Relevant topic for physical activity in ageing

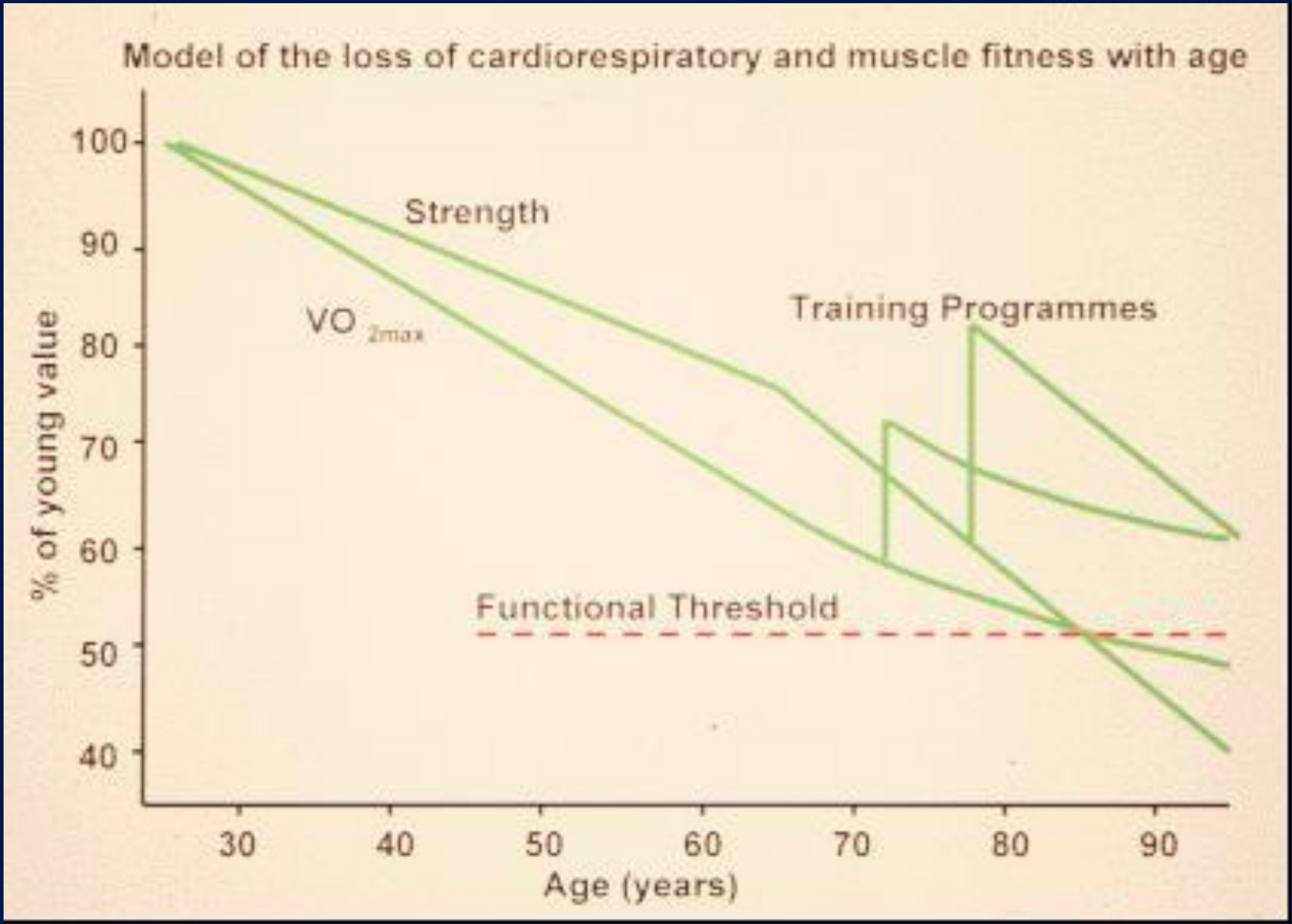
Aerobic conditioning

Prof. Federico Schena

Outline of presentation

- Ageing aerobic decline and function/survival
- Limitations to training changes
- Disuse &/or ageing….what the worse
- Successful ageing…centenarians

Physiological performance decline in ageing: training effect



How much cardiorespiratory fitness decrease in a successful ageing ?

Population:

441 randomly selected men and women 55-85 y

10-y follow-up, n = 115 (62 VO_2max, fatigue treadmill; 45 T_{VE})
lost to follow-up (death, dependent, refusals, no contact)
(**Paterson et al** . Longitudinal changes in aerobic power in older men and women. *JAP*, 97: 2004)

Therefore "successful" ageing; from mean ages
64 to 74 y

Purpose/Rationale:

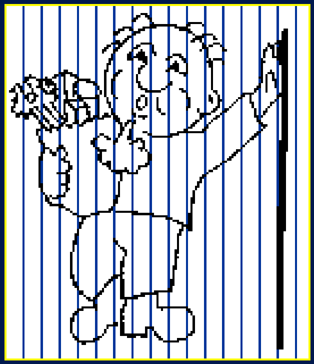
1. 10-y change in CR fitness in older adults
2. men and women
3. relationship with daily physical activity

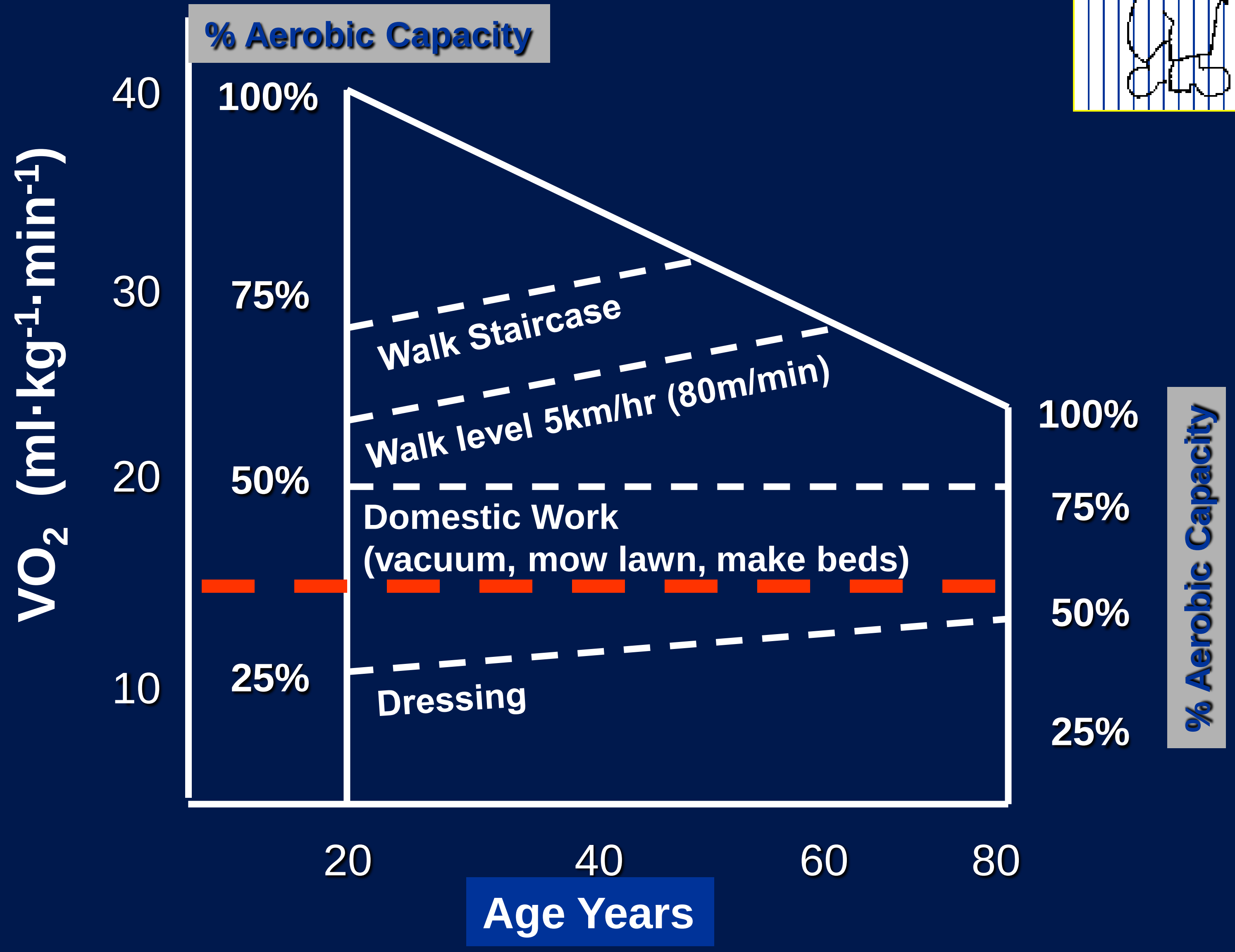
- ***Longitudinal Decline in VO_2max***
  - **Paterson** et al., 2004
  - Men: ***15% per decade*** (4.3 ml/kg.min per decade, to 22 ml/kg.min at age 73 y)
  - Women: ***7% per decade*** (1.9 ml/kg.min per decade, to 20 ml/kg.min at age 72 y)

  - Hollenberg et al., 2006
  - median age 70 years longitudinally for 6-years;
  - Men: ***24% per decade*** (6.9 ml/kg.min per decade)
  - Women: ***18% per decade*** (3.9 ml/kg.min per decade)

  - Fleg et al., 2005
  - accelerated decline with each decade from ~5% in the 20s and 30s to ***>20% in the 70s and 80s, and greater rate of decline in men*** ***(Stathokostas: not so 55 - 70 vs 70 - 85 y)***

Aerobic capacity required for selected activities





CR Fitness and Function: Conclusions

1. Loss in VO_2 max:

   O_2 delivery:

   Cardio – Cardiac Output (Maximum HR = 220 – age)

   Vascular - blood flow to exercising muscle (Doppler blood flow; NIRS - vascular control, microvascular O_2)

   O_2 utilization:

   Respiratory - muscle mitochondria (oxidative enzymes)

1b. T_{VE} as %VO_2max increases (T_{VE} preserved with age)

T_{VE} determined by muscle metabolism - mitochondria (preserved); VO_2max limited by blood flow

CR Fitness and Function: Conclusions (cont'd)

2. Successful ageing: ~75 y - VO_2max ~20 $ml.kg^{-1}.min^{-1}$
   Thus, activities > 4 METS (14 $ml.kg^{-1}.min^{-1}$) i.e., *ADL* = "heavy" intensity – fatiguing

3. Relative to VO_2max - e.g., brisk walking - 3.5 mph, VO_2 12-14 $ml.kg^{-1}.min^{-1}$, 60-70% VO_2max = exercise training prescription

Functions vs independent life

Purpose: To describe those factors, from the host of initial measures in ambulatory, independent older men and women that were determinants of becoming dependent in an 8-y follow-up

8-y follow-up sample

188 independent
(89 m, 99 f; age 67 y)

43 dependent (15 m, 28 f; age 76 y)
- 25 nursing home or LTC
- 9 non-ambulatory,
- 9 professional assessment
  (home care)

not in follow-up: deceased (n = 48),
not contacted (n = 53),
did not participate (n = 41)
follow-up sample was representative of initial sample

Determinants of Future Dependence in the Final Logistic Model (Normal walk, Depression, Education – Effect Modifiers)

Variable	Probability	Odds Ratio	Confidence Interval
Age	**<.001**	1.22	1.11-1.34
Gender	.885	1.10	0.31-4.0
Disease	**.012**	3.97	1.35-11.7
VO_2max	**.047**	0.86	0.74-0.99
Plantar Flexion	.084	1.00	0.97-1.00

Determinants of Independence/Dependence – Conclusions (*Petrella et al., 2004)*

Longitudinal follow-up study first to provide evidence that fitness is critical determinant of dependence/independence in older adults

1. ***Lower CR fitness*** (VO_2max) significantly associated with ***increased odds of dependent living*** in the elderly (after controlling for age, disease, gender, and other covariates)
2. Given VO_2max for ***independent lifestyle***

   ~15 ml.kg^{-1}.min^{-1}, and age-related decline in VO_2max: at ***>age 78 y - 1/4 at minimum threshold***

3. Magnitude of relationship of VO_2max with dependency similar to relationship with morbidity and all-cause mortality (OR = 0.86)

   i.e., ***higher VO_2max decreased the odds of subsequent dependence by 14% for each ml/kg.min, or ~50% lower in those of above average CR fitness***

4. Given OR = 0.86 (14% reduction per unit)

   - ***with exercise training 10% - 20%*** (~3 - 4 $ml.kg^{-1}.min^{-1}$) ***increase in VO_2max predicts 50% decrease in odds for becoming dependent***

Cardiorespiratory Training Recommendations

- ***CR fitness decline with age: by mid-70s approach thresholds for functional daily activities***
- ***Higher CR fitness is associated with decreased morbidity and all-cause mortality, AND improved odds of remaining independent***
- ***Moderately vigorous exercise, NOT more activities of daily living ("accumulation" not likely to affect functional outcomes) is required to improve CR fitness for function, and***

Practical Conclusion:

Public health initiatives aimed at preserving and or improving CR fitness in the later years provide an important strategy for maintaining independence

Initiatives to encourage physical activity in older adults should emphasize exercise, such as brisk walking, to maintain or improve CR fitness

"Get Fit for Active Living"

How does train the elderly for VO2 max?

If cardiorespiratory fitness is so important we can determine the limitations in the training effects?

Central and peripheral adaptations to exercise training in elderly.
(with special empahsys on the arm)

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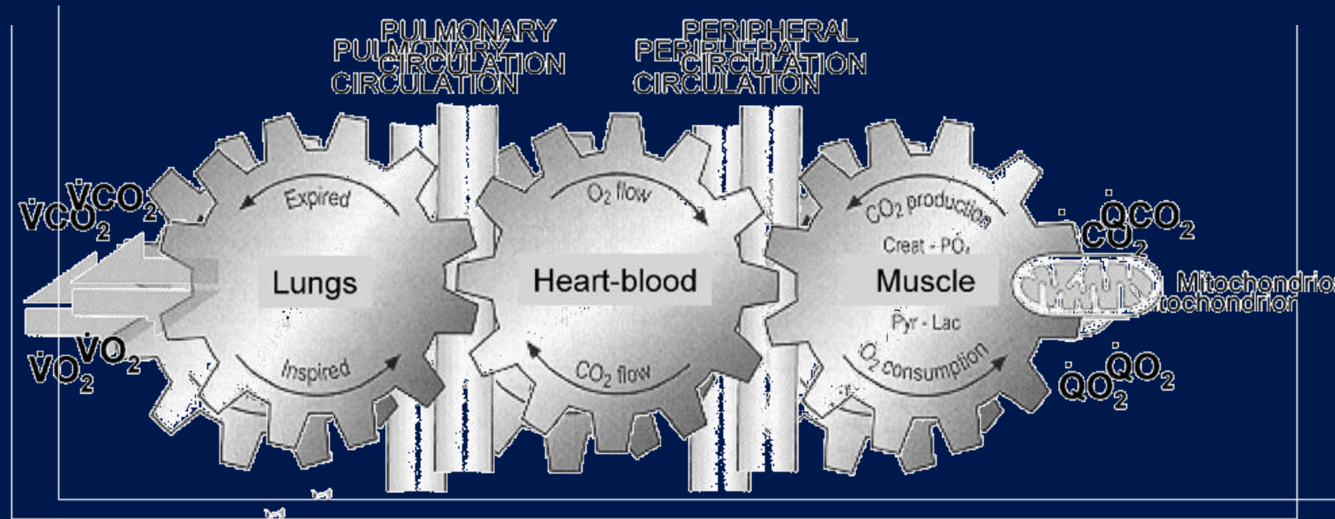
CeBiSM, Center of Bio-enginering and Sport Science, Rovereto.

(Pogliaghi et al. EJAP 2006)

FACTORS INFLUENCING V'O2max DECREASE IN AGEING



CENTRAL FACTORS:
- Cardiac Output
- Blood mass
- Hb Saturation

PERIPHERAL FACTORS
- Muscle mass
- Caps/fibers ratio
- Mitho&enzym activities

Main question

How central and peripheral factors contribute to aerobic training adaptation in eldelry subject

Goal

describe a quantitative model that can allow to detremine the changes in aerobic capacity as a result of physiological changes in the ageing framework

Methodology

separate central and peripheral factors by using:

- Measurements of specific parameters

- Training and testing protocol

- Special populations

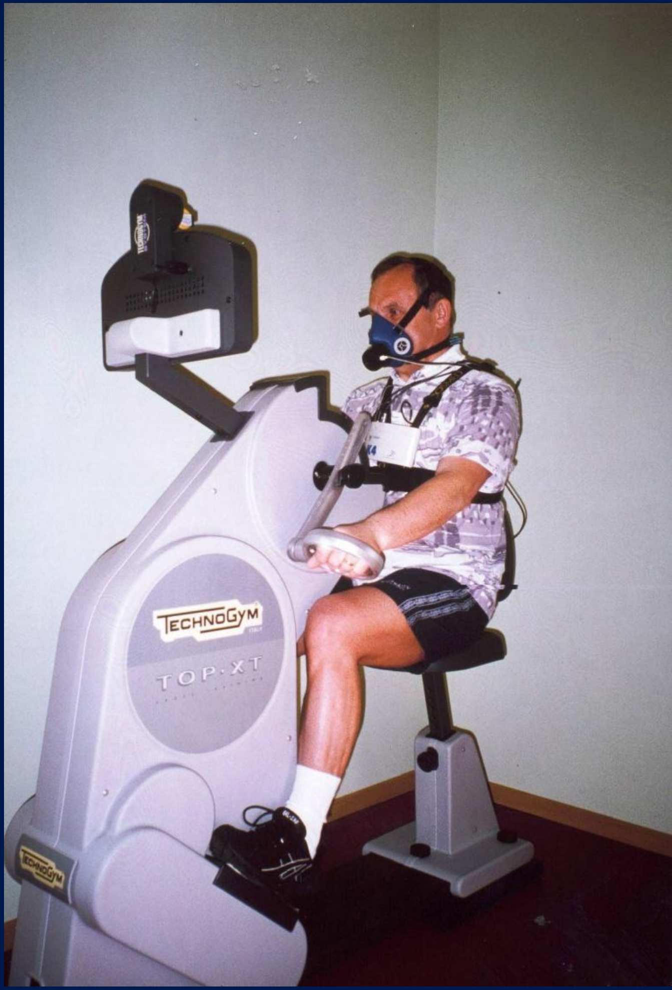
Protocol

Before and after the 12w training period
Incremental tests to exhaustion

arm cranking
(ARM test)
Warm-up 40w +5w/min

cycle ergometer
(CYC test)
Warm-up 50 W +10w/min

24 subjs 62-69y



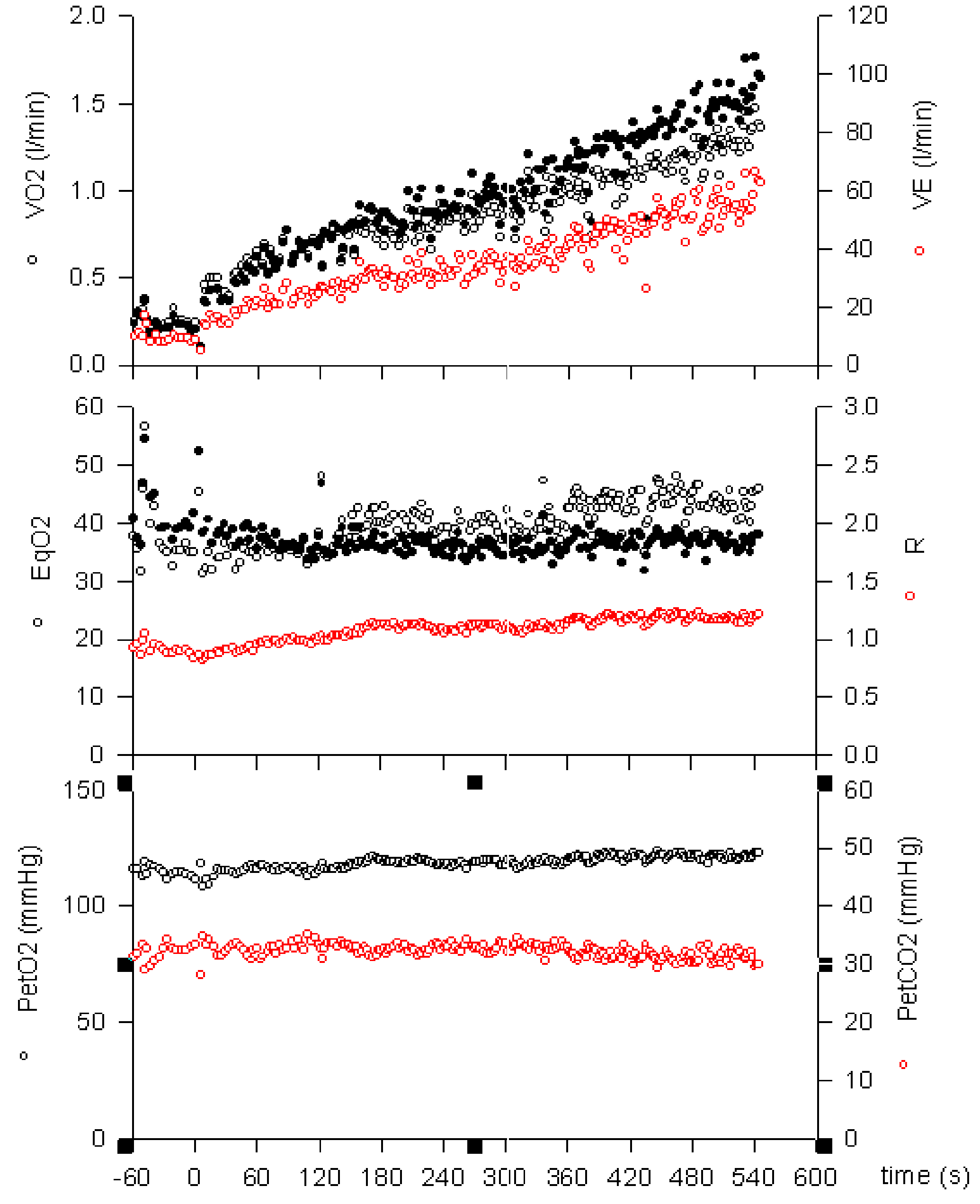
Measures

- respiratory variables were measured breath by breath and heart rate (HR) was continuously recorded.

- Power (Wpeak)
- Oxygen uptake (VO2peak)
- ventilation (VEpeak)
- oxygen pulse (O2Ppeak)
- Heart rate (HRpeak)

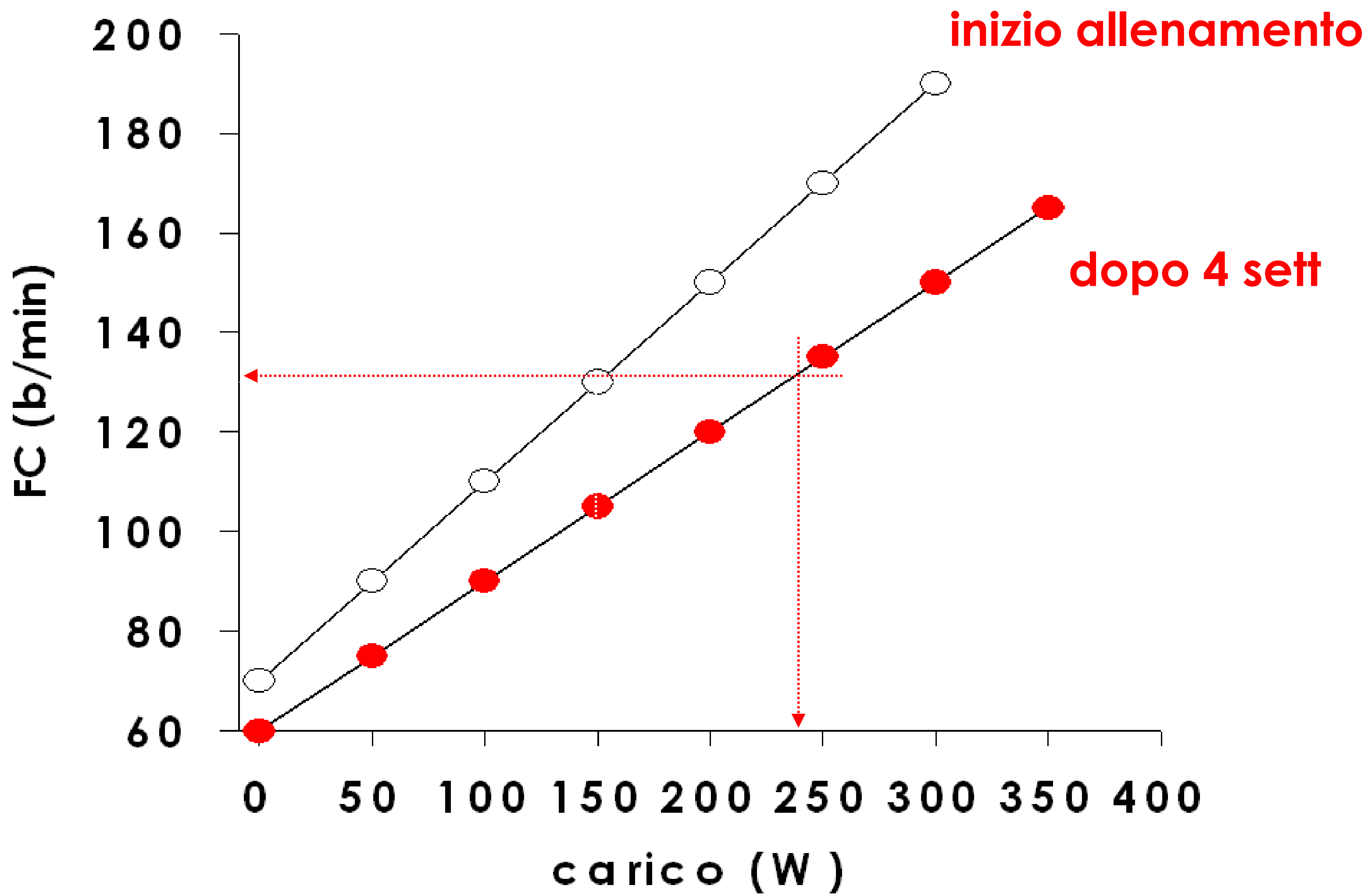
were calculated as the average of the last 10s of exercise.

Ventilatory threshold (VT) was determined by Wasserman method



Training design:

- ✓ VT identification during incremental test
- ✓ HR corresponding to VT
- ✓ using steady-state tests, translate HR_{VT} in W_{VT}
- ✓ calculate $W_{90\%VT}$ and $W_{110\%VT}$
- ✓ HR monitored and recorded every training session
- ✓ every 2 weeks check the HR/W relationship
- ✓ Re-calculation of W related to the target HR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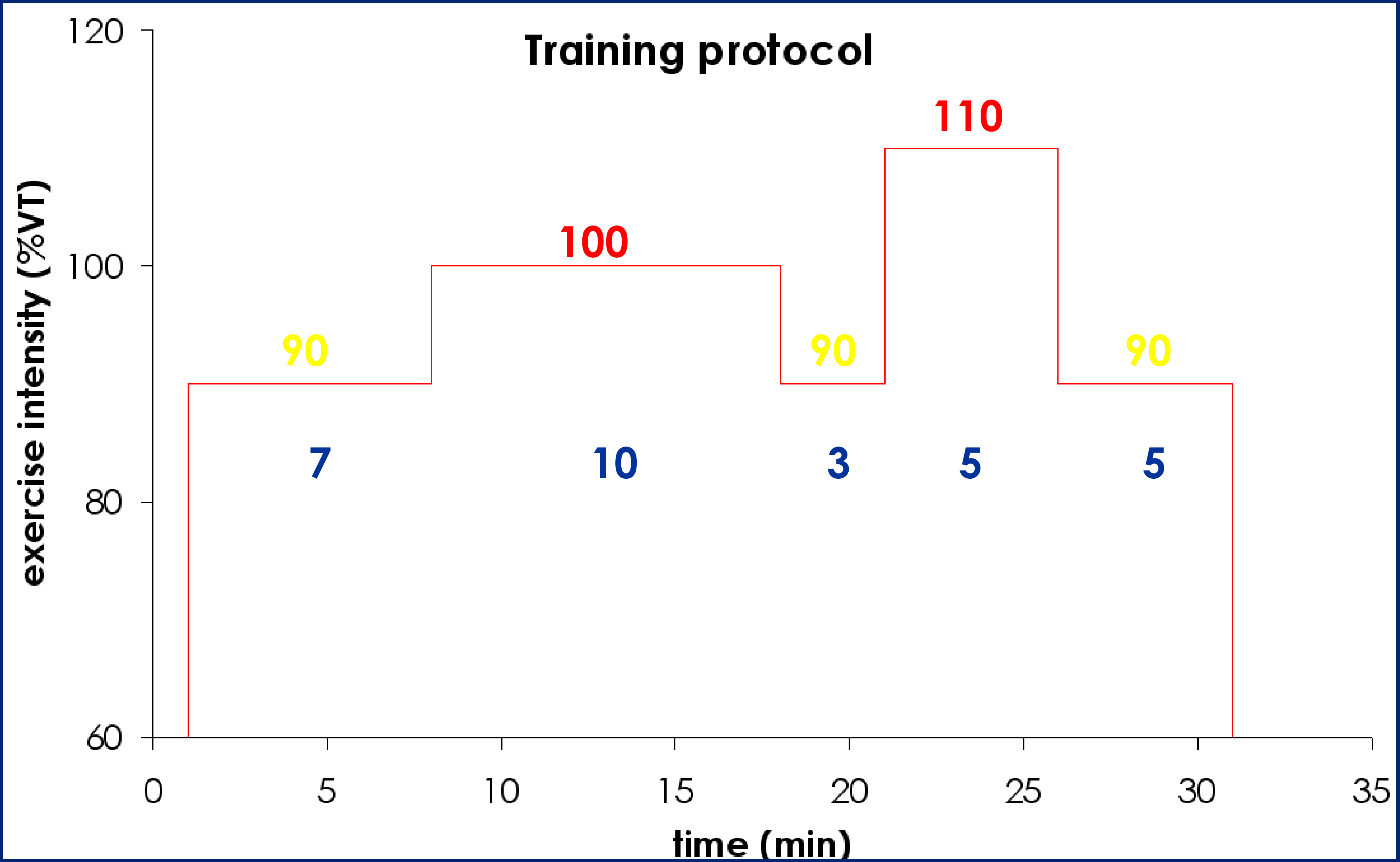
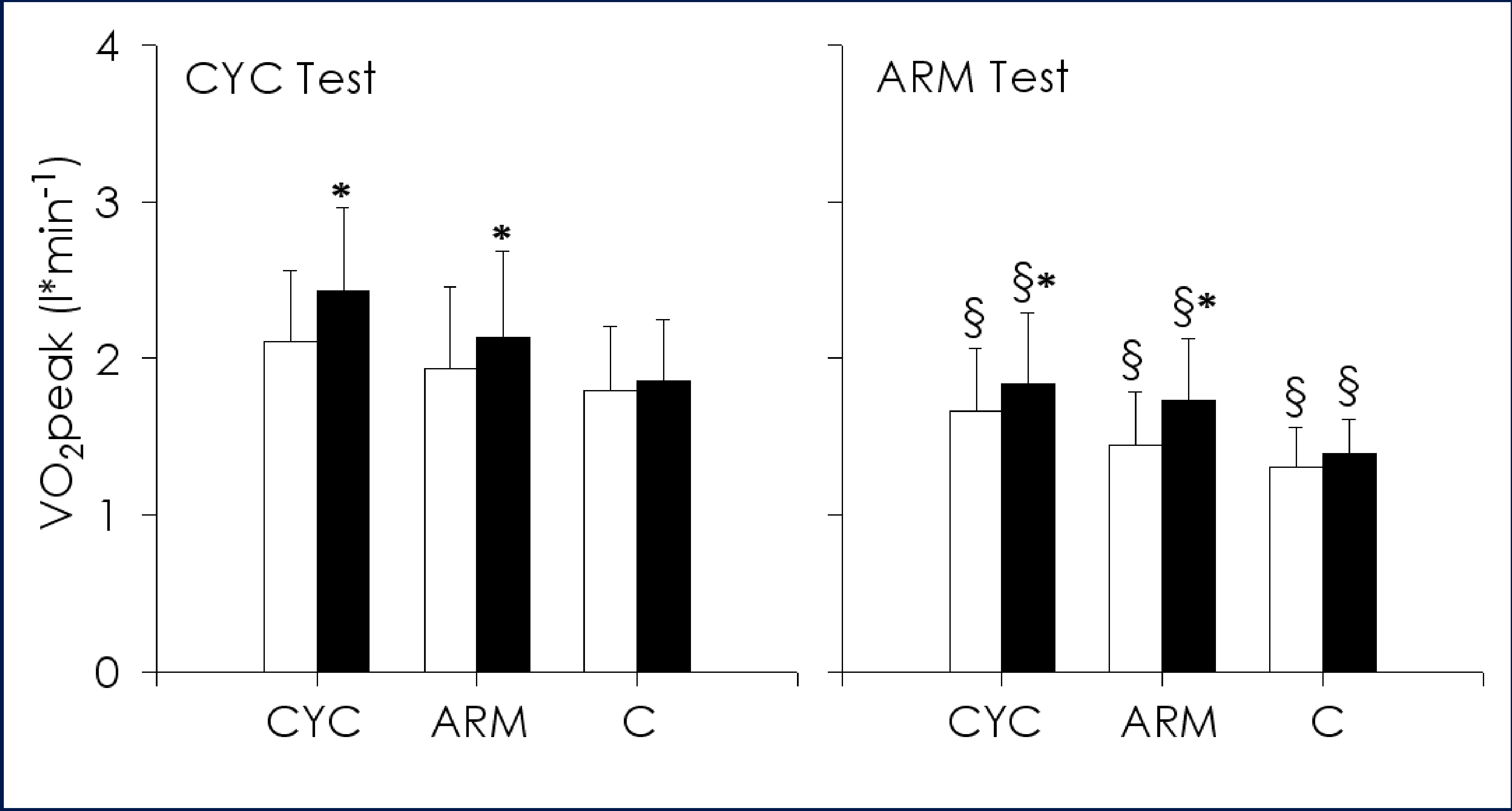


