KATHOLIEKE UNIVERSITEIT LEUVEN

Belang en effecten van fysieke activiteit en van cardiale revalidatie

Is er iets veranderd in de periode 1976 – 2016?

Prof. Dr. Luc Vanhees

Harpa, Leuven

13 februari 2016

Cardiale Revalidatie voor 1950

Onbestaande

Behandeling:

Hospitalisatie met absolute bedrust gedurende 6 weken

KATHOLIEKE UNIVERSITEIT LEUVEN

Vroeger: anno 1956-1980

Gegradeerd oefenschema voor de hospitalisatierevalidatie van cardiale patiënten

Week (Fase)	Houding	Oefeningen	Duur & Frequentie
1	Ruglig	➢|p| mobilisatie alle gewrichten ➢AH-oefeningen ➢Ontspanningsoef. ➢|a| oef. kleine gewrichten, enkels, tenen, polsen	10 à 20 min 1 à 2 maal/dag
2	Ruglig	|a| mob. benen,armen, schouders	2 maal/dag
3	Zit	|a| oef. OL & BL Relaxatie	2 maal/dag
4	Stand	|a| oef. OL & BL & romp	2 maal/dag
5	Idem 4	Idem 4 + prog. marsreëducatie	2 maal/dag
6	Idem 4	Idem 5 + prog. trappen (van 3 trappen naar 3 maal 10 trappen)	2 maal/dag

(Newman LB, Arch Intern Med 1952

KATHOLIEKE UNIVERSITEIT LEUVEN

Anno 1956 – 1980?

ADL activiteiten

FASE	Toegelaten activiteiten van de coronaire patiënt
1	Gebruik van bedtafel voor eten
2	¼ uur in leunstoel zitten
3	2 maal één uur/dag rechtop zitten
4	Activiteiten in stoel aan tafel (met rugsteun), 2X1uur/dag; Rechtop zitten in leunstoel
5	Verplaatsingen te voet, slechts zo ver als bij kiné, anders in rolstoel
6	Activiteiten waarbij wandelingen en trappan bestijgen

(Newman LB, Arch Intern Med 1952

KATHOLIEKE UNIVERSITEIT LEUVEN

Cardiale Revalidatie

- Eerste definitie van cardiale revalidatie in 1964 tijdens een symposium van de WHO in Noordwijk aan Zee, Nl[1]
- Eerste studies over effect van training vanaf 1966 [2-5]

[1] Brown RA. Rehabilitation of patients with cardiovascular diseases: report of a WHO expert Committee. WHO Tech Rep Ser. **1964**; 270: 3-46
[2] Naugthon J, Am J Med Sci1966;
[3] Varnauskas E, Lancet,1966;
[4] Frick MH, Mal cardiovasc, 1969
[5] Pollock ML, N C Med J, 1970

KATHOLIEKE UNIVERSITEIT LEUVEN

Eerste effect studies in België

1: **Detry JM**, **Rousseau M, Vandenbroucke G, Kusumi F, Brasseur LA**, Bruce RA. Increased arteriovenous oxygen difference after physical training in coronary heart disease. Circulation. **1971** Jul;44(1):109-18.

2: **Degré S**. Short and mean term results of physical training in patients with myocardial infarction: physiological and pathophysiological aspects. G Ital Cardiol. **1973** May;3(5):637-45.

3: **Rousseau MF**, **Degré S, Messin R, Brasseur LA, Denolin H, Detry JM.** Hemodynamic effects of early physical training after acute myocardial infarction; comparison with a control untrained group. Eur J Cardiol. **1974** Aug;2(1):39-45.

4: **Detry JM**, **Rousseau MF, Brasseur LA**. Early hemodynamic adaptations to physical training in patients with healed myocardial infarction. Eur J Cardiol. **1975** Jan;2(3):307-13.

5: **Salhadin P, Degre S, Van Elst P, Denolin H**. From physical capacity to fitness to work in coronary patients. Acta Cardiol. **1975**;30(2):79-83..

CARDIALE REVALIDATIE
UZ LEUVEN/KU LEUVEN
1976 – 2016

KATHOLIEKE UNIVERSITEIT LEUVEN

Hoe ik startte binnen de cardiale revalidatie

- 1ste contact als stagiair in 1975
- September 1976 – Juli 1977 werkzaam bij Prof L. Brasseur in "Laboratoire d'exploration fonctionelle cardiopulmonaire“, UCL Leuven en Woluwe
- Augustus 1977 – Mei 1978 legerdienst in Heverlee en om 16u30 training in UZ Pellenberg
- Vanaf mei 1978 voltijds werkzaam binnen UZ Leuven en/of KU Leuven
- In 1979 nam ik 2 belangrijke beslissingen:
    - Starten van een doctoraat
    - Betere organisatie van cardiale revalidatie op langere termijn: HARPA

KATHOLIEKE UNIVERSITEIT LEUVEN

Eerste wetenschappelijk begin

Tijdschr. voor Geneeskunde, **36**, nr. 17, 1980

OORSPRONKELIJKE BIJDRAGEN

INVLOED VAN TRAINING BIJ PATIENTEN MET ISCHEMISCH HARTLIJDEN, BEHANDELD MET EN ZONDER BETA-BLOKKERENDE MEDICATIE

L. VANHEES, R. FAGARD, T. REYBROUCK, A. AMERY *

Vanhees, L., Fagard, R., Amery, A. (1981). Influence of beta-adrenergic blockade on the effects of physical training in patients with ischemic heart disease. Hermes, XV, 332-342.

Reybrouck, T., Fagard, R., Vanhees, L., Cattaert, A., Amery, A. (1981). The effect of physical training on the anaerobic threshold in cardiovascular patients. Hermes, XV, 325-332.

Vanhees, L., Fagard, R., Amery, A. (1982). Niet-invasieve evaluatie van hartfunctie en hartstructuur na fysieke training bij patiënten met ischemische hartlijden. Werken van de Belgische Vereniging voor Sportgeneeskunde en Sportwetenschappen, