THE HEALTH BENEFITS OF SPORT FOR WOMEN THROUGHOUT THE DIFFERENT TIMES IN THEIR LIVES

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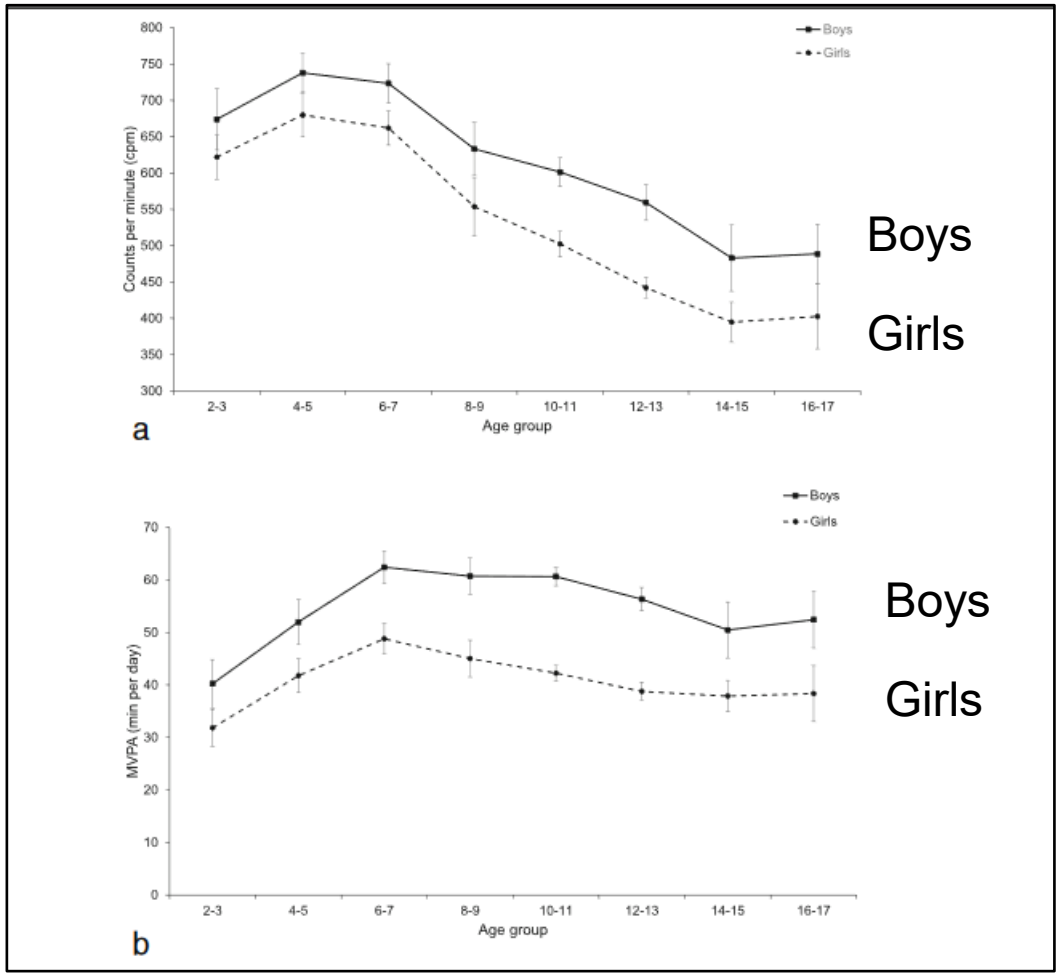
Women: the great forgotten of research

Women have historically been underrepresented in exercise physiology research compared to men

→ **only 20% of publications are dedicated to women**

In the absence of information recommendations are based on male physiology

Physical activity level by age and sex



RESEARCH Open Access

Variations in accelerometry measured physical activity and sedentary time across Europe – harmonized analyses of 47,497 children and adolescents

N= 47,497

Regarless of age,
women engage in less physical activity than men

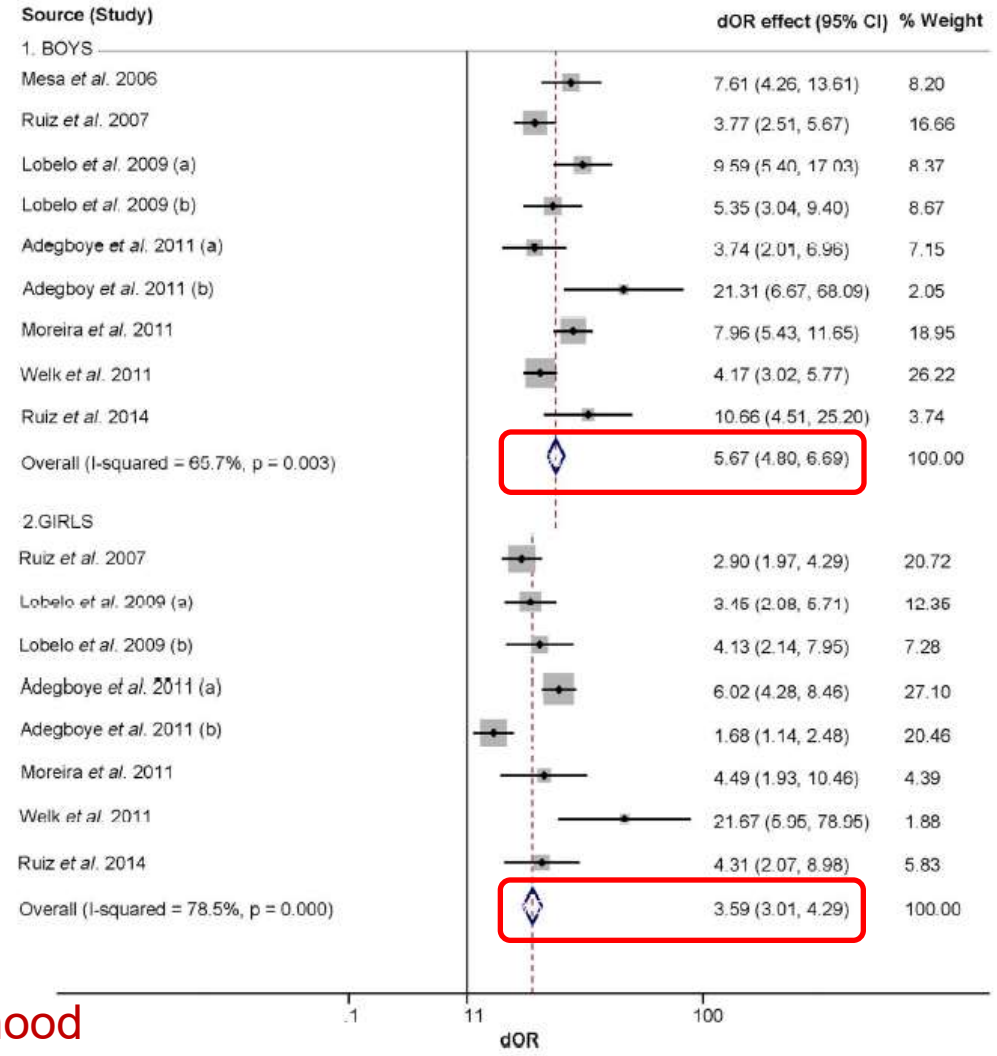
Steene-Johannessen et al. International Journal of Behavioral Nutrition and Physical Activity 2020

Below-normal exercise capacity is associated with a fourfold increase in the risk of cardiometabolic disorders

Meta-analysis
9280 child and adolescents
8 to 19 years
From 14 countries

Low CRF is associated with ↑risks of:
- ✓ Insulin resistance
- ✓ Dyslipidemia
- ✓ Adiposity
- ✓ High blood pressure

Cardiometabolic risks persist in adulthood



Ruiz JR et al. 2016

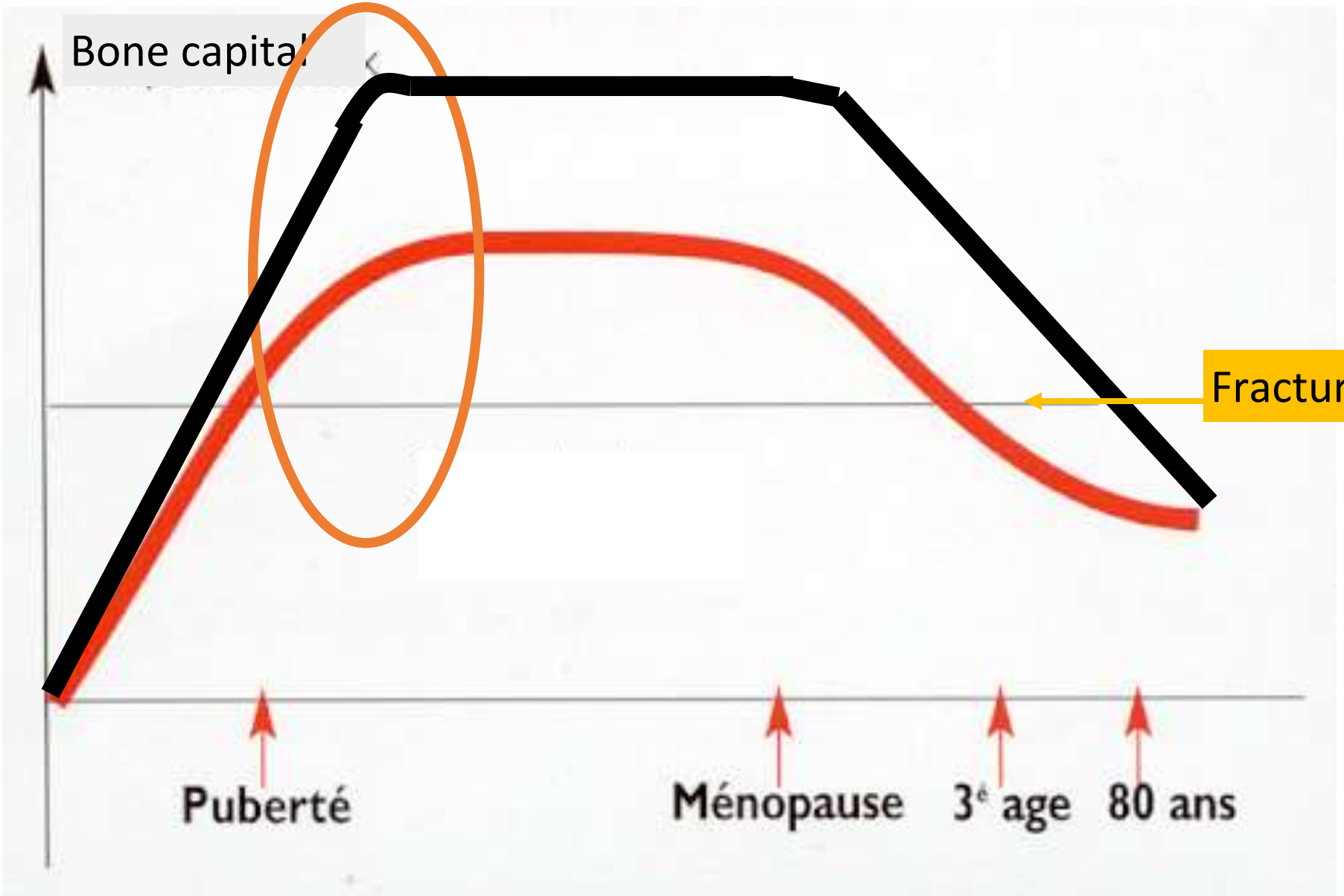
Effects of sedentary behavior on children's and adolescent's health

- ✓ ↑Risks of obesity
- ✓ ↓Cardiometabolic health
- ✓ ↓Physical capacities
- ✓ Social behavior of lower quality
- ✓ ↓Sleep duration
- ✓ Depression
- ✓ Low self-esteem
- ✓ ↓Academic performances
- ✓ ↑ Myopia

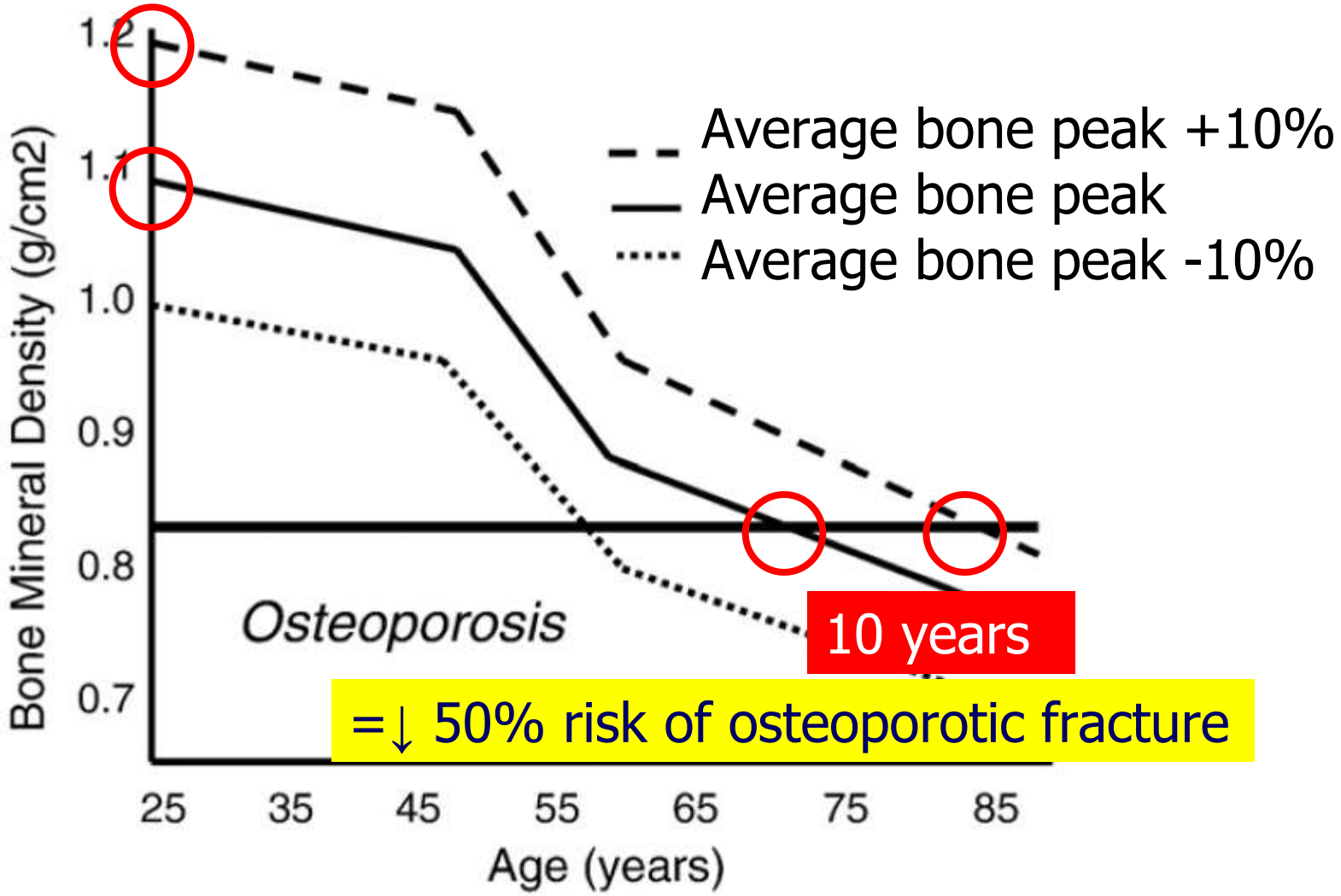
Katzmarzyk et al MSSE 2015
Skrede et al Obesity Reviews 2019
OMS 2020
Kontostoli et al. Obesity Reviews 2021

Pediatric prevention of osteoporosis for women

Bone mass/age curve



Simulation of the influence of peak bone mass on the age of reaching the diagnostic threshold for osteoporosis



Rizzoli *et al.* Bone 46: 294-305, 2010

Physical activity and pregnancy

INFLUENCE OF EXERCISE ON PREGNANCY

Beneficial effects for the mother

-↓weight gain

- Prevention of gestational diabetes
  and management of gestational diabetes

-↓risk of pre-eclampsia

-↓anxiety and depression (including post-partum depression)

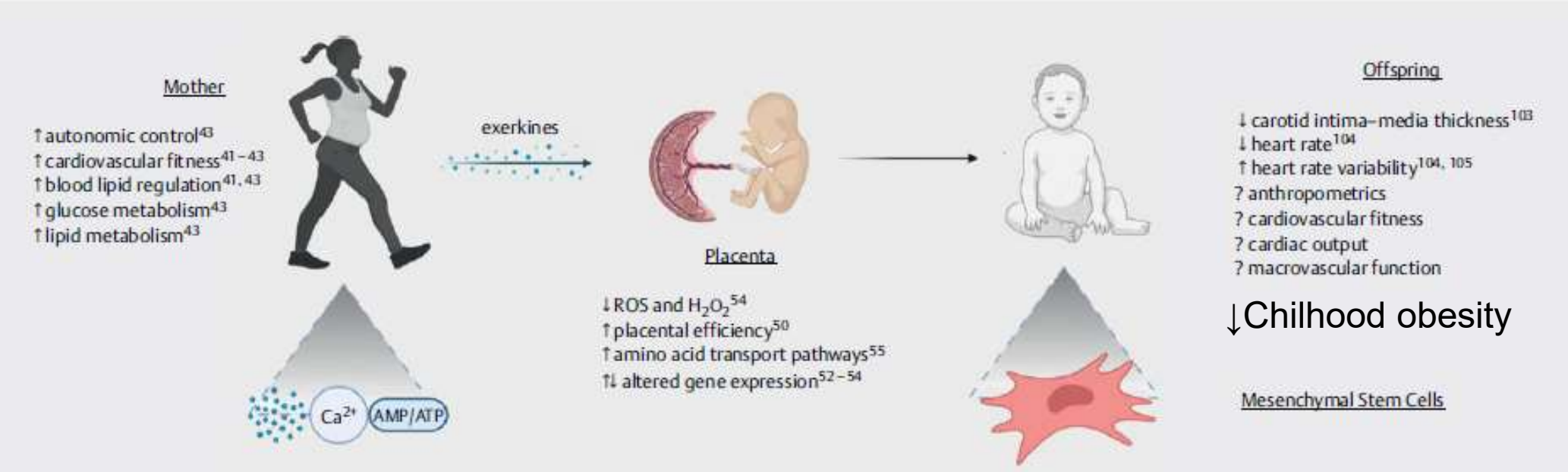
-↓venous disorders

-↓lower back pain

-↑ overall weel-being of pregnant women

INFLUENCE OF EXERCISE ON PREGNANCY

Beneficial effects for the fœtus and the child



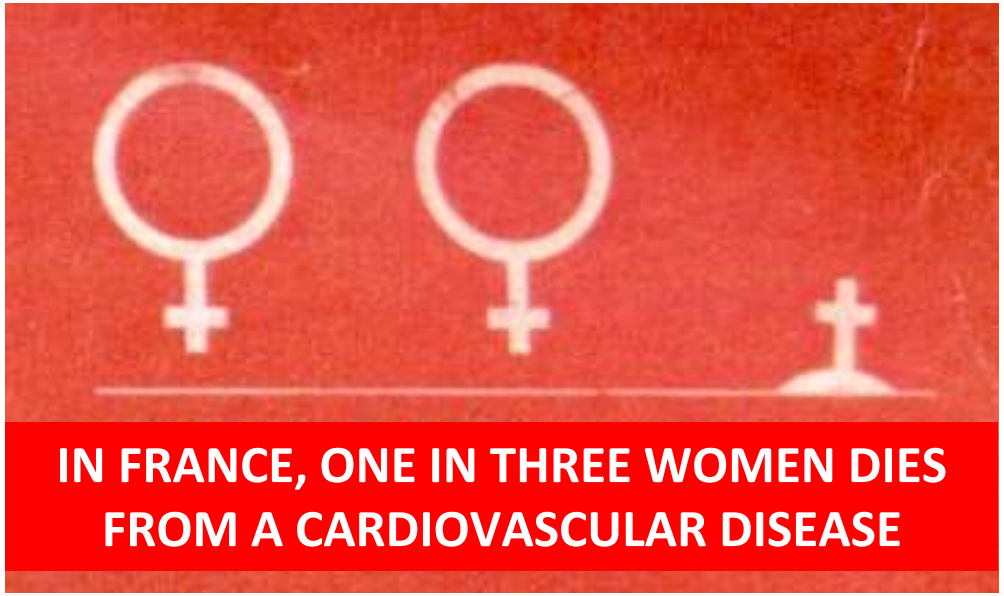
→ Recommandations of PA during pregnancy

Krassovskaia PM et al. 2021
Chen et al. 2021

Physically active during menopause

Cardiovascular diseases

First cause of death in women



They kill six times more than breast cancer

Myocardial infarction is the leading cause of death, followed by stroke, and then other vascular diseases.

(BEH, InVS 8 mars 2016)

Physical activity and cardiovascular mortality in post-menopausal women

OPACH cohort (Objective PA and Cardiovascular Health)
Multi-ethnic cohort ♀ living in USA
N= 6489 ♀, 63-99 years (mean age 78 years)
Physical activity : accelerometers
Mean follow-up 3.1 years

LaMonte et al. J Am Geriatr Soc 2018

	Physical Activity Tertile				
	1 (low) 25min/d	2 45min/d		3 (high) 76min/d	P-Trend
All-Cause Mortality					
Total PA, deaths (rate[a])	259 (38.2)	124 (17.8)		67 (9.4)	
RR (95% CI)[b]	1.00	0.58 (0.47–0.73)	-32%	0.38 (0.28–0.51)	-62% <.001
RR (95% CI)[c]	1.00	0.68 (0.54–0.85)		0.49 (0.37–0.66)	<.001
RR (95% CI)[d] (N = 5479)	1.00	0.73 (0.57–0.93)		0.56 (0.41–0.76)	<.001
Low light intensity PA, deaths (rate[a])	211 (30.8)	135 (19.3)		104 (14.8)	
RR (95% CI)[b]	1.00	0.77 (0.61–0.95)		0.69 (0.54–0.89)	.002
RR (95% CI)[c]	1.00	0.86 (0.69–1.08)		0.80 (0.62–1.03)	.07
RR (95% CI)[d] (N = 5479)	1.00	0.91 (0.71–1.15)		0.87 (0.66–1.14)	.28
High light intensity PA, deaths (rate[a])	263 (38.7)	113 (16.2)		74 (10.4)	
RR (95% CI)[b]	1.00	0.49 (0.39–0.62)		0.36 (0.28–0.48)	<.001
RR (95% CI)[c]	1.00	0.57 (0.45–0.71)		0.47 (0.35–0.61)	<.001
RR (95% CI)[d] (N = 5479)	1.00	0.61 (0.47–0.78)		0.57 (0.42–0.76)	<.001
MVPA, deaths (rate[a])	280 (41.9)	116 (16.6)		54 (7.6)	
RR (95% CI)[b]	1.00	0.54 (0.43–0.67)		0.31 (0.23–0.42)	<.001
RR (95% CI)[c]	1.00	0.63 (0.50–0.79)		0.42 (0.30–0.57)	<.001
RR (95% CI)[d] (N = 5479)	1.00	0.66 (0.51–0.84)		0.46 (0.33–0.65)	<.001
CVD Mortality					
Total PA, deaths (rate[a])	97 (14.3)	43 (6.2)		14 (1.9)	
RR (95% CI)[b]	1.00	0.56 (0.39–0.81)	-44%	0.23 (0.13–0.41)	-77% <.001
RR (95% CI)[c]	1.00	0.64 (0.44–0.94)		0.29 (0.16–0.53)	<.001
RR (95% CI)[d] (N = 5479)	1.00	0.66 (0.44–1.01)		0.34 (0.18–0.64)	<.001
Low light intensity PA, deaths (rate[a])	82 (11.9)	41 (5.9)		31 (4.4)	
RR (95% CI)[b]	1.00	0.61 (0.42–0.89)		0.55 (0.35–0.85)	.003
RR (95% CI)[c]	1.00	0.69 (0.47–1.02)		0.64 (0.41–0.99)	.03
RR (95% CI)[d] (N = 5479)	1.00	0.78 (0.51–1.18)		0.72 (0.44–1.18)	.16
High light intensity PA, deaths (rate[a])	100 (14.7)	37 (5.3)		17 (2.4)	
RR (95% CI)[b]	1.00	0.44 (0.30–0.65)		0.24 (0.14–0.39)	<.001
RR (95% CI)[c]	1.00	0.50 (0.34–0.74)		0.30 (0.17–0.51)	<.001
RR (95% CI)[d] (N = 5479)	1.00	0.49 (0.32–0.76)		0.33 (0.18–0.59)	<.001
MVPA, deaths (rate[a])	99 (14.8)	39 (5.6)		16 (2.2)	
RR (95% CI)[b]	1.00	0.57 (0.39–0.53)		0.31 (0.18–0.53)	<.001
RR (95% CI)[c]	1.00	0.68 (0.45–0.99)		0.42 (0.24–0.75)	.001
RR (95% CI)[d] (N = 5479)	1.00	0.68 (0.44–1.05)		0.43 (0.23–0.81)	.005

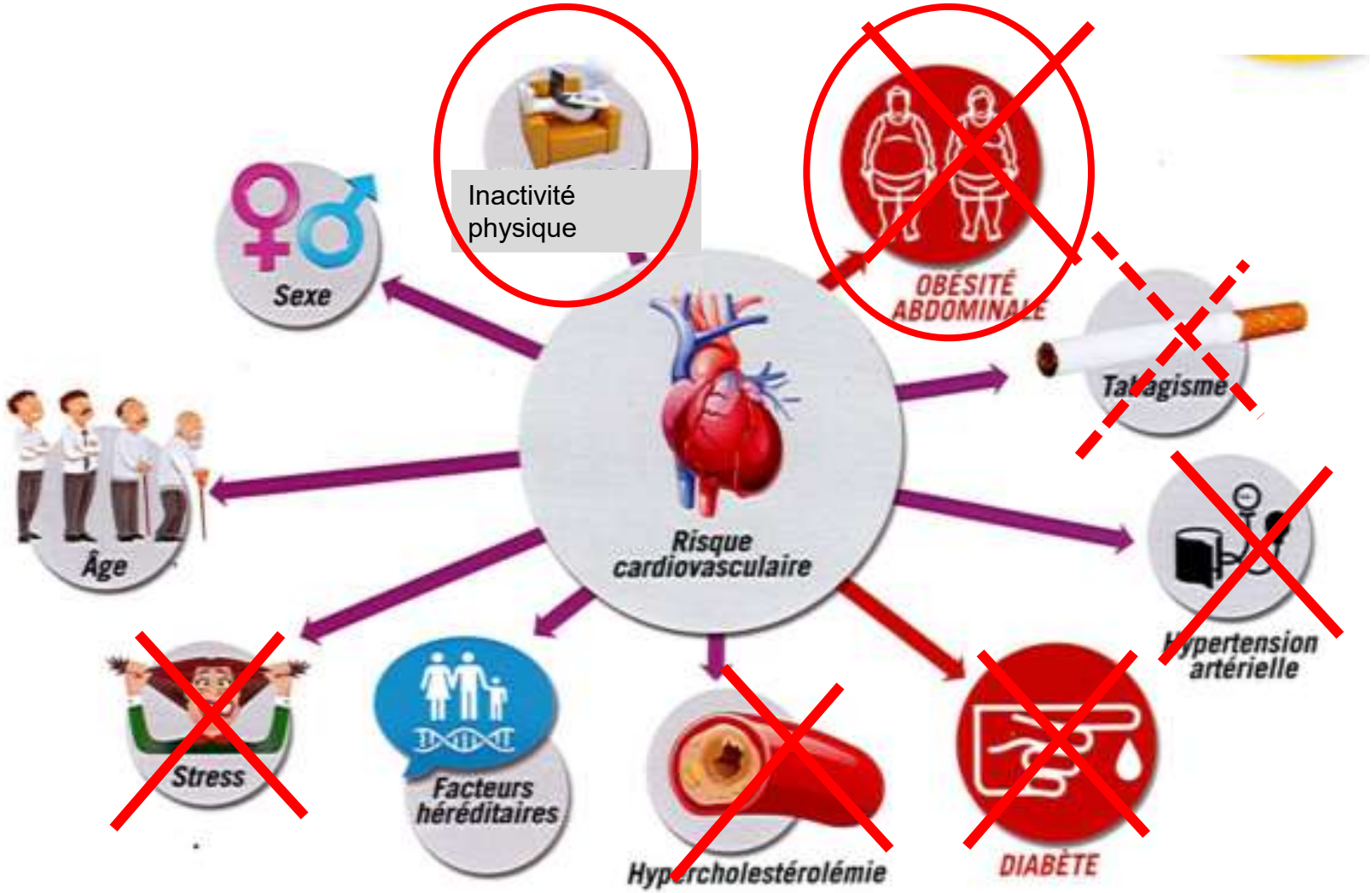
Physical activity
reduces mortality in post-menopausal women

Effects observed in all groups examined

- ✓ obese ♀
- ✓ ≥80 years
- ✓ with multi-morbidity (3 chronic diseases)
- ✓ low physical capacities

LaMonte et al. J Am Geriatr Soc 2018

Physical activity reduces all modifiable cardiovascular risk factors



Yusuf et al., Lancet 2004

Physical activity and bone health

↓

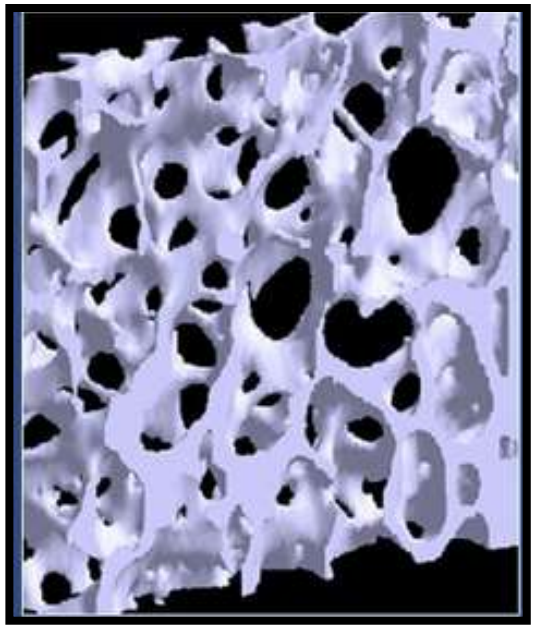
Post-menopausal osteoporosis

Stress exerted by physical activity on the bone

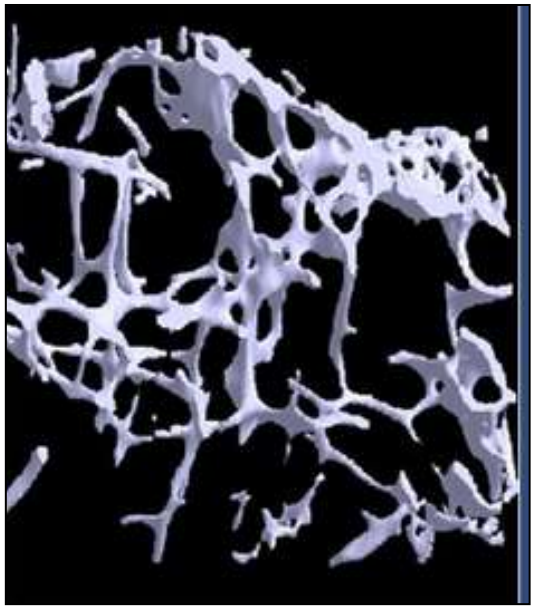
→ osteogenic effect

Osteoporosis: a bone disease

Normal bone



Osteoporotic bone



↑ Porosity

Disconnections of the trabeculae

Bone stimulating-exercises

with high impacts

Danse
« Aerobic »
Hikking
Jogging
Jump rope
Stairs
Tennis, volley, basket

with low impacts

If high impacts no possible:
Elliptical bikes
Steppers
Fast walking

Strength training/muscle strengthening exercises
with high resistance

Physical activity and fracture risks

Fracture : associated with low bone mineral density, propensity to fall, and declines in muscle strength, balance, mobility, and physical functioning

Nurses' Health Study : 61 000 postmenopausal women

Relative risk of hip fracture
decreases by 6% per hour of walking/ week

4h walking/week : reduced risk of 41%
compared to <1h /week

Feskanich et al. JAMA 288: 2300-2306, 2002

Physical activity reduces the risk of 13 cancers

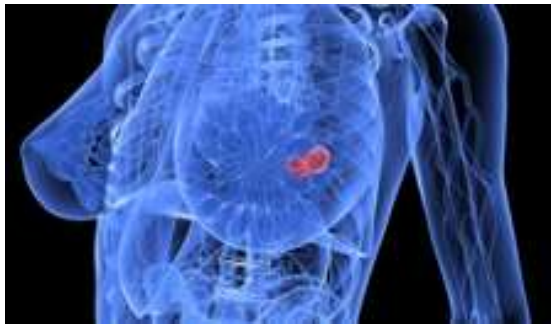
Physical activity-related cancer incidence included the following 13 sites:	n
Esophageal adenocarcinoma	59
Liver	47
Lung	114
Kidney	37
Gastric Cardia	29
Endometrial	52
Myeloid Leukemia	39
Myeloma	48
Colorectal*	188
Head and neck	137
Bladder	80
Breast	254
TOTAL	**1084**

*Colon and rectal cancer have been collapsed into colorectal in accordance with UKBB linkage (https://biobank.ndph.ox.ac.uk/~bbdatan/DeathSummaryReport.html)

Being physically active reduces significantly the risk of developing the most common cancers in women

Breast cancer

-25%



Colon cancer

-25%

Endometrial cancer

-20-30%

PA benefits present in multivariable analysis including all prognostic factors.

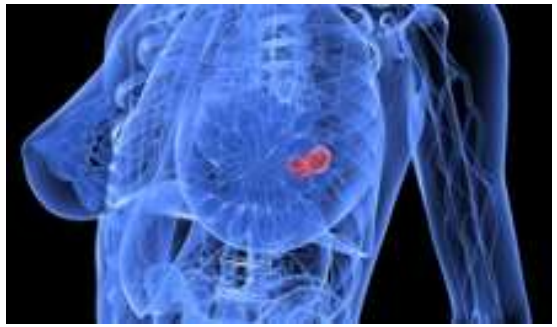
(Sun JY et al, 2012; Keum N et al, 2014; Friedenreich 2020)

After cancer

physical activity is associated with a reduction in overall mortality, specific mortality, and the risk of recurrence

Breast cancer

-40%



Colon cancer

-40%

No study has shown an adverse effect of physical activity

(McTiernan et al. MMSE 2019; Friedenrich et al 2020)

Clinical Interventions in Aging

Dovepress

open access to scientific and medical research

REVIEW

Aging brain: the effect of combined cognitive and physical training on cognition as compared to cognitive and physical training alone – a systematic review

9/10 studies → positive effects of training (endurance) on cognitive functions, brain structures or both

Cognition

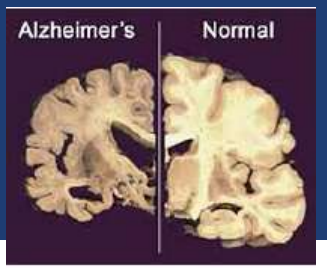
- ✓ ↑short-term memory and working memory
- ✓ ↑ medium and long-term memory
- ✓ ↑ attention
- ✓ ↑ executives functions

Brain

- ✓ Morphological changes in white and grey matter
- ✓ ↑ Connectivity between brain structures
- ✓ ↑ Blood brain flow
- ✓ ↑ Cerebral oxygénation in brain areas specific to a cognitive task

Joubert and Chainay 2018

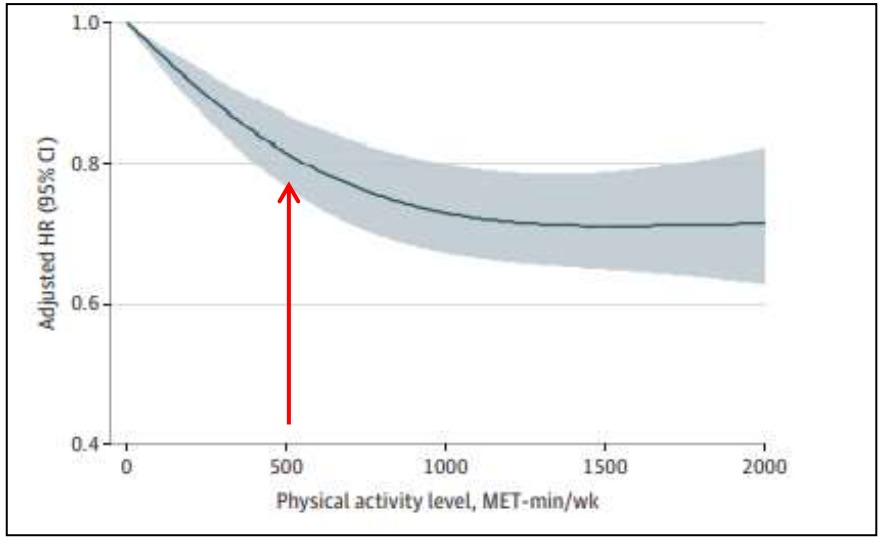
Physical activity reduces the risk of dementia



All-cause dementia	15	20,771	Moderate PA vs Low PA	OR: 0.76	0.61, 0.94	τ=0.06
	24	30,980	High PA vs low PA (participants ≥65 years)	OR: 0.74	0.63 to 0.83	τ=0.06
Guure et al., 2017 *Alzheimer's disease*	21	32,057	High PA vs low PA	OR: 0.62	0.49 to 0.75	τ=0.12
	12	15,326	Moderate PA vs Low PA	OR: 0.71	0.56 to 0.89	τ=0.04
Guure et al., 2017 *Vascular Dementia*	8	NS	High PA vs low PA	OR: 0.92	0.62 to 1.30	NS
Guure et al., 2017 *Cognitive Decline*	22	38,343	High PA vs low PA	OR: 0.67	0.55, 0.78	τ=0.06
	11	27,596	Moderate Pa vs Low PA	OR: 0.74	0.60, 0.90	τ=0.04
	16	21,342	High PA vs low PA (participants ≥65 years)	OR: 0.64	0.50 to 0.77	τ=0.40
Lee, J. 2019 *All-cause dementia*	3	3,117	Vigorous P intensity PA	OR: 0.72	0.59 to 0.86	43.51%
Lee, J. 2019	8	31,372	Highe of PA	OR: 0.54	0.42 to 0.69	32.47%
Vascular dementia	5	22,111	Mo PA	OR:0.72	0.54 to 0.97	44.68%
Cognitive impairment/decline, Dementia and Alzheimer's disease						
Beydoun et al., 2014 *Alzheimer's disease*	8	17,595	High Pa	0.58	0.49 to 0.70	NS
Alzheimer's disease						
Beckett et al., 2015	9	20,326	Active vs inactive	0.61	0.52 to 0.73	NS
Santos-Lozano, A. et al.,2016	10	23,345	More active vs less active	0.65	0.56 to 0.74	NS
	5	10,615	≥150 min/wk of MVPA	0.60	0.51 to 0.71	NS
Lee, J. 2019	12	40,994	Highest PA vs lowest levels of PA	OR: 0.72	0.66 to 0.80	69.80%
	12	37,165	Moderate PA vs lowest levels of PA	OR: 0.68	0.60 to 0.77	67.60%
Incident depression						
Schuch, 2018	36	266,939	High PA vs low PA (overall)	OR: 0.83 (ADJ)	0.79 to 0.88	NS
	4	NS	≥150 min/wk of MVPA	OR: 0.78 (ADJ)	0.62 to 0.99	NS
				RR/HR: 0.69 (ADJ)	0.49 to 0.95	NS
	16	NS	High PA vs low PA (participants ≥65 years)	OR: 0.79 (ADJ)	0.73 to 0.87	NS
	7	NS	High PA vs low PA (participants ≥65 years)	RR/HR: 0.70 (ADJ)	0.57 to 0.88	NS

-30%

Cunningham Scand J Med Sci Sports 2020



Model adjusted for age, sex, body mass index, Hospital Frailty Risk score, annual income, smoking, alcohol, hypertension, diabetes, dyslipidemia, chronic kidney disease, heart failure, vascular disease, prior ischemic stroke or transient ischemic attack, chronic obstructive pulmonary disease, and malignancy.

Yoon M et al. *JAMA Network Open 2021*

Physical activity relationship with health is strong

Prevention

Improvement

Maintenance

Treatment

Non-pharmacological intervention of chronic diseases

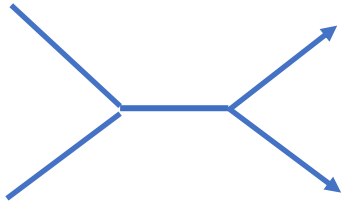
From Professor Charlie Foster
Nuffield Department of Population Health
University of Oxford

Women's physiology: a distinct entity

Significant gender disparity in response to exercise

One session of exercise

Exercise training

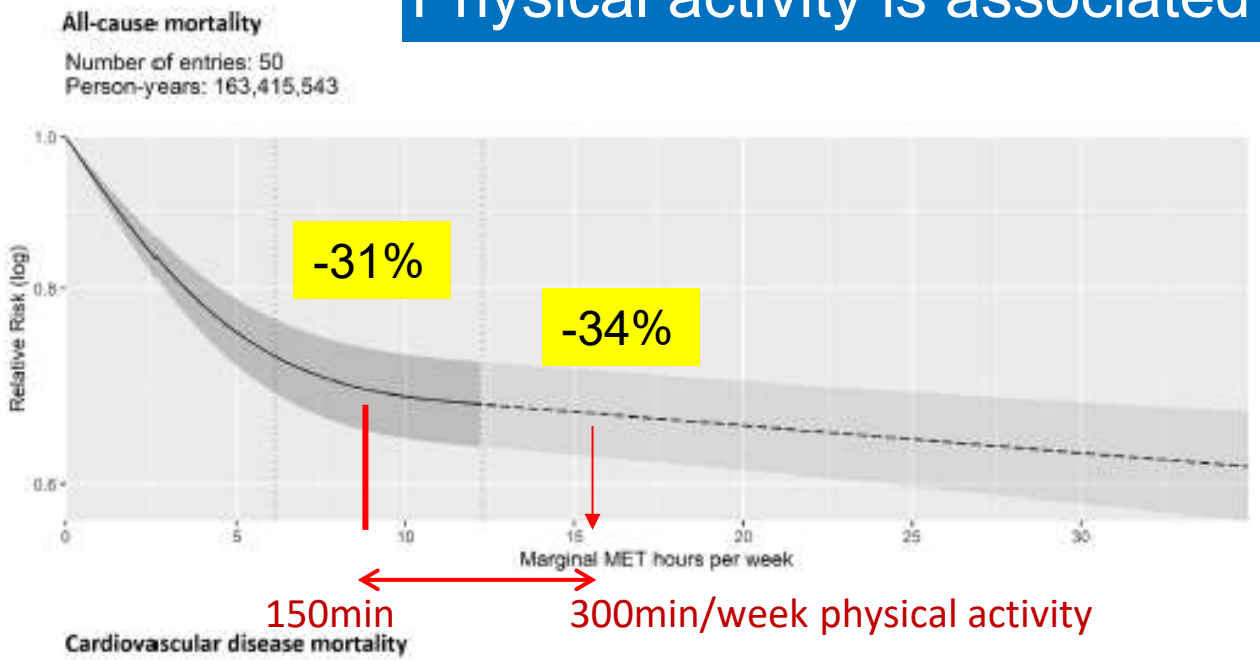


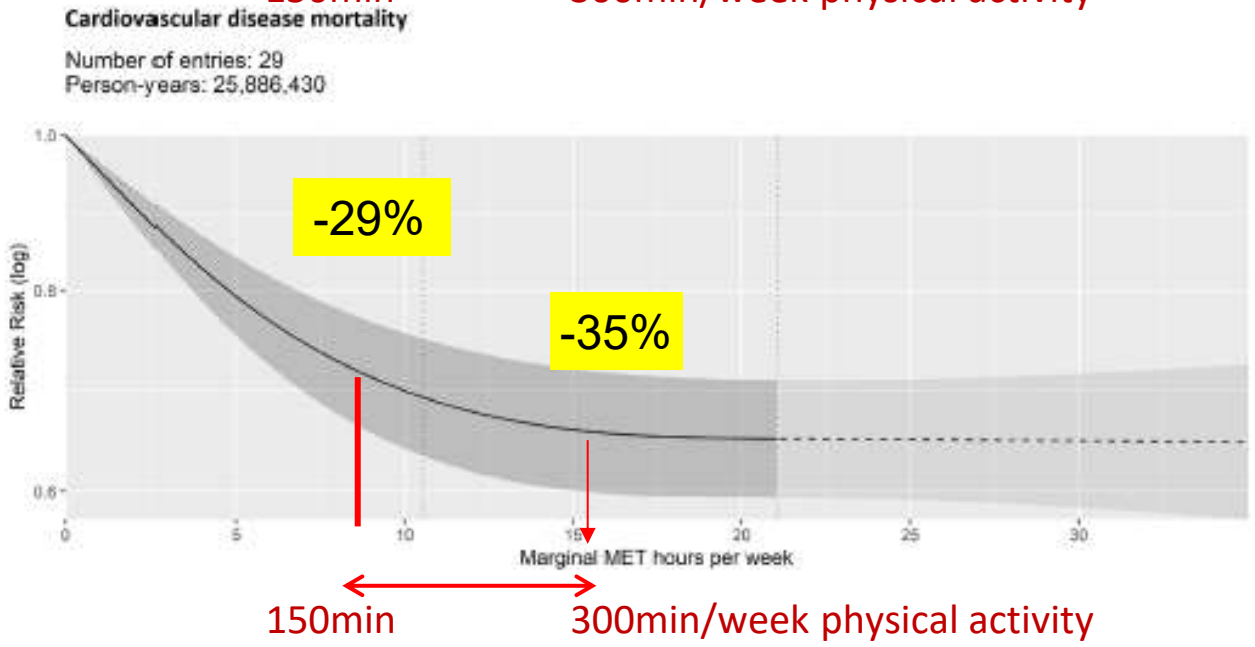
Healthy ♀

♀ with chronic diseases

Garcia M et al. Circ Res 2016
Duclos M Presse Med Formation 2024

Physical activity is associated with decreased mortality





Review

Non-occupational physical activity and risk of cardiovascular disease, cancer and mortality outcomes: a dose–response meta-analysis of large prospective studies

196 articles
94 cohorts
>30 million participants
810 000 deaths
Non-occupational PA

Garcia L et al. Br J Sports Med 2022

Sex-stratified results

Relative risk of mortality and incidence of cardiovascular diseases and cancers at three physical activity levels in relation to 0 mMET-h/week, by sex.

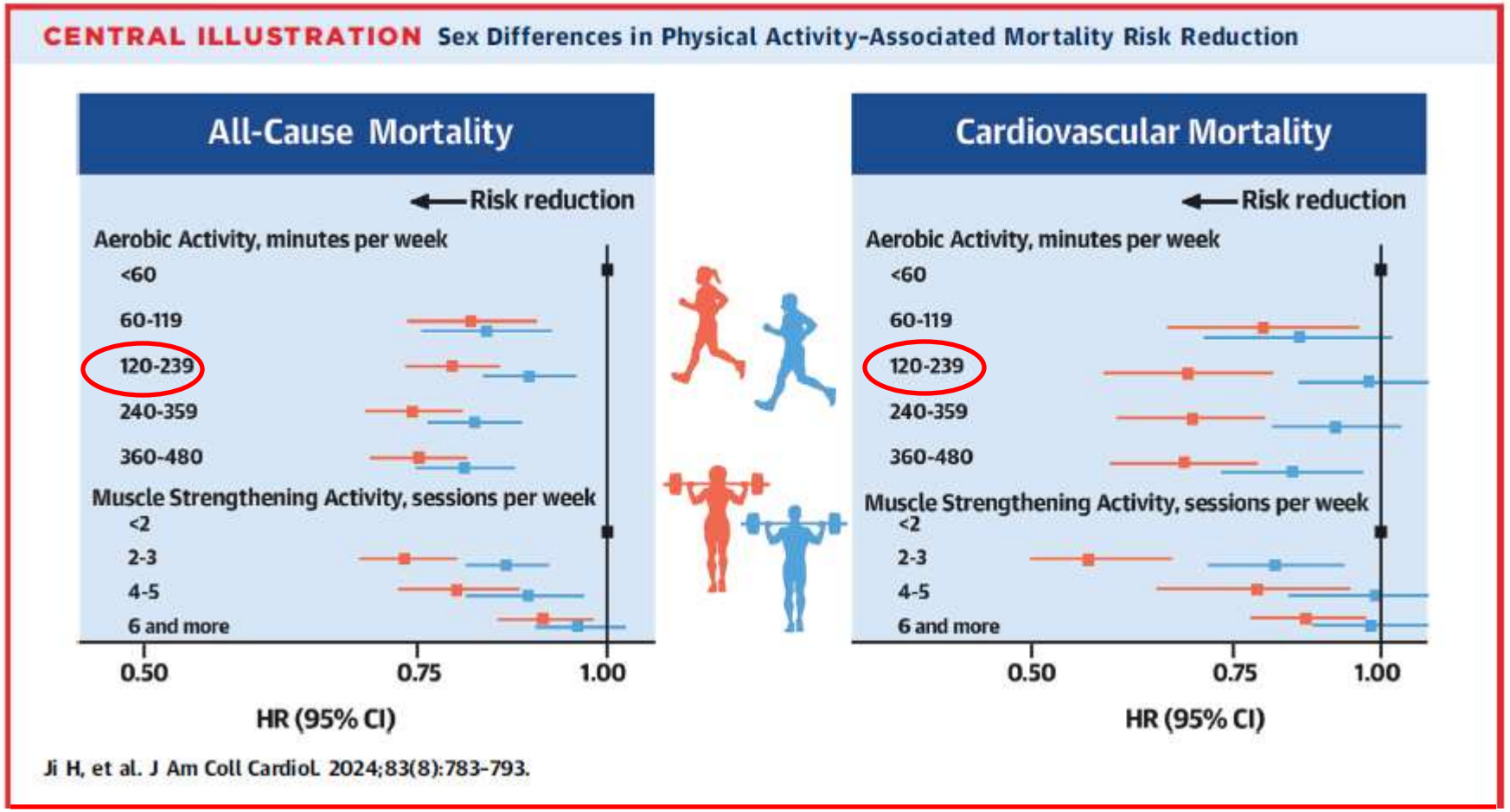
	4.375 mMET-h/week		8.75 mMET-h/week		17.5 mMET-h/week	
	Men	Women	Men	Women	Men	Women
Outcomes	RR (95% CI)	RR (95% CI)	RR (95% CI)	RR (95% CI)	RR (95% CI)	RR (95% CI)
Mortality						
All-cause mortality	0.88 (0.85 - 0.91)	0.84 (0.8 - 0.87)	0.80 (0.76 - 0.85)	0.71 (0.66 - 0.76)	0.75 (0.71 - 0.80)	0.71 (0.66 - 0.76)
Total CVD	0.87 (0.82 - 0.94)	0.81 (0.74 - 0.88)	0.80 (0.72 - 0.89)	0.67 (0.60 - 0.77)	0.75 (0.68 - 0.82)	0.67 (0.60 - 0.77)
Total cancer	0.90 (0.87 - 0.94)	0.95 (0.92 - 0.98)	0.86 (0.80 - 0.91)	0.88 (0.83 - 0.93)	0.84 (0.79 - 0.09)	0.88 (0.83 - 0.93)
CVD incidence (fatal and non-fatal events combined)						
Total CVD	0.89 (0.84 - 0.93)	0.84 (0.76 - 0.91)	0.81 (0.75 - 0.88)	0.70 (0.62 - 0.79)	0.76 (0.71 - 0.82)	0.70 (0.62 - 0.79)
Coronary heart disease	0.92 (0.85 - 0.99)	0.84 (0.75 - 0.93)	0.88 (0.79 - 0.98)	0.73 (0.60 - 0.87)	0.86 (0.76 - 0.97)	0.73 (0.60 - 0.87)
Stroke	0.90 (0.86 - 0.94)	0.88 (0.79 - 0.97)	0.85 (0.79 - 0.91)	0.76 (0.66 - 0.88)	0.82 (0.76 - 0.89)	0.76 (0.66 - 0.88)
Cancer incidence (fatal and non-fatal events combined)						
Total cancer	0.95 (0.92 - 0.98)	0.98 (0.96 - 0.99)	0.92 (0.86 - 0.97)	0.93 (0.89 - 0.97)	0.89 (0.82 - 0.96)	0.93 (0.89 - 0.97)
Colon	0.91 (0.86 - 0.96)	0.97 (0.92 - 1.02)	0.85 (0.78 - 0.94)	0.93 (0.84 - 1.03)	0.81 (0.72 - 0.91)	0.93 (0.84 - 1.03)
Rectum	0.92 (0.80 - 1.07)	1.09 (0.90 - 1.33)	0.90 (0.74 - 1.1)	1.13 (0.73 - 1.76)	0.92 (0.76 - 1.11)	1.13 (0.73 - 1.76)

mMET = marginal metabolic equivalent of task; RR = relative risk; 95% CI = 95% confidence interval. CVD = cardiovascular disease.

Garcia L et al. Br J Sports Med 2022

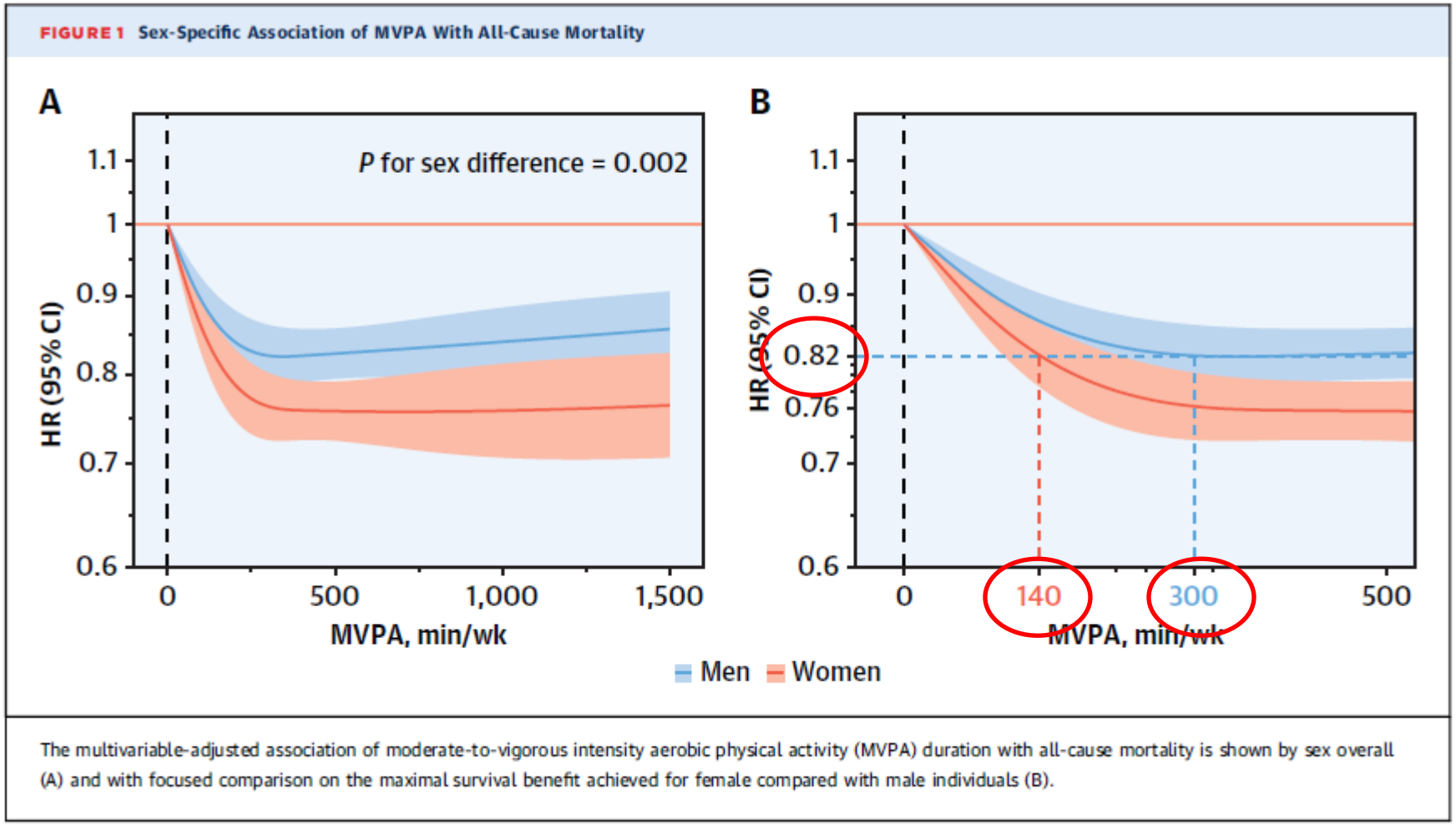
Women derive greater gains in mortality risk reduction than men from physical activity

225 689♀
186 724♂
18-85 years
43.9±16.6 years
PA questionnaires
Follow-up: 20 yrs



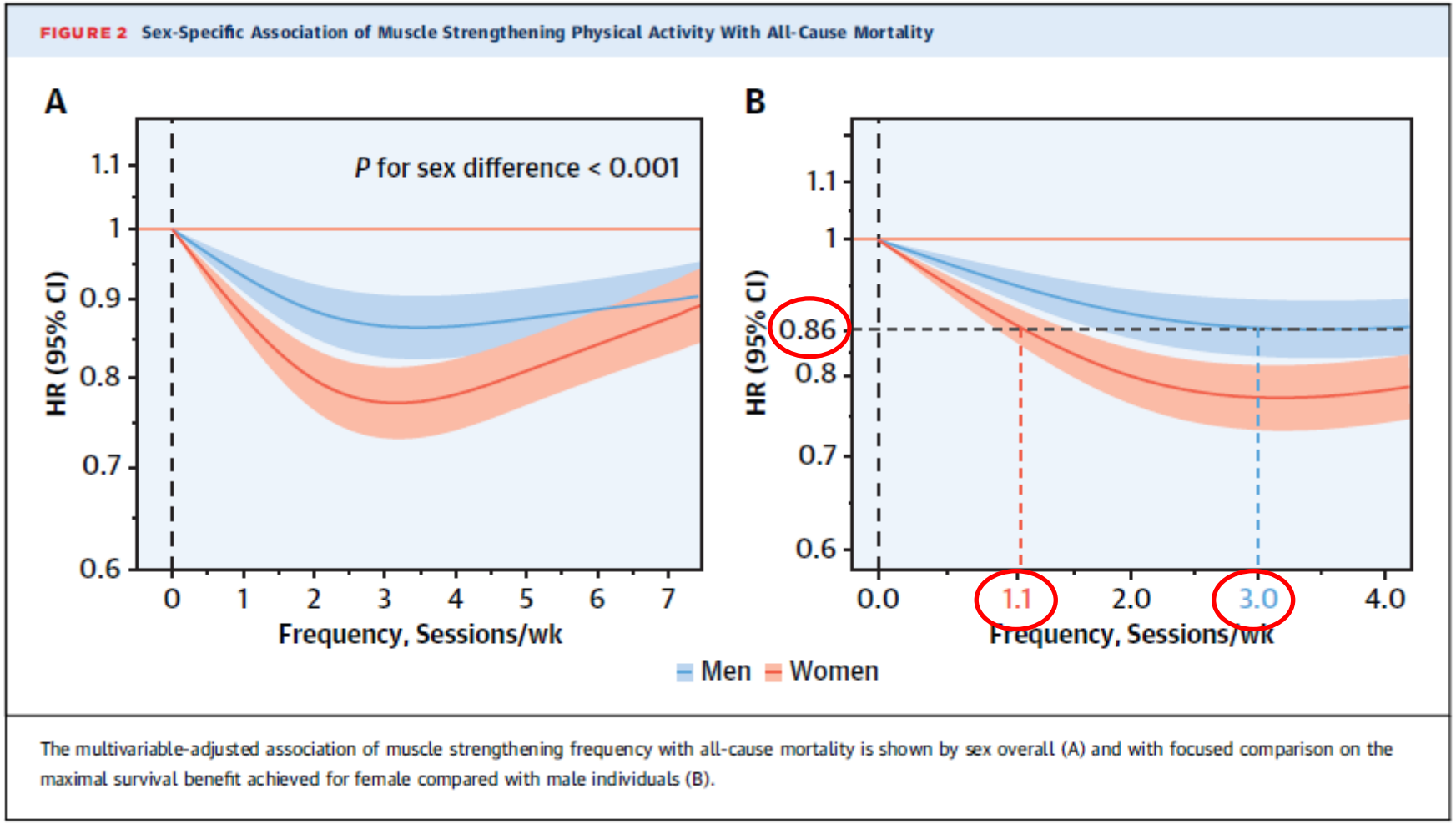
Ji H et al. J Am Coll Cardiol 2024

A lower effective minimum threshold in ♀ for aerobic MPVA



Ji H et al. J Am Coll Cardiol 2024

A lower effective minimum threshold in ♀ for strength training



Ji H et al. J Am Coll Cardiol 2024

Take home messages

Physical activity a unique health issue for women with its specificities

Starting physical activity early in life and maintaining it throughout life

It is never to late to engage in physical activity

Large areas of research remain necessary