Average WL 97% individual VT
12-weeks 3 times /week

Absolute values before and after 12 w training

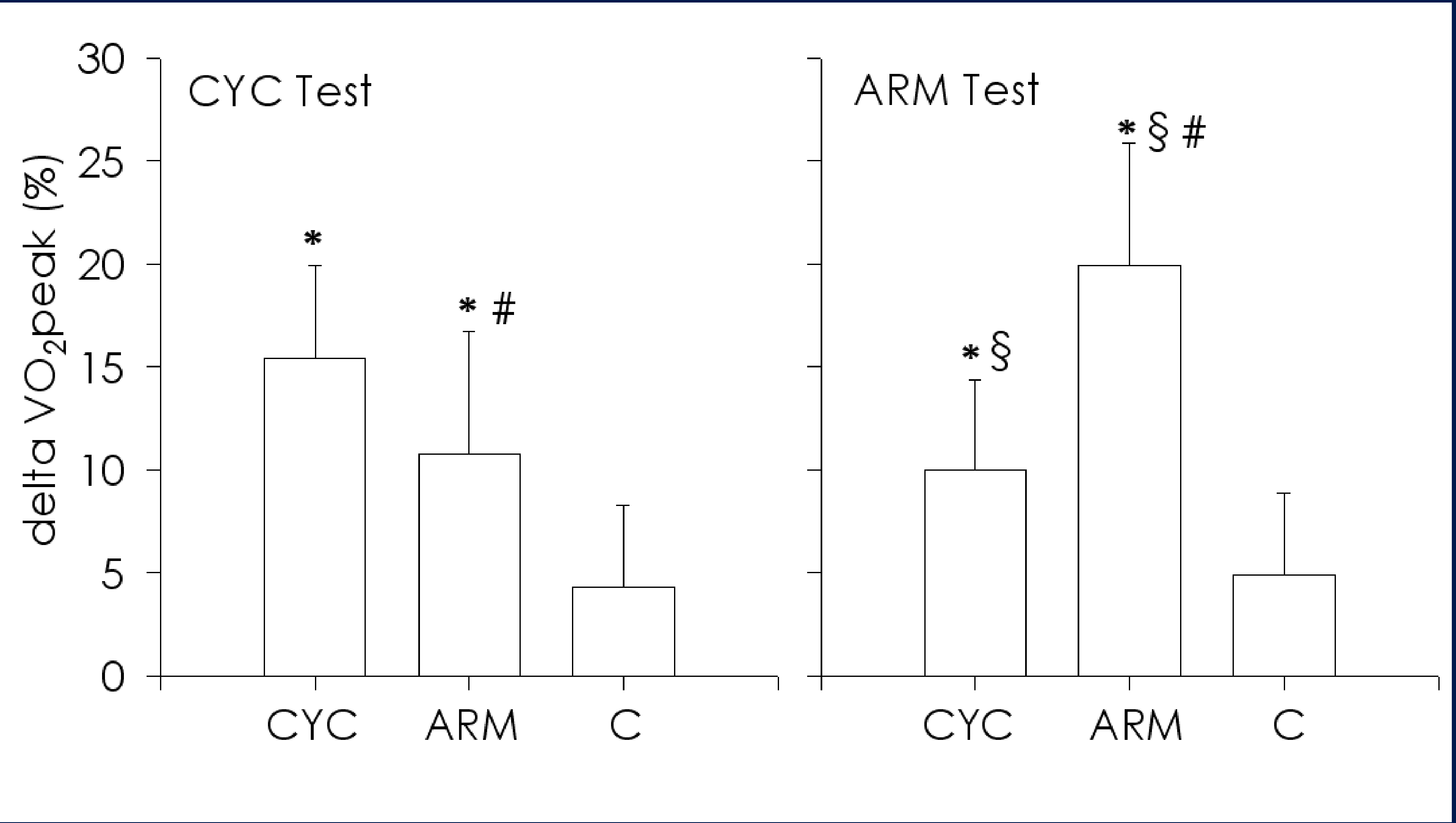


* Post vs. pre

§ ARM vs CYC

Pogliaghi et al., 2006

% Changes



 # ARMgr vs CYC gr

Conclusions:

Our data demonstrate that a 12-week large muscle masses and smaller muscle masses training have a similar potential to increase cross ergometer exercise tolerance by ~10 % **(aspecific effect).**

Similarly, both ARM and CYC training increase homeo-ergometer exercise capacity by ~15-20 % **(specific effect).**

It could also be suggested that central and peripheral factors contribute for about 50% each at the adaptations to training