



Combined strength and endurance exercise training in CAD: lessons from molecular insights towards clinical application in cardiac rehabilitation

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Background

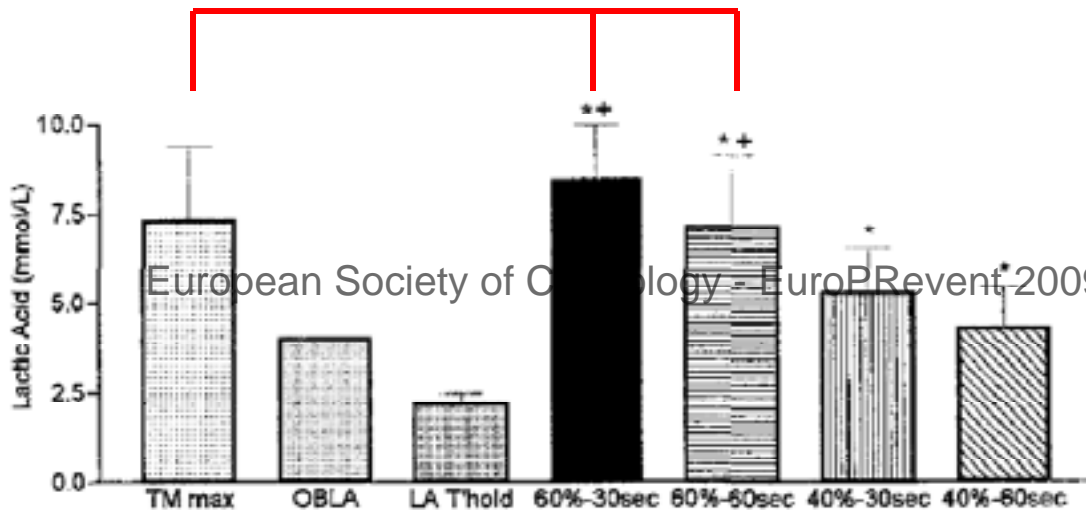
- Exercise interventions in CAD
 - Endurance-type exercises
 - Molecular effect: induces mitochondrial biogenesis
 - Clinical effect: improves VO_{2peak} and ventilatory/anaerobic threshold
 - Resistance-type exercises
 - Molecular effect: induces ribosomal biogenesis
 - Clinical effect: improves muscle strength and mass



Background

- Clinical guidelines
 - Add resistance-type exercises to endurance-type exercise intervention;
Exercise Intensity & Cardiology - EuroPREvent 2009
 - Pre-training: <30% 1RM, 5-10 reps
 - 1st training fase: 30-50% 1RM, 12-25 reps
 - 2nd training fase: 40-60% 1RM, 8-15 reps

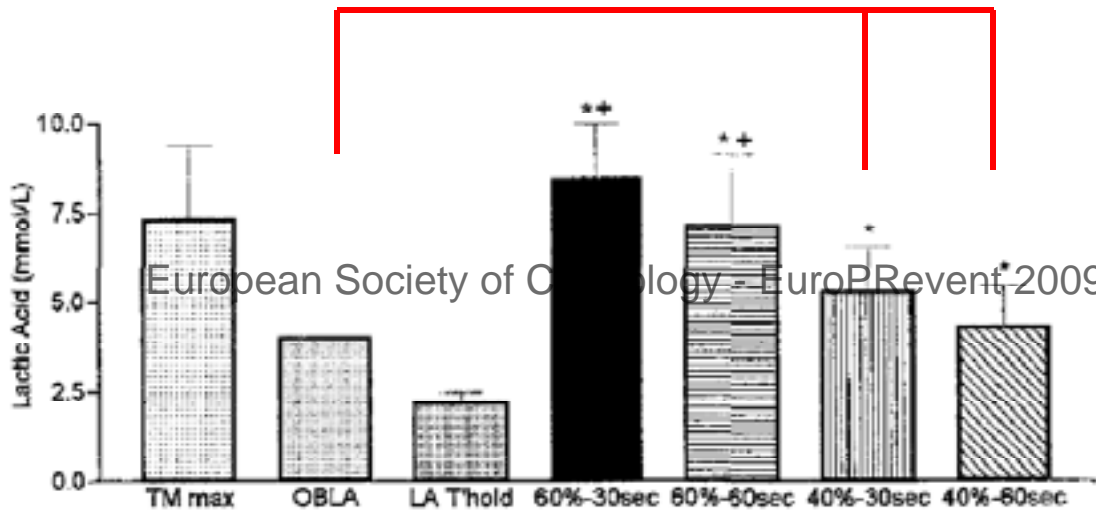
Safety



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Blood LA response to maximal treadmill (TM) exercise, theoretical onset of blood lactic acid (OBLA), determined LA threshold, and four CWT protocols. Values are mean \pm SD. *Significantly greater than LA threshold, $p < .05$. †Significantly greater than OBLA (4.0mmol/L), $p < .05$. 60%-30sec, 60%-60sec > 40%-30sec > 40%-60sec, $p < .05$.

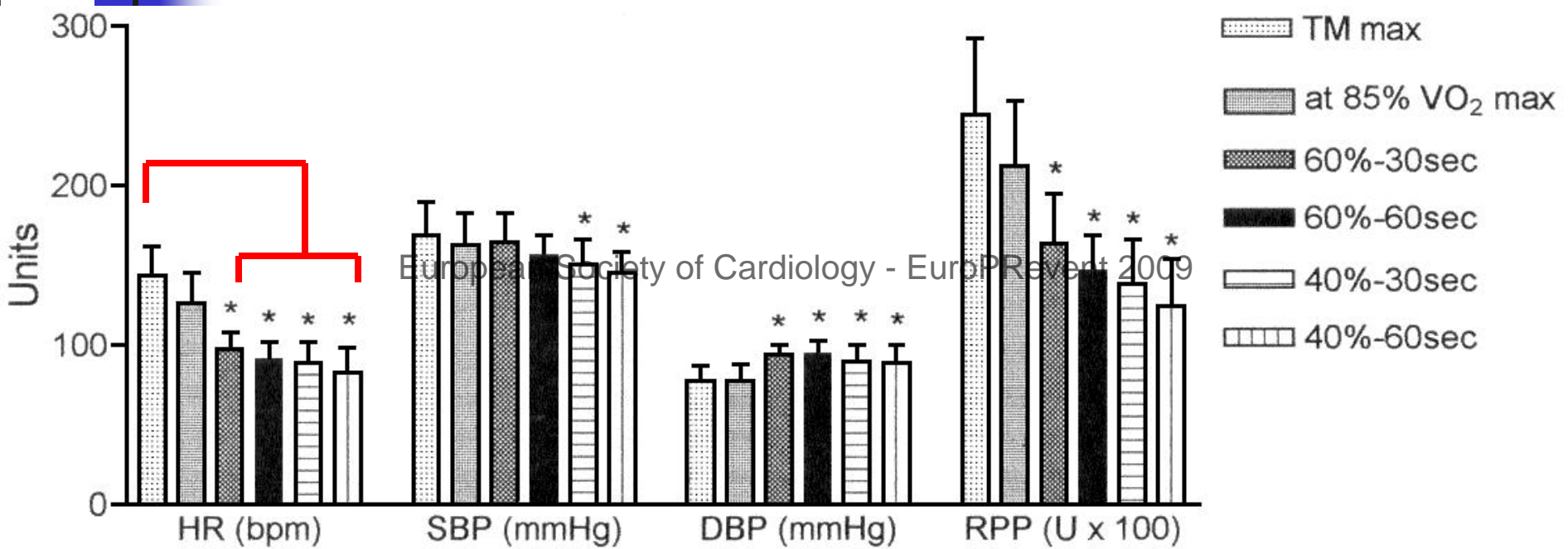
Safety



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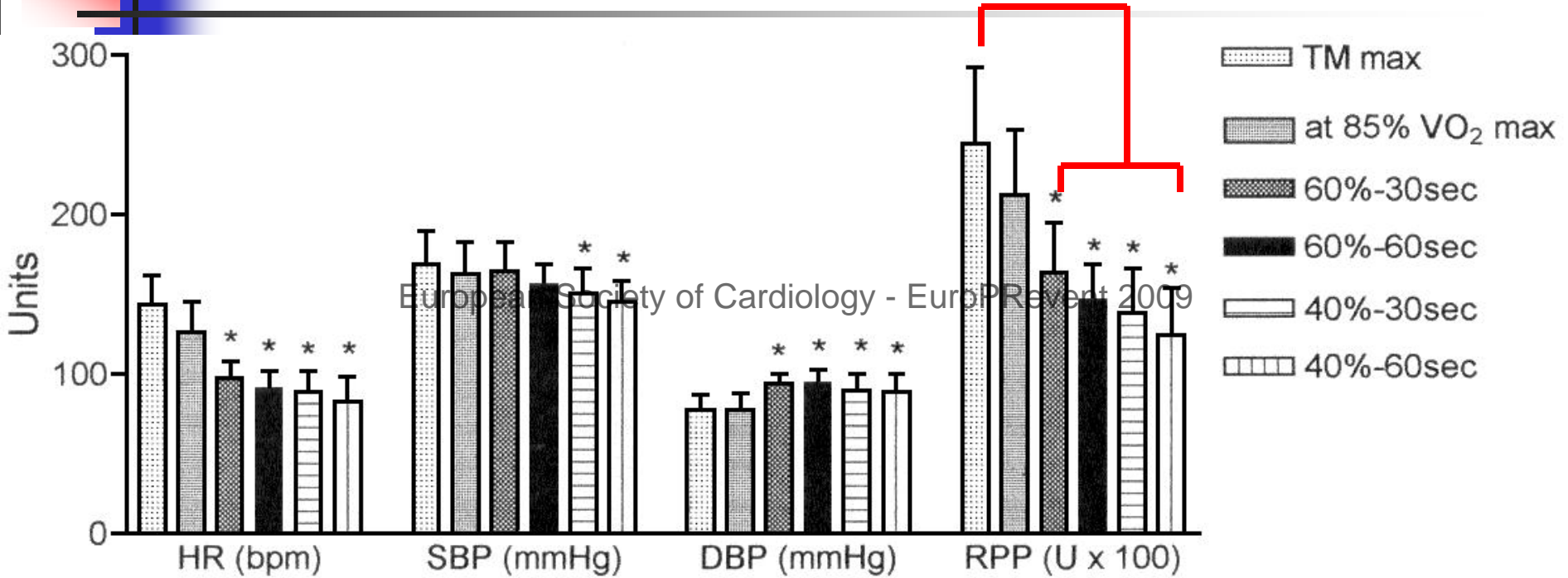
Safety



Comparison of physiologic responses between treadmill exercise and various circuit weight training protocols

*Indicates significantly different (P<.05) from value at 85% VO₂max

Safety



Comparison of physiologic responses between treadmill exercise and various circuit weight training protocols

*Indicates significantly different (P<.05) from value at 85% VO₂max



Safety

“The perceived increased risk of cardiovascular complications related to blood pressure elevations are the primary concern with resistance training in cardiac patients...
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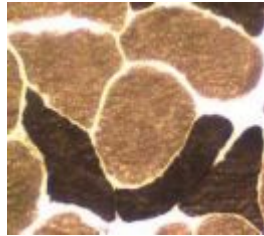
...recent studies have demonstrated that this does not need to be a contradiction in all cardiac patients.”

Background



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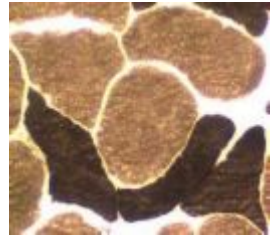
↑ Strength
Mass



Background



↑ Strength
Mass



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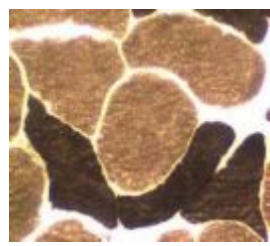


VO_{2peak}
Ventilatory threshold
Anaerobic threshold

Background



↑ Strength
Mass



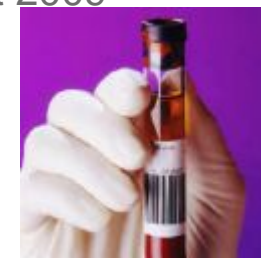
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VO_{2peak}
Ventilatory threshold
Anaerobic threshold

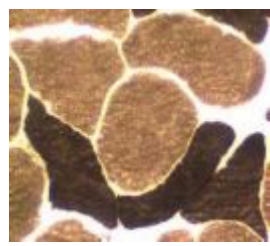


Lipid profile
Glycaemic control
Inflammation

Background



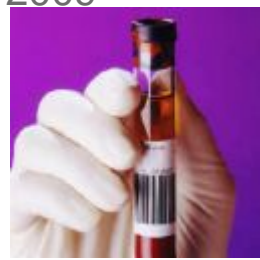
↑ Strength
Mass



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VO_{2peak}
Ventilatory threshold
Anaerobic threshold



Lipid profile
Glycaemic control
Inflammation



Adipose tissue

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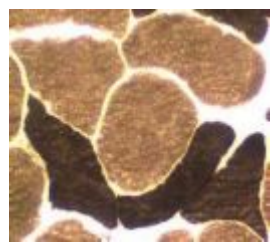
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Background



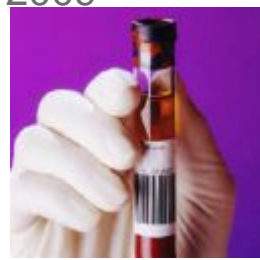
↑ Strength
Mass



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VO_{2peak}
Ventilatory threshold
Anaerobic threshold



Lipid profile
Glycaemic control
Inflammation



Psychological well-being



Adipose tissue

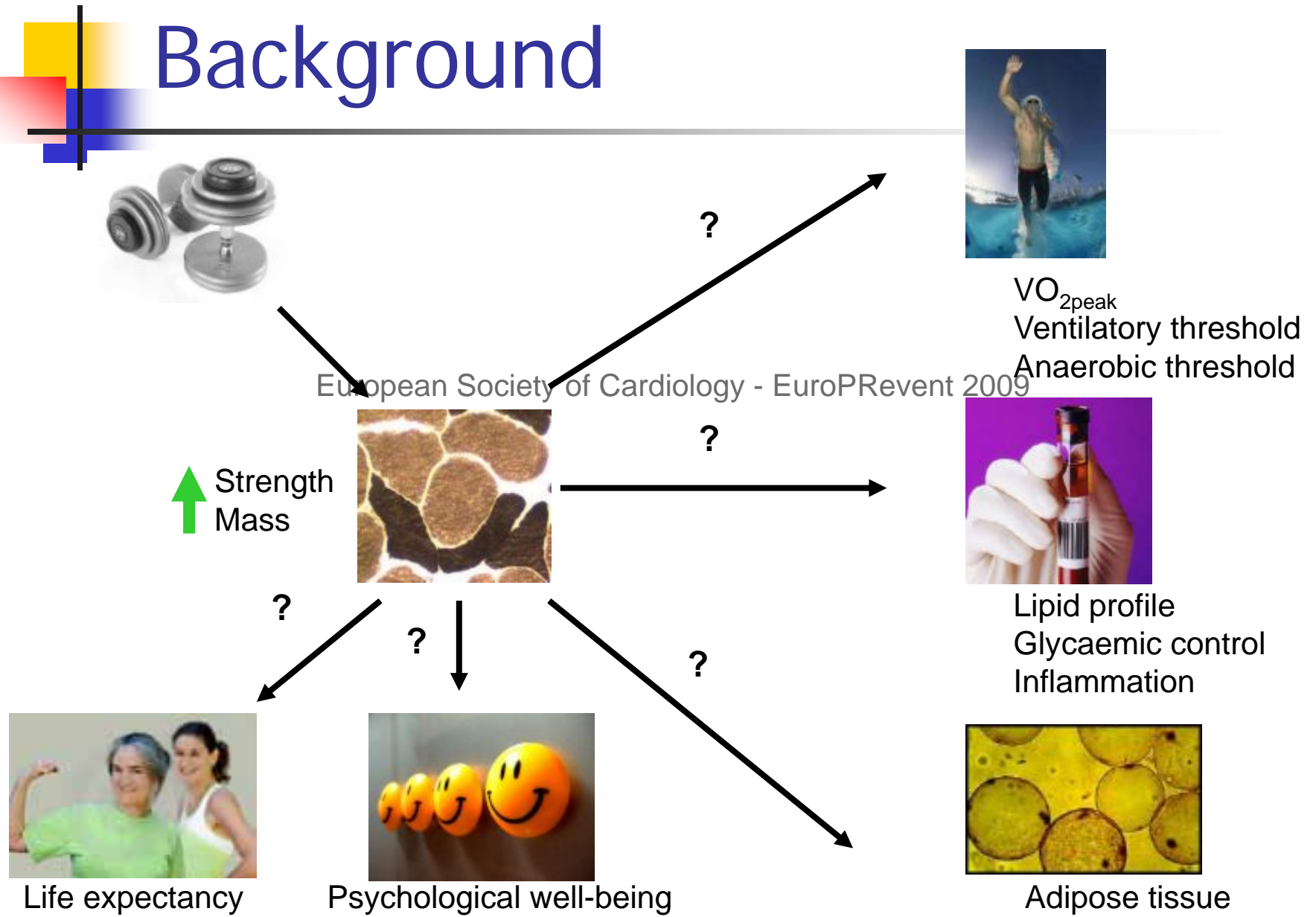
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Background





Literature review

- Studies examining CAD patients
 - Endurance-type exercise training vs endurance- and resistance-type exercise training
 - Clinical parameters
 - Body composition
 - Muscle strength
 - Exercise performance capacity
 - Blood plasma parameters
 - Psychological well-being
 - Mortality and cardiovascular morbidity



Literature review

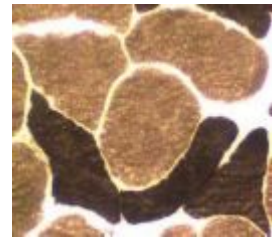
- Included studies

- **McCartney** et al. Am J Cardiol 1991
- **Stewart** et al. J Cardiopulm Rehabil 1998
International Society of Cardiopulm Rehab 2009
- **Beniamini** et al. J Cardiopulm Rehabil 1999
- **Pierson** et al. J Cardiopulm Rehabil 2001
- **Santa-Clara** et al. Eur J Appl Physiol 2002 and
Metabolism 2003
- **Arthur** et al. J Rehabil Med 2007
- **Gayda** et al. J Electromyogr Kinesiol 2007
- **Marzolini** et al. Med Sci Sports Exerc 2008

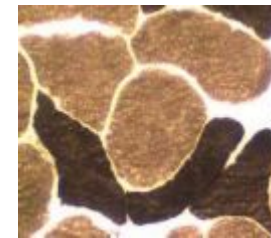
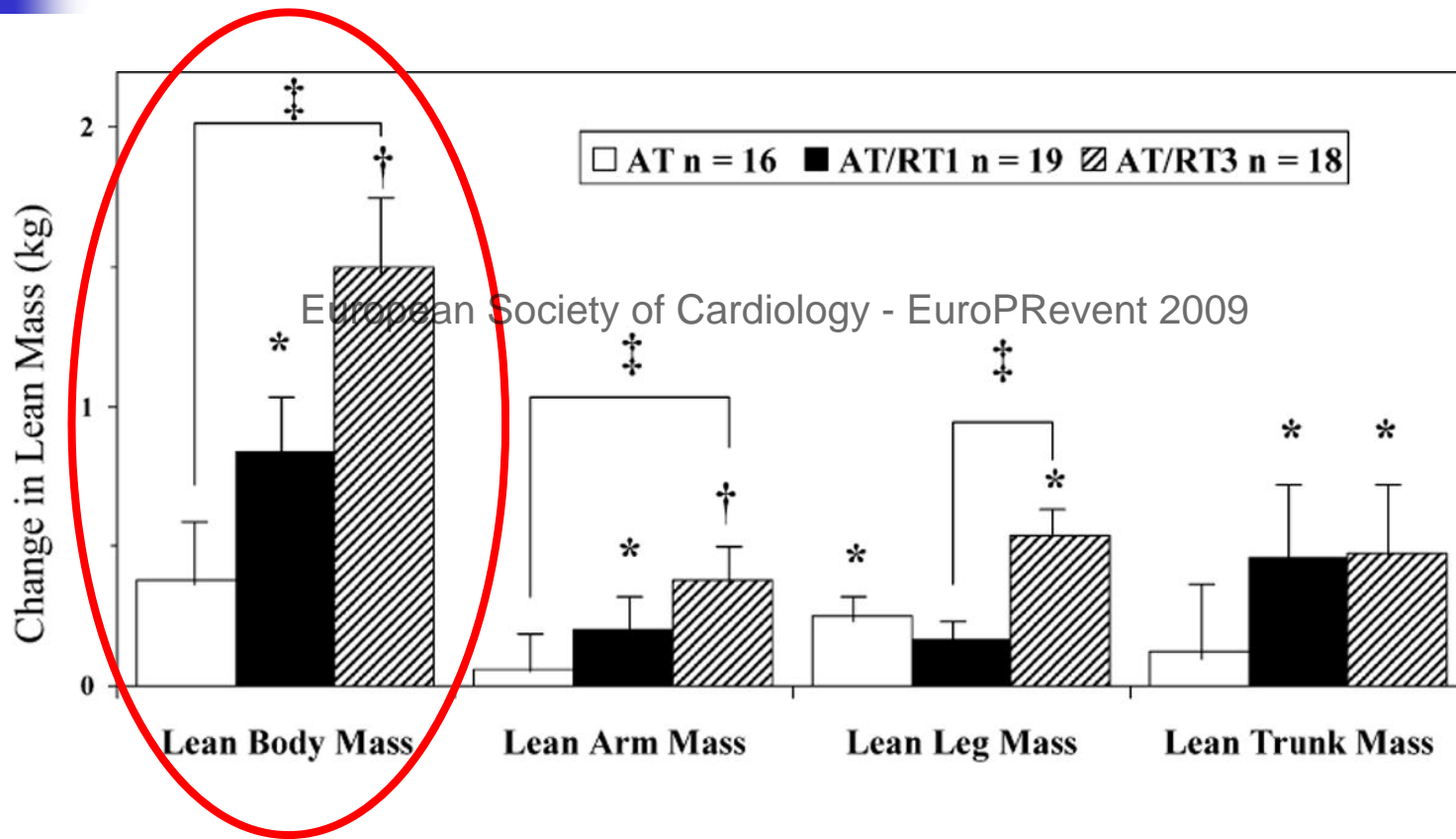
Skeletal muscle (fat-free) mass

- No impact of additional resistance-type exercises
 - Gayda et al. 2008
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- Positive impact of additional resistance-type exercises
 - Beniamini et al. 1999
 - Pierson et al. 2001
 - Santa-Clara et al. 2003
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Skeletal muscle (fat-free) mass

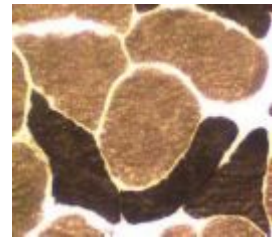


Muscle strength

- No impact of additional resistance-type exercises
 - Arthur et al. 2007
 - Gayda et al. 2008

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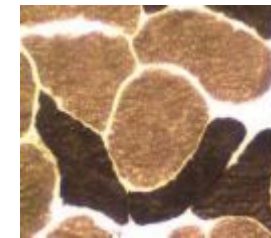
Muscle strength

	Aerobic Training (AE)			Combined Training (AE + R)			P-value
	Baseline	Final	Δ (%)	Baseline	Final	Δ (%)	
Knee extension	130.8 ± 44.7	157.4 ± 53.6	21.1*	123.8 ± 40.2	188.3 ± 49.2	56.3*	0.02
Hamstring curl	50.5 ± 13.1	61.9 ± 15.4	24.6 [†]	55.4 ± 15.7	98.5 ± 30.2	78.7*	0.002
Chest press	59.9 ± 29.7	72.9 ± 36.3	23.2*	70.8 ± 29.2	109.8 ± 39.3	61.1*	0.01
Shoulder press	45.4 ± 18.1	61.1 ± 30.3	35.4*	45.4 ± 18.1	61.1 ± 30.3	55.7*	0.06
Pullover	88.8 ± 35.3	101.2 ± 44.7	12.6 [†]	94.8 ± 30.2	135.8 ± 42.4	44.3*	0.004
Bicep curl	51.8 ± 25.6	61.1 ± 32.9	16.1	55.4 ± 23.6	84.3 ± 27.1	63.8*	0.008
Tricep extension	39.3 ± 16.0	49.3 ± 23.6	23.7 [†]	49.8 ± 17.8	86.1 ± 32.2	81.0*	0.03

Data are presented as mean ± standard deviation, P value column indicates difference between groups.

*Indicates significant increase compared to baseline (P < 0.01).

[†]Indicates significant increase compared to baseline (P < 0.05).



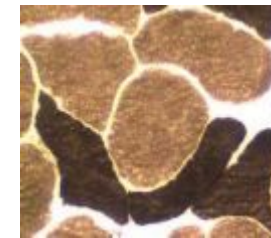
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Preliminary conclusion

- Additional resistance-type exercises contribute to greater increase in
 - skeletal muscle (fat-free) mass
 - muscle strength

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Are there beneficial effects on other parameters?

Exercise capacity ($\text{VO}_{2\text{peak}}$)

- No impact of additional resistance-type exercises
 - Santa-Clara et al. 2002
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 - Arthur et al. 2007
 - Marzolini et al. 2008
- Positive impact of additional resistance-type exercises
 - Stewart et al. 1998
 - Gayda et al. 2007



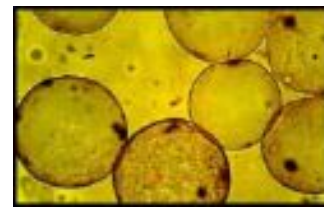
Exercise capacity (VT/AT)

- No impact of additional resistance-type exercises
 - none
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- Positive impact of additional resistance-type exercises
 - Santa-Clara et al. 2002
 - Gayda et al. 2007
 - Marzolini et al. 2008

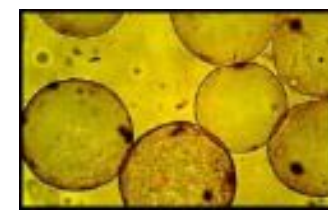
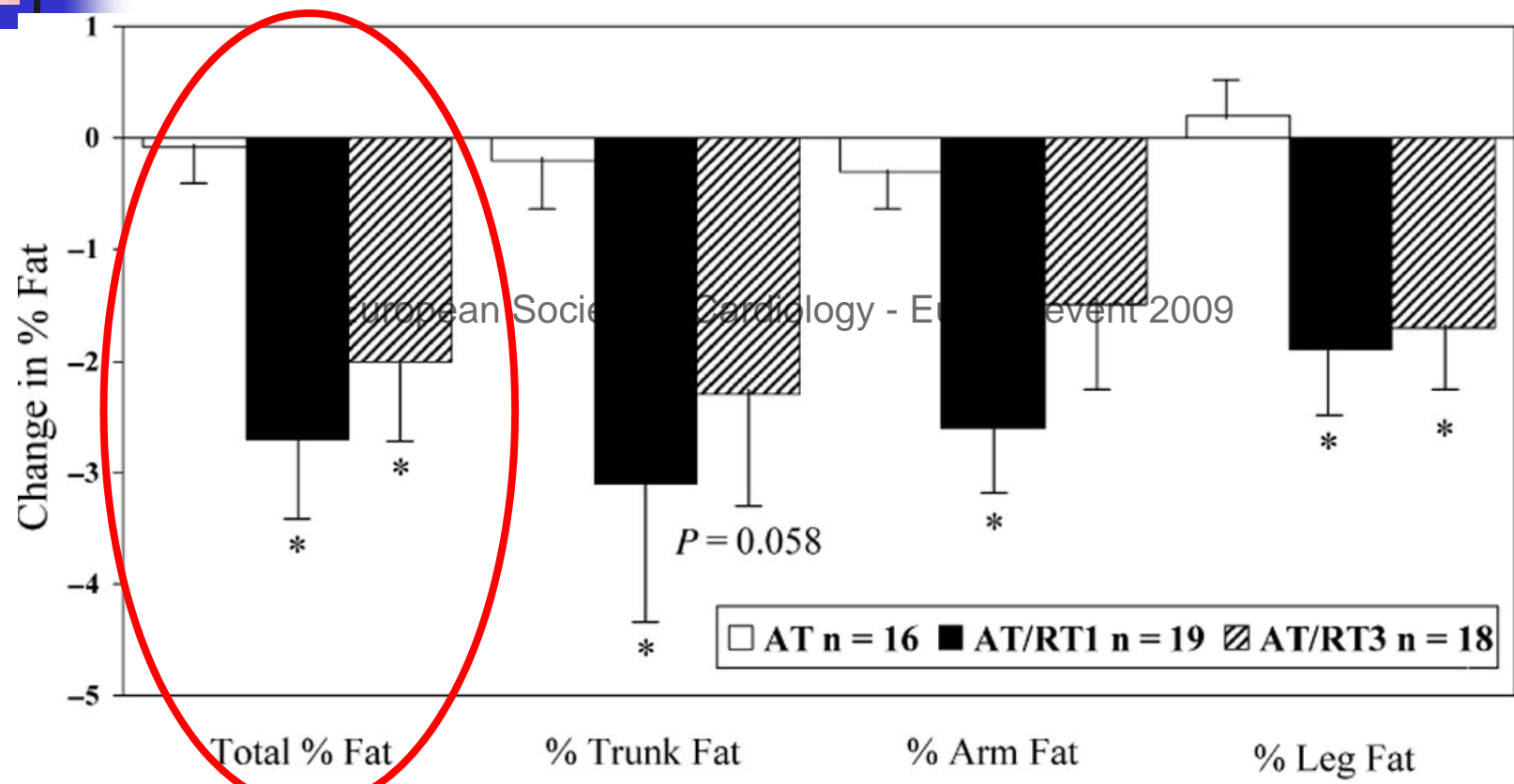


Adipose tissue mass

- No impact of additional resistance-type exercises
 - Stewart et al. 1998
 - Gayda et al. 2007
- Positive impact of additional resistance-type exercises
 - Beniamini et al. 1999
 - Pierson et al. 2001
 - Santa-Clara et al. 2003
 - Marzolini et al. 2008



Adipose tissue mass



Blood parameters

- Impact of additional resistance-type exercises in CAD patients on

- European Society of Cardiology - EuroPREvent 2009 Lipid profile
- Glycaemic control/insulin sensitivity
- Inflammation

No study found...



Blood parameters

- Comparison with other populations?
 - Healthy, elderly, and/or obese individuals

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- Difficult
 - Statin use in CAD patients
 - Inflammatory response post-infarction or post-revascularisation

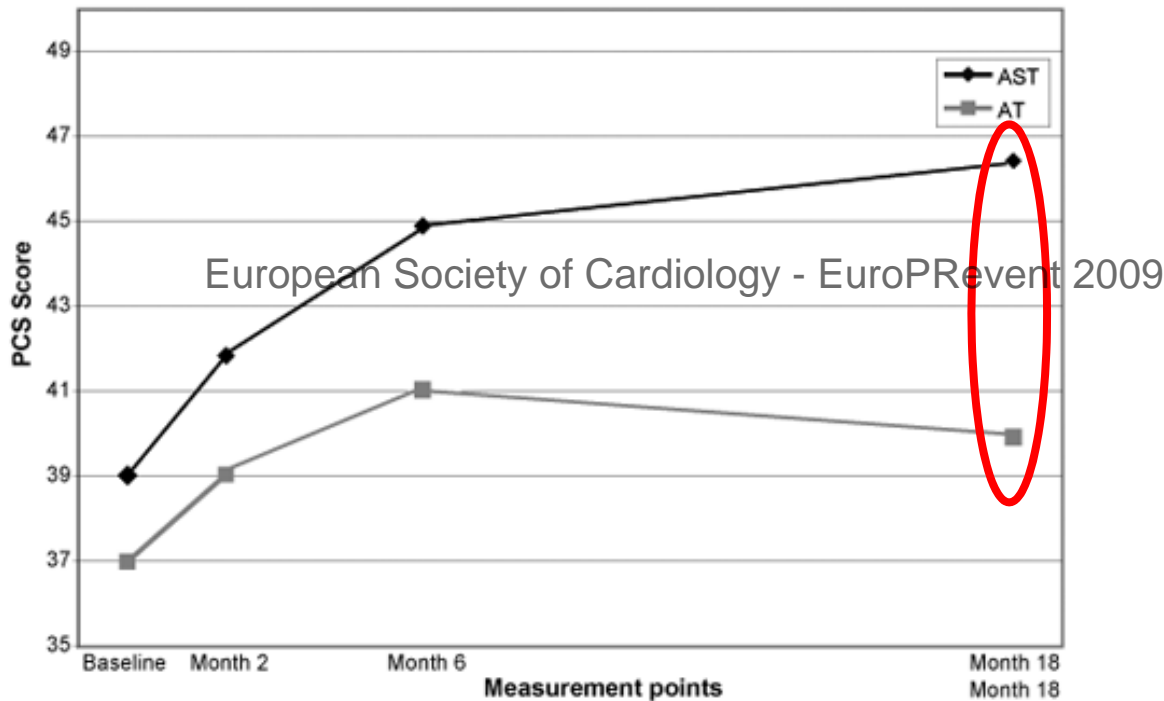


Psychological well-being

- No impact of additional resistance-type exercises
 - none
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- Positive impact of additional resistance-type exercises
 - Arthur et al. 2007



Psychological well-being



Change in physical component summary (PCS) score from baseline to 1-year follow-up.
AST: combined aerobic-strength training; AT: aerobic exercise training.



Mortality

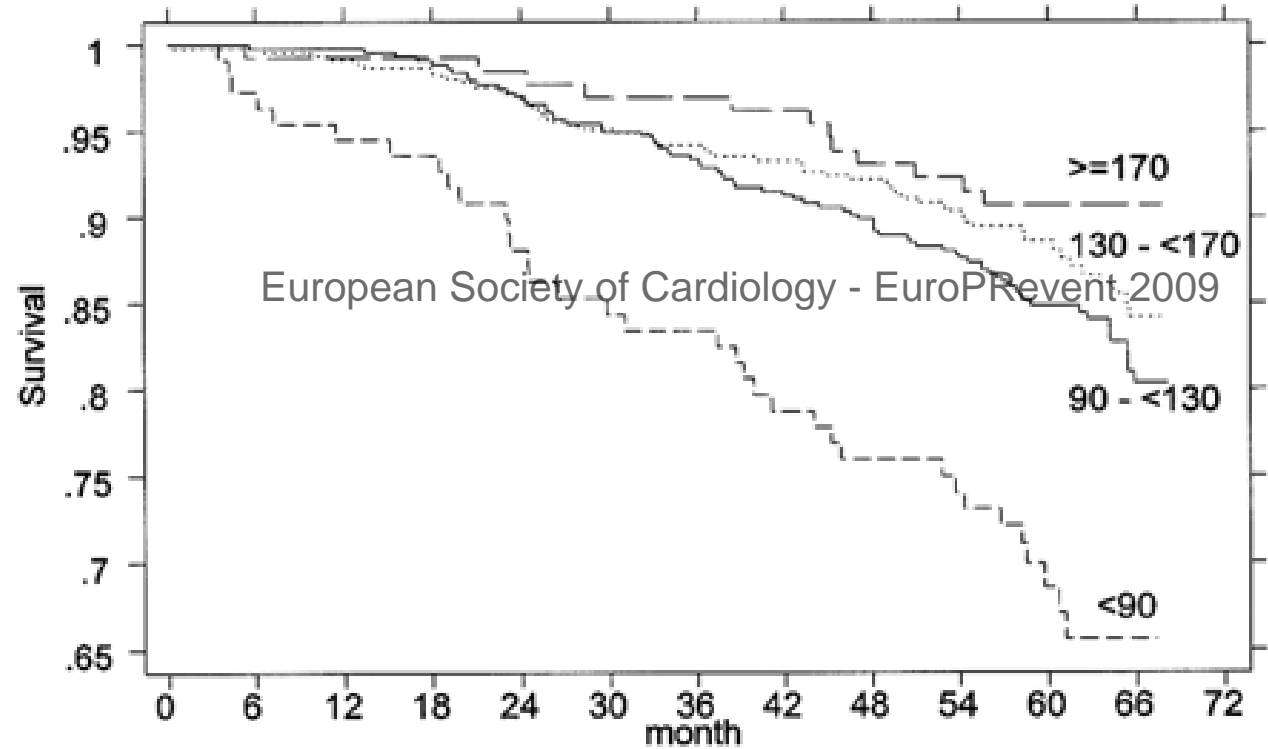
- Impact of additional resistance-type exercises in CAD patients on mortality

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No study found...



Mortality

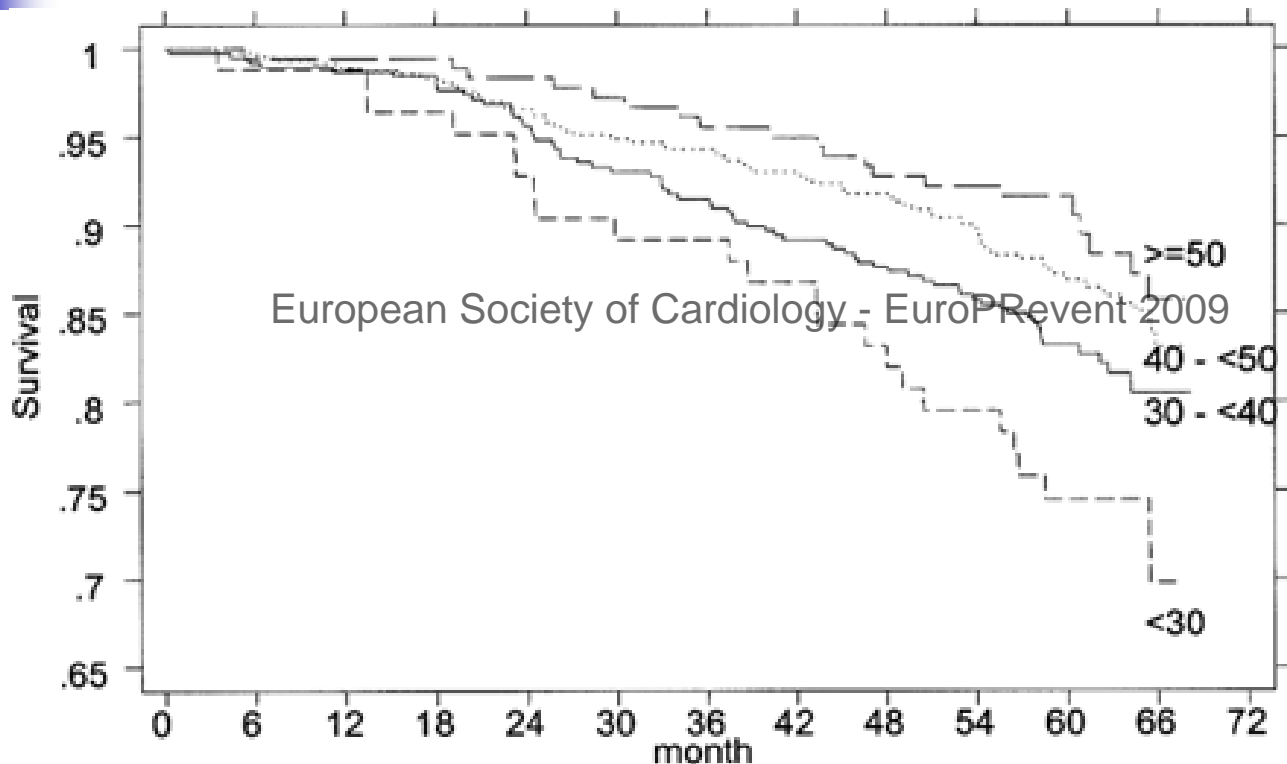


Men, leg strength, and mortality.

Kaplan–Meier survival curves for leg strength groups (<90 , $90\text{--}<130$, $130\text{--}<170$, 170 Nm).



Mortality



Men, grip strength, and mortality.

Kaplan–Meier survival curves for grip strength groups (<30, 30–<40, 40–<50, 50 kg).

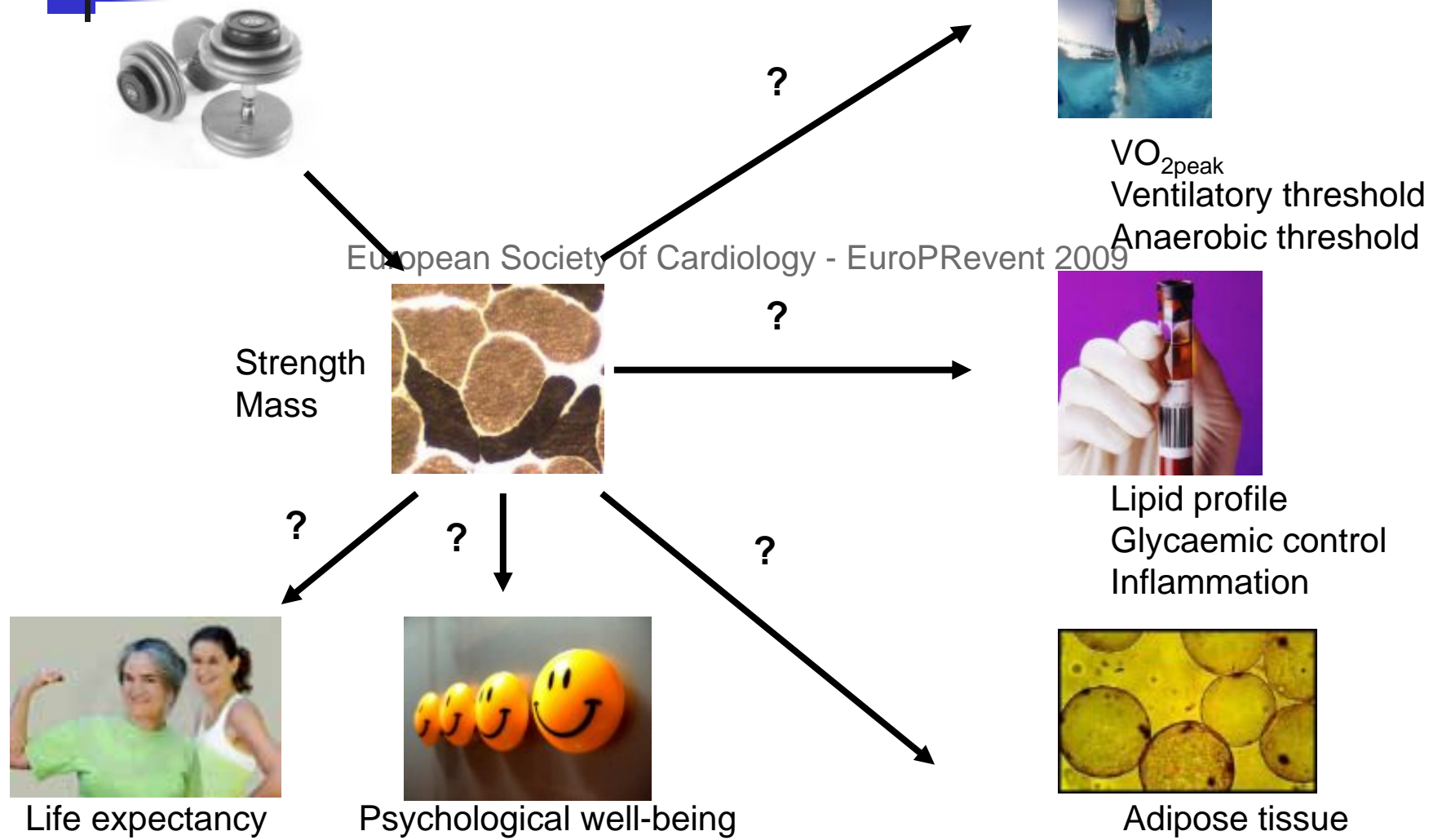


Mortality

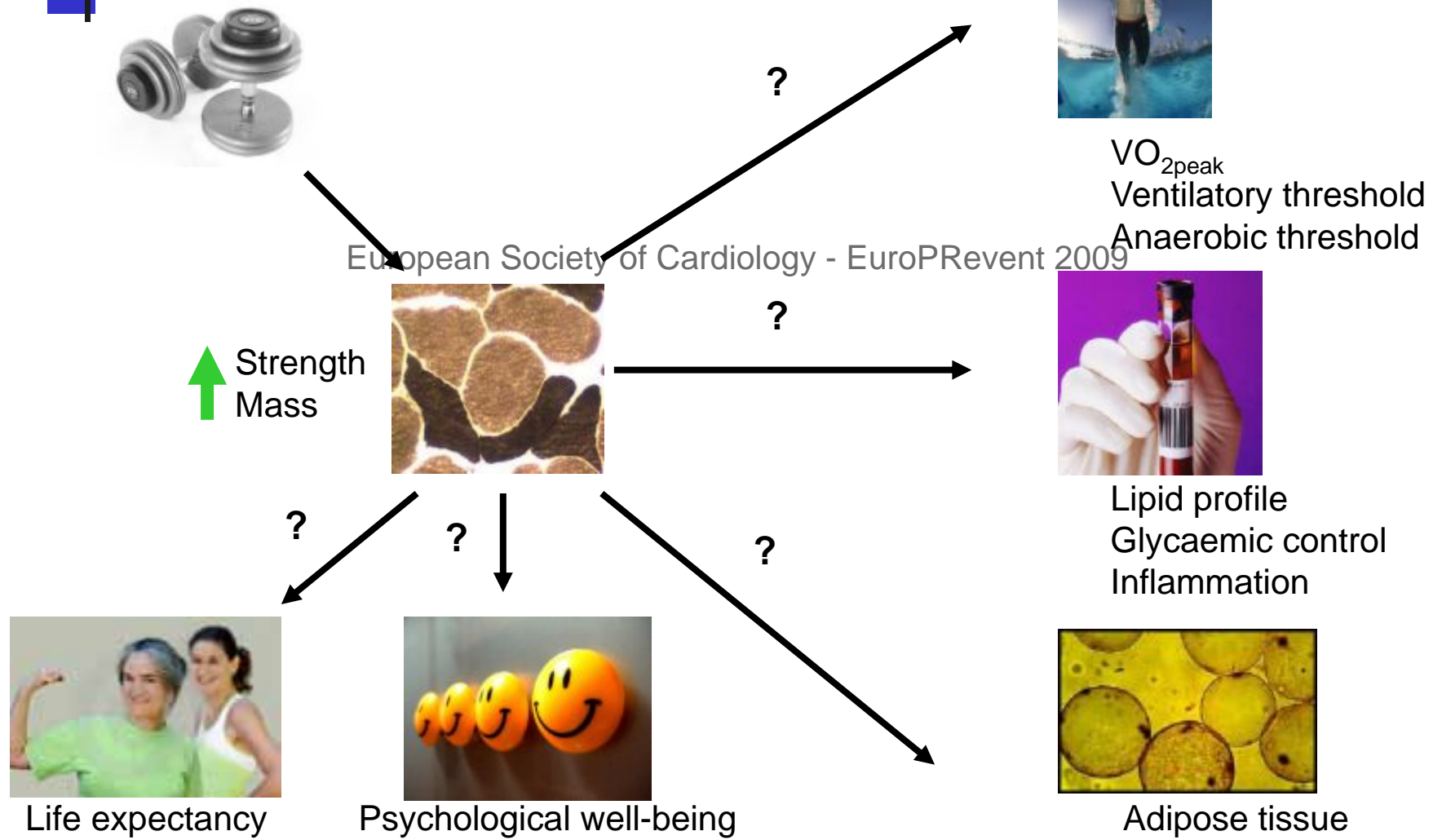
“Low muscle mass did not explain the strong association of strength with mortality, demonstrating that muscle strength as a marker of muscle quality is more important than quantity in estimating mortality risk.”



Effect summary



Effect summary

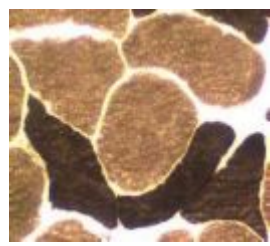


Effect summary

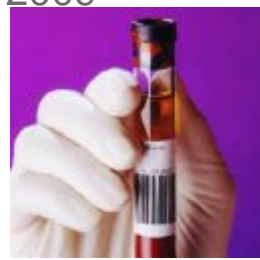


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↑ Strength
Mass



~~VO_{2peak}~~
↑ Ventilatory threshold
↑ Anaerobic threshold



Lipid profile
Glycaemic control
Inflammation



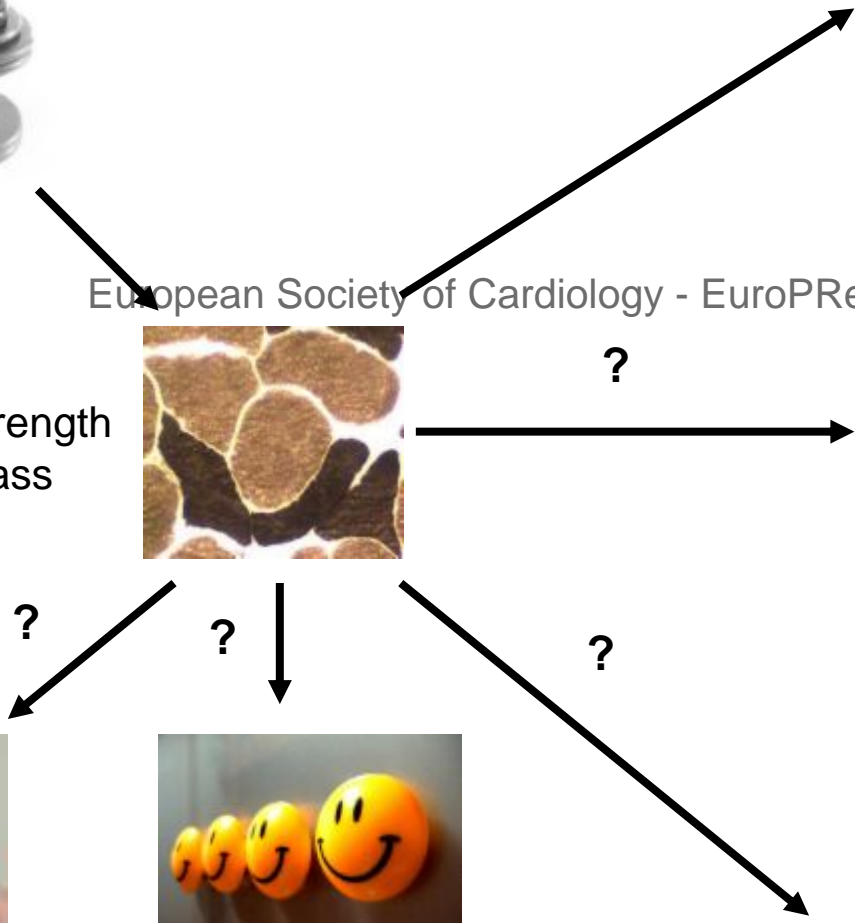
Life expectancy



Psychological well-being



Adipose tissue

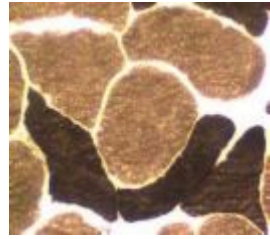


Effect summary



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↑ Strength
↑ Mass



?



~~VO_{2peak}~~
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Lipid profile
Glycaemic control
Inflammation



