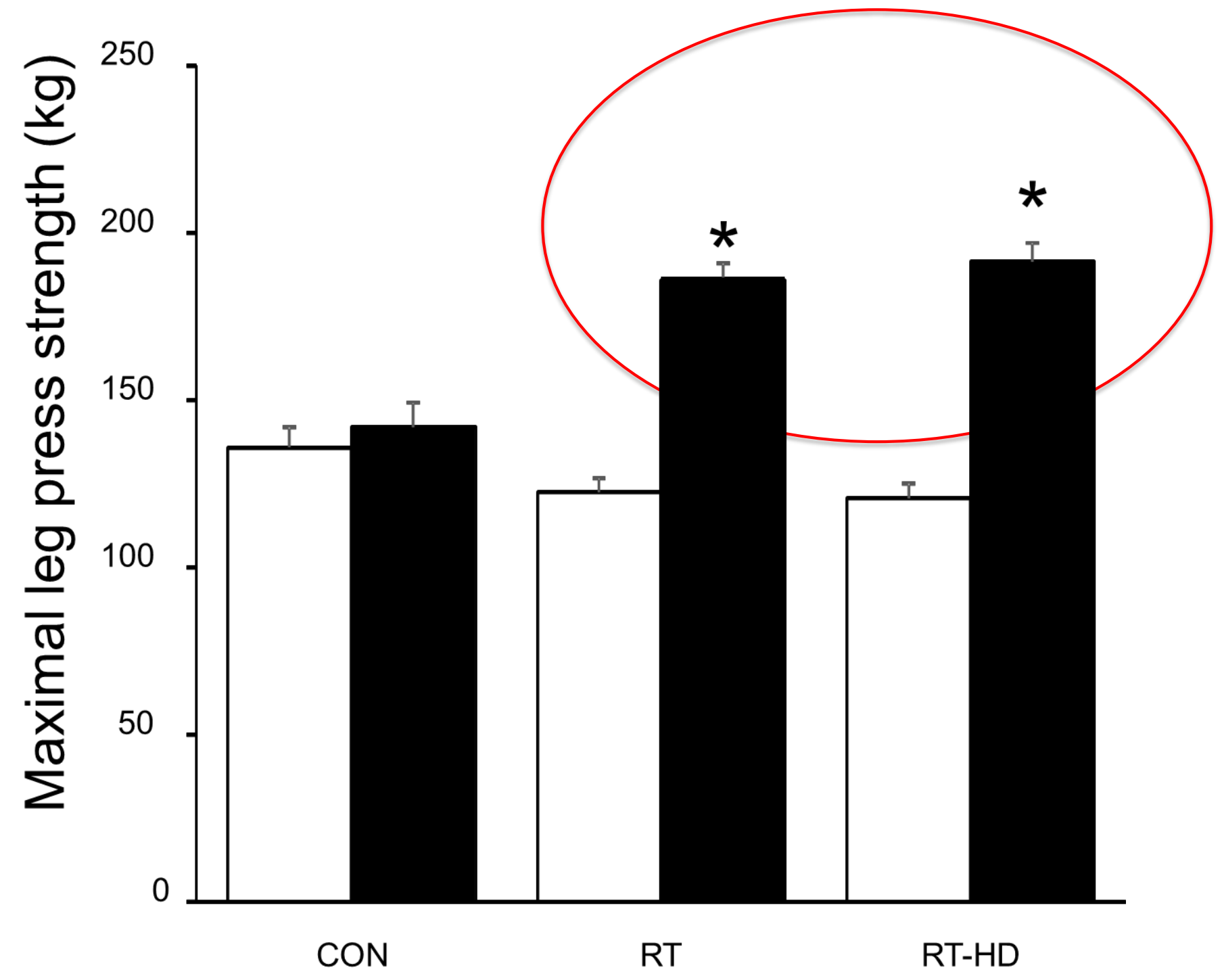
### Phospholipid fatty acid composition (%) in blood in RTHD

- DHA (n-3): ↑  $5.19 \pm 0.88$  to  $5.62 \pm 0.95$
- AA (n-6): ↓  $9.03 \pm 0.9$  to  $8.54 \pm 1.18$

No changes in CON and RT

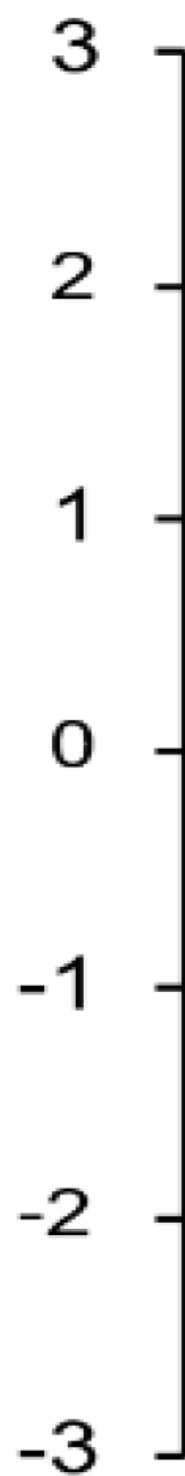


# Maximal muscle strength



# Muskelmassa

Changes in leg lean mass (%)



KONTROLL ÖVNINGSGRUPPEN





# STUDY III

## Systemic inflammation

Table 2. *Body composition, physical activity level, serum inflammatory markers and muscle strength at baseline and by the end of the study*

Variable	CON		RT		RT-HD	
	PRE, <i>n</i> = 21	POST, <i>n</i> = 18	PRE, <i>n</i> = 21	POST, <i>n</i> = 17	PRE, <i>n</i> = 21	POST, <i>n</i> = 20
Height, cm	165 ± 4.6	–	163 ± 5.3	–	165 ± 5.3	–
Body mass, kg	67.1 ± 8.2	67.7 ± 8.6	65.2 ± 8.0	65.8 ± 8.2	65.9 ± 11.0	65.7 ± 10.9
BMI, kg/m <sup>2</sup>	24.5 ± 2.8	24.8 ± 2.9	24.5 ± 2.8	24.6 ± 2.9	24.3 ± 3.9	24.4 ± 4.6
1 RM leg extension	49.7 ± 9.6	49.8 ± 10.3	49.2 ± 10.2	59.0 ± 10.3*	49.5 ± 6.3	60.0 ± 7.1*
CRP, mg/l	1.29 ± 0.93	1.30 ± 0.87	1.25 ± 0.78	1.33 ± 0.76	1.35 ± 0.89	1.46 ± 1.06
IL-6, pg/l	1.85 ± 1.77	1.86 ± 1.92	1.29 ± 0.92	1.27 ± 1.05	1.22 ± 0.90	1.44 ± 1.12
Leg lean mass, kg	12.61 ± 1.66	12.41 ± 1.67	12.78 ± 1.28	12.82 ± 1.43	12.50 ± 1.58	12.71 ± 1.53*
Leg fat mass, kg	8.34 ± 1.94	8.55 ± 1.81	8.53 ± 1.85	8.72 ± 1.99	9.17 ± 3.43	8.99 ± 3.18
Leg BMD, g/cm <sup>2</sup>	1.15 ± 0.11	1.16 ± 0.11	1.13 ± 0.08	1.12 ± 0.08	1.14 ± 0.10	1.15 ± 0.09
PA, cnts·min <sup>-1</sup> ·day <sup>-1</sup>	278 ± 151	327 ± 178	268 ± 62	257 ± 49	337 ± 127	329 ± 174

All values are given as means ± SD. \**P* ≤ 0.05. CON, control group; RT, resistance training group; RT-HD, resistance training + healthy diet group; CRP, C-reactive protein; BMI, body mass index; RM, repetition maximum; BMD, bone mineral density; PA, physical activity.



# STUDY IV

## Explosive strength and physical function

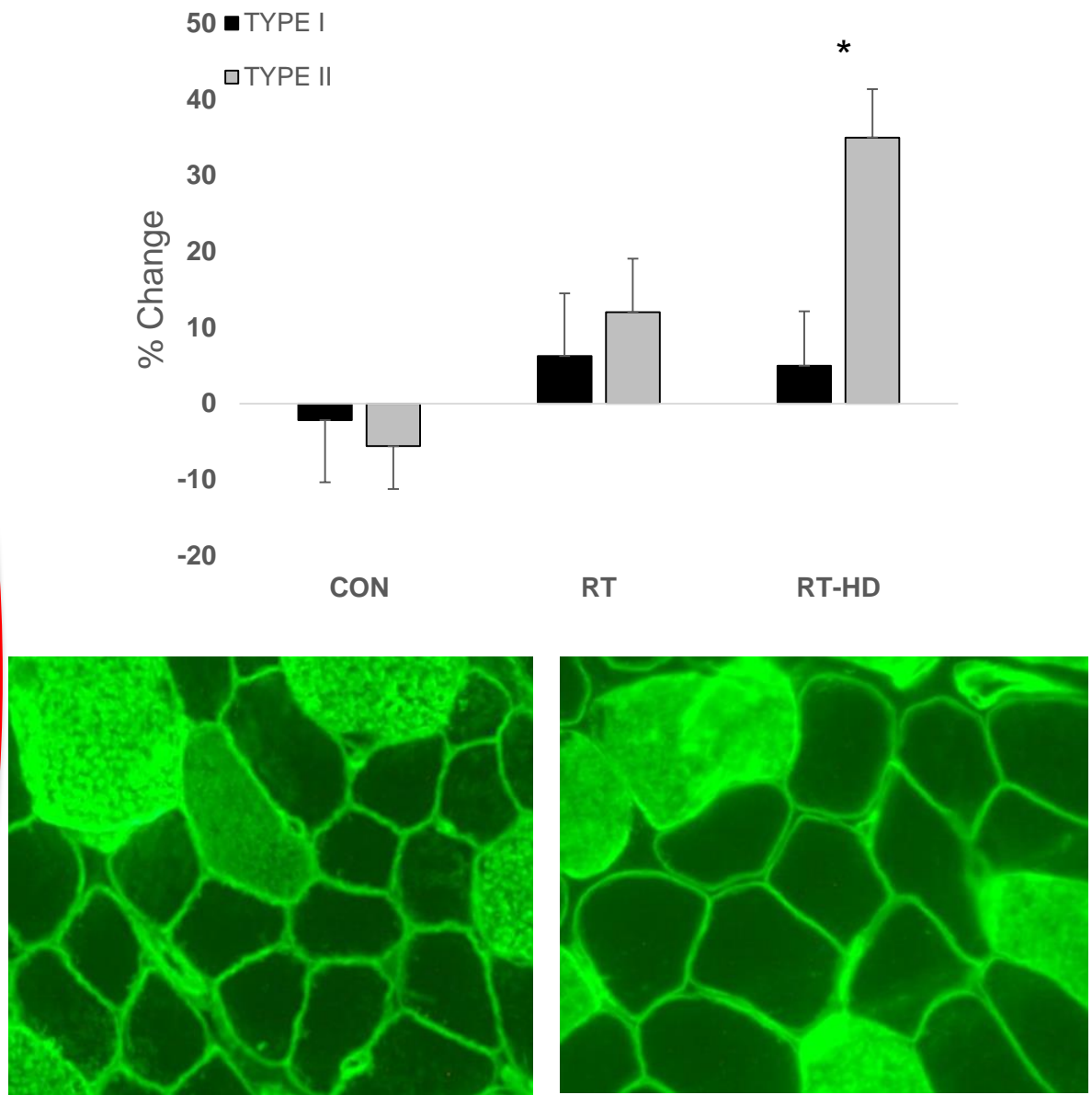
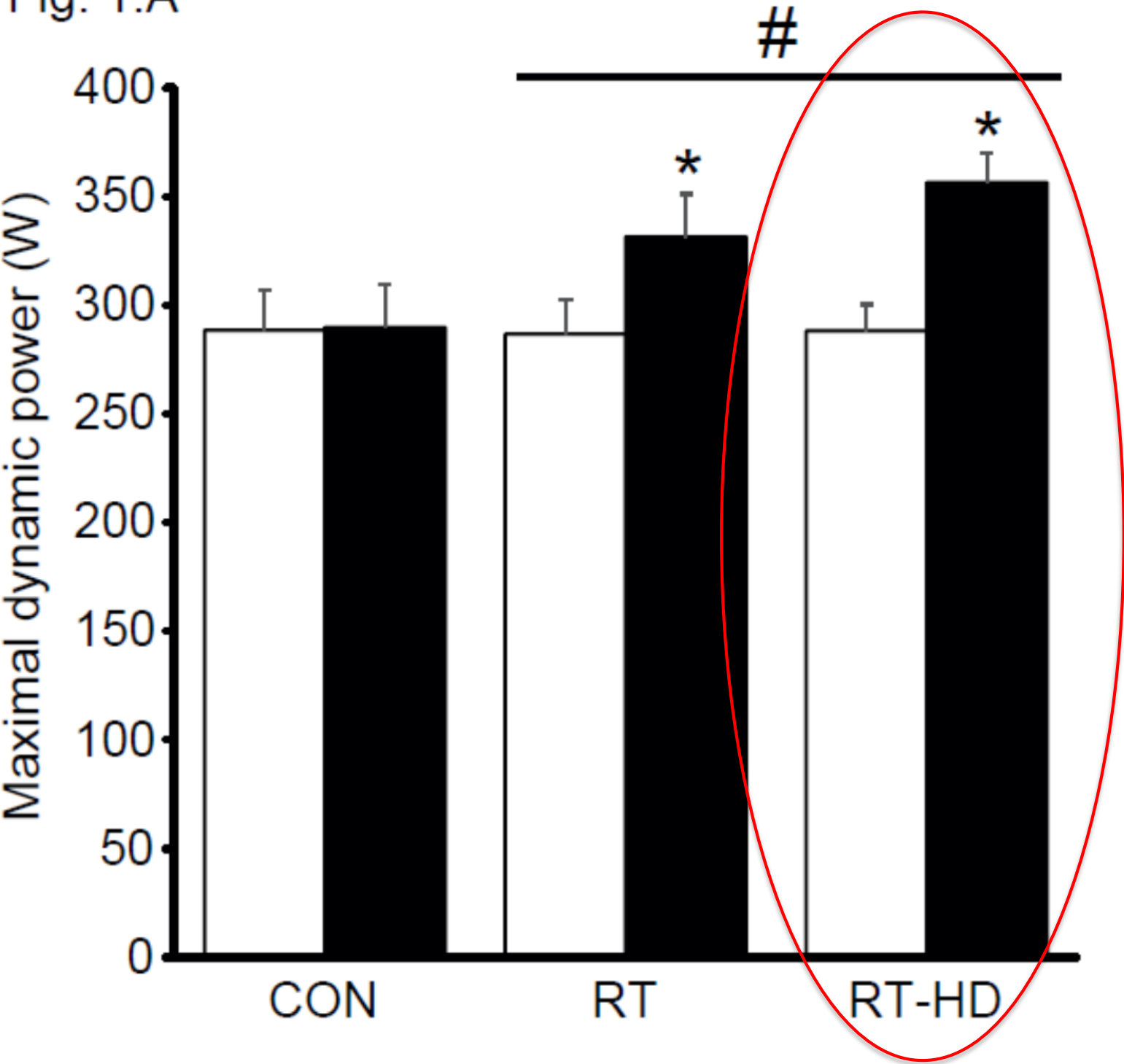
RESEARCH ARTICLE | *Aging and Exercise*

Lower limb explosive strength capacity in elderly women: effects of resistance training and healthy diet

Peter Edholm, Emelie Strandberg, and Fawzi Kadi

School of Health and Medical Sciences, Örebro University, Örebro, Sweden

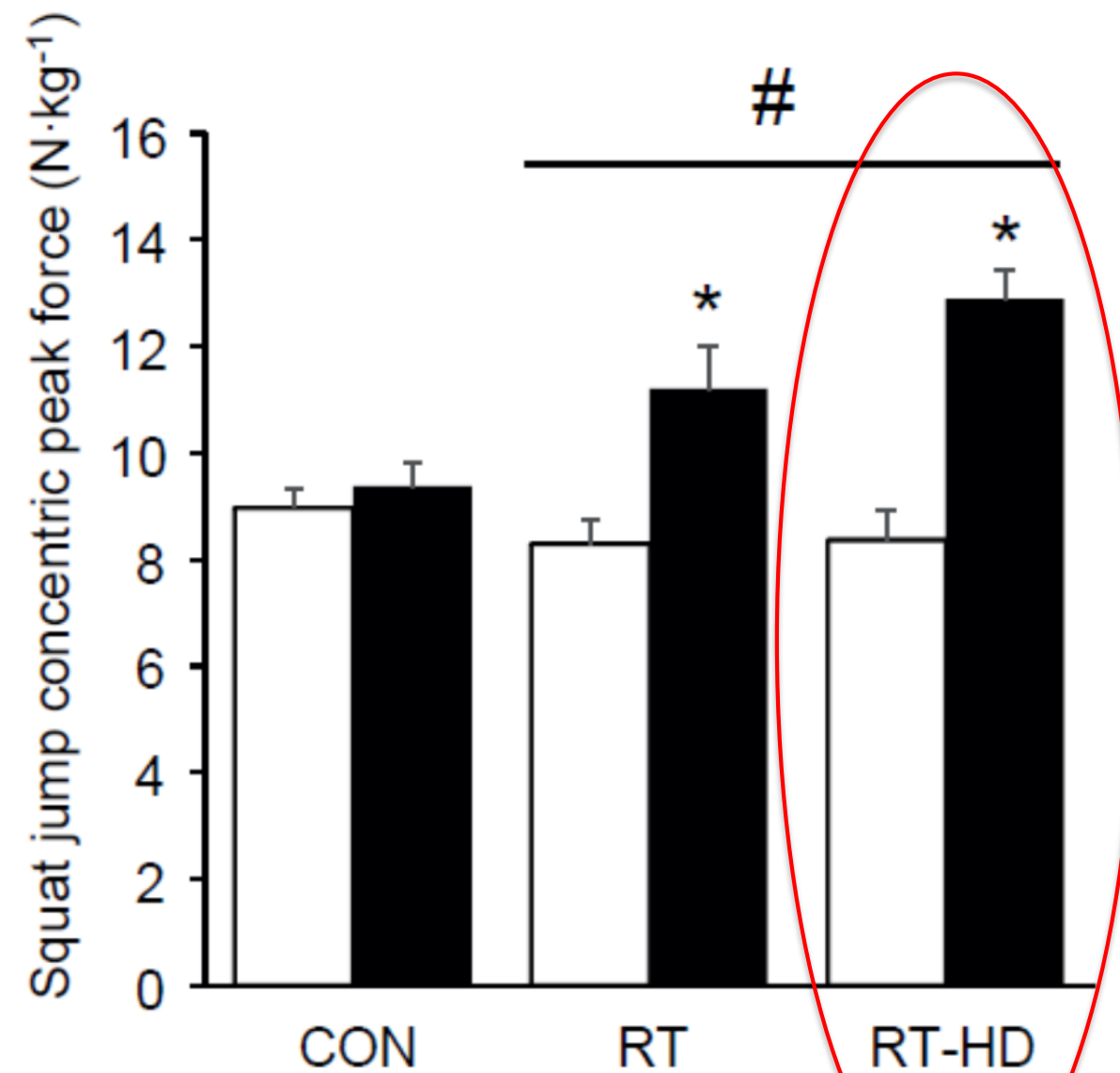
Fig. 1.A



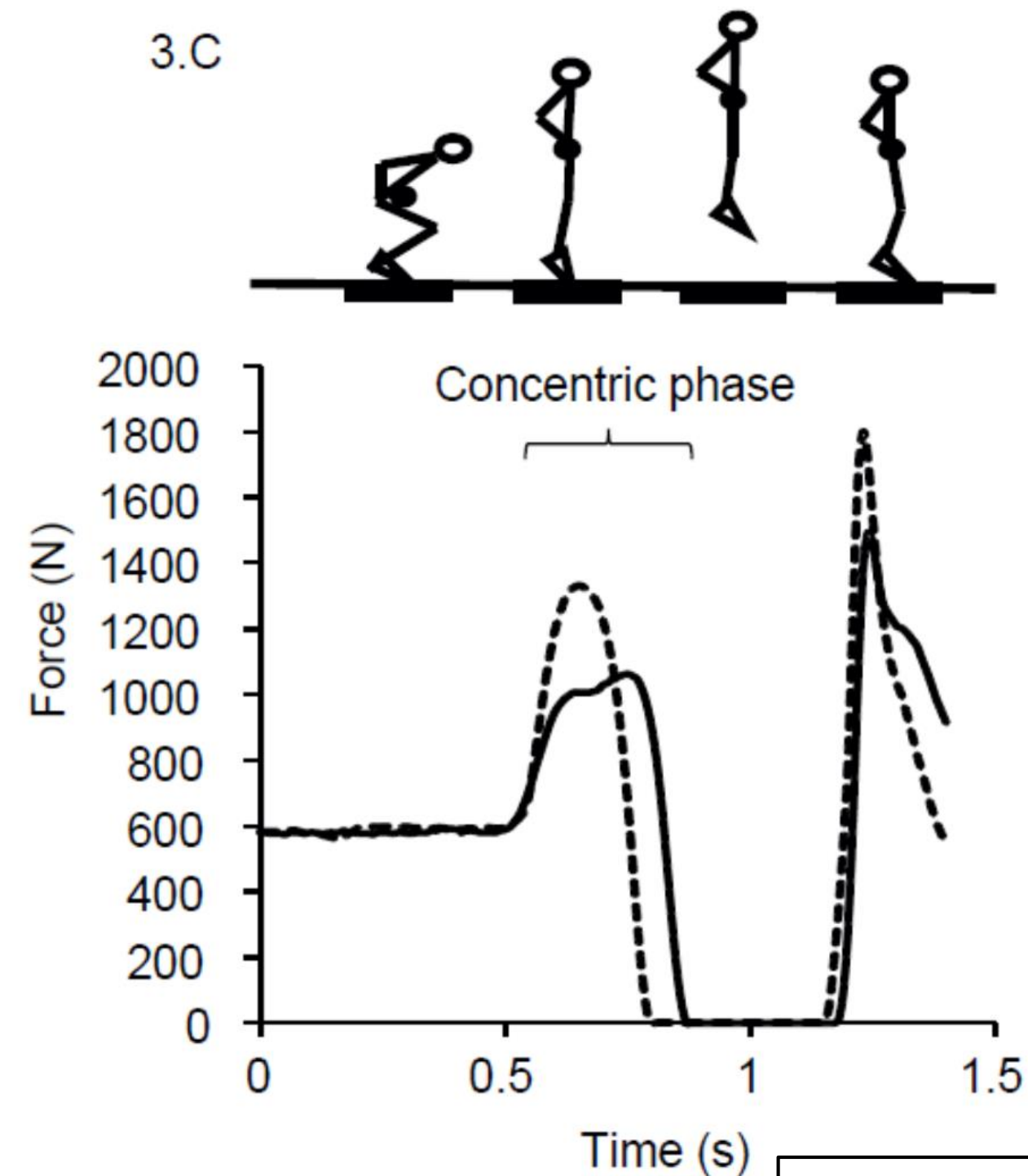
# STUDY IV

## Physical function (squat jump)

Fig. 3.A



3.C



## What are the implications from study III and IV?

The lack of gain in muscle mass after RT based on WHO/ACSMs recommendation raises the question whether current recommendations are optimal for healthy older women?

The increased myotropic effects (muscle mass, explosive strength and physical function) in RT+HD demonstrates the need of integrated recommendation that takes both nutritional and exercise training aspects into account in order to optimize skeletal muscle adaptation in healthy older women.





- Leva ett fysisk aktivt liv (> 20 min MVPA/dag)
- Aldrig för sent att börja!
- Styrketräning 2 ggr/v, rejäla vikter, hemma/gym
- Kombinera med en hälsosam diet rik på omega-3




# Vad händer nu då....







Studying dietary habits and health impact in aging European populations.




## PROJECT RATIONALE

[Project rationale](#)



## PROJECT GOALS AND DELIVERABLES

[Project goals and  
deliverables](#)



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## Cold water immersion



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# Tack för att ni lyssnat!



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Elodie Ponsot

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