Life expectancy



Psychological well-being



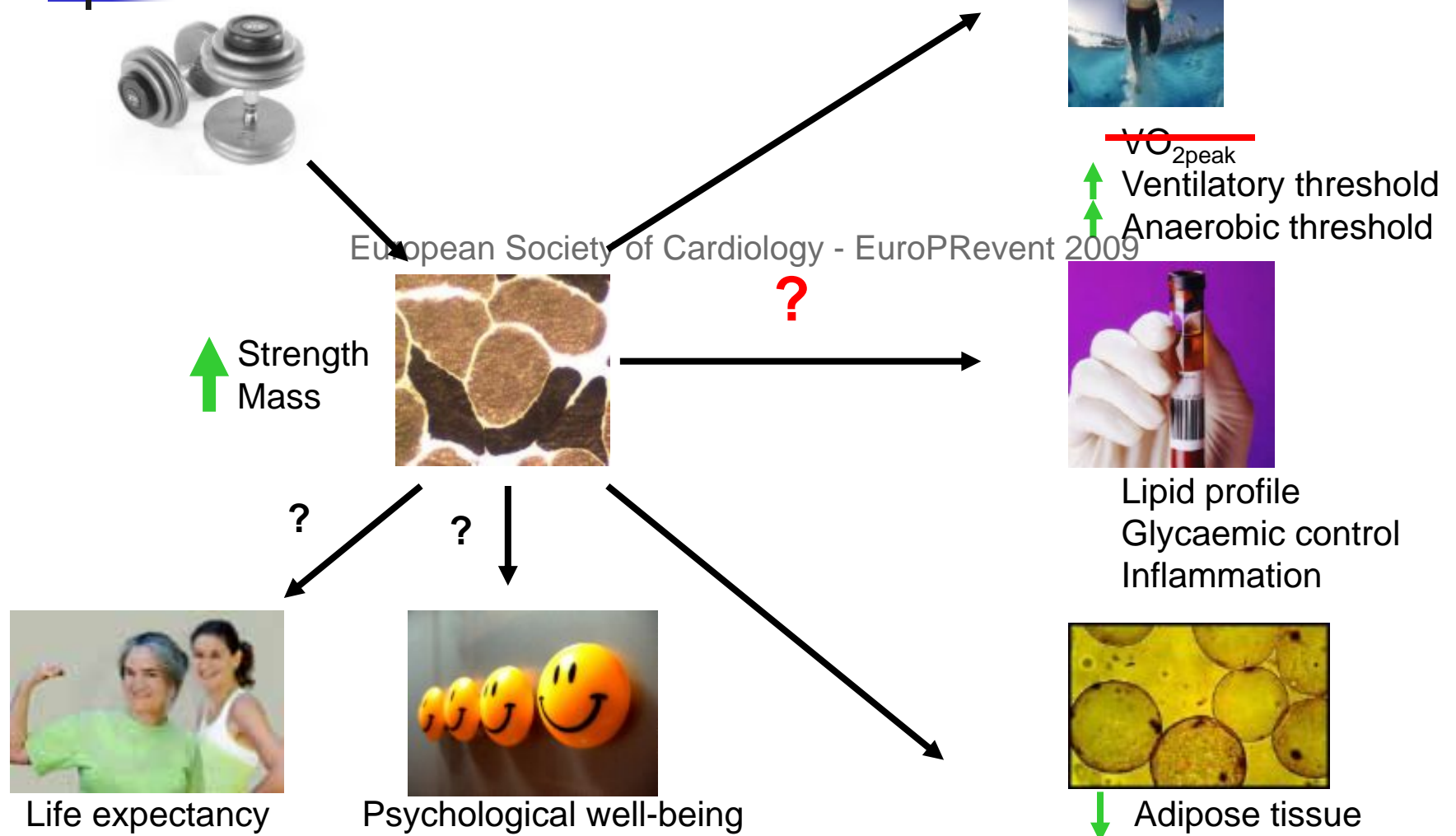
Adipose tissue

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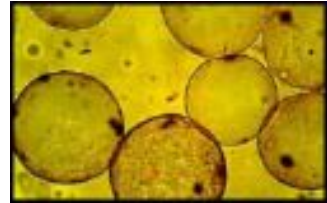
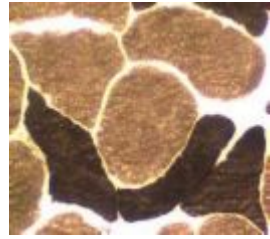
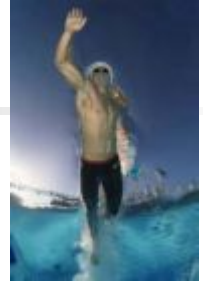
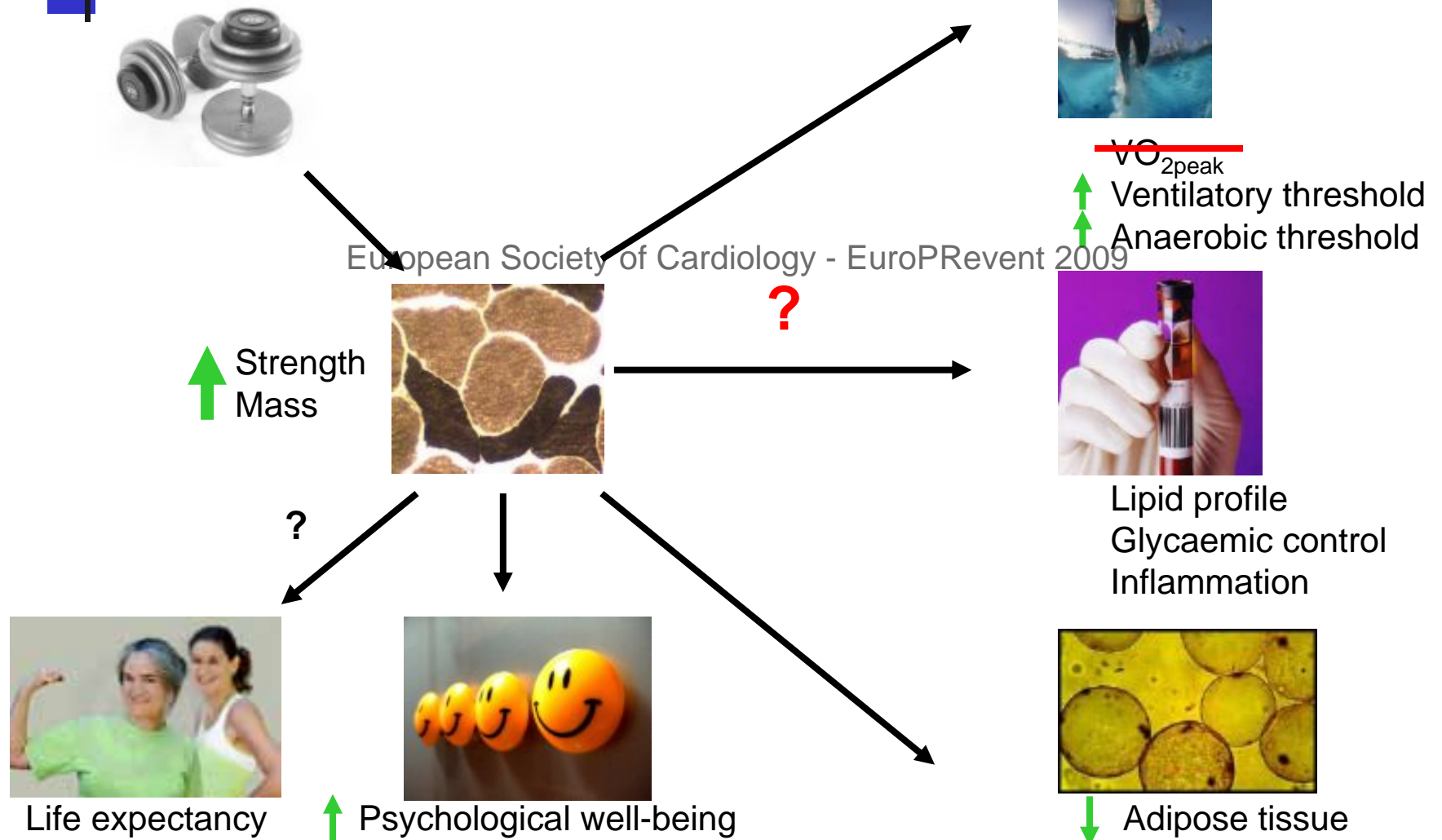
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Effect summary



Effect summary

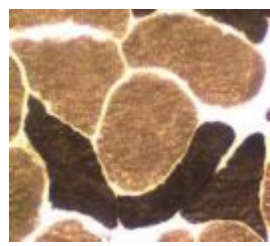


Effect summary



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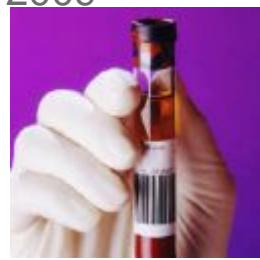
↑ Strength
↑ Mass



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~~VO_{2peak}~~
↑ Ventilatory threshold
↑ Anaerobic threshold



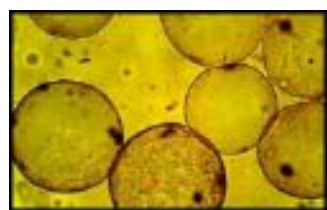
Lipid profile
Glycaemic control
Inflammation



↑ Life expectancy ?



↑ Psychological well-being



↓ Adipose tissue



Exercise modalities

Impact of resistance-type exercise modalities during long-term endurance exercise interventions in CAD patients: evidence from literature

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Exercise modalities

Impact of resistance-type exercise modalities during long-term endurance exercise interventions in CAD patients: evidence from literature

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Exercise modalities

- Studies warranted on:
 - Contraction type
 - Excentric vs isometric vs concentric
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 - Modalities:
 - Intensity (% 1RM)
 - Volume (number of series or contractions)
 - 1 study executed (Marzolini et al.)
 - Recovery period
 - Timing to endurance-type exercises?



General conclusion

- Addition of resistance-type exercises is safe in low-to-moderate risk CAD patients

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- Addition of resistance-type exercises during endurance exercise interventions generate greater clinical benefits in CAD patients
- The definition of resistance-type exercise modalities requires further study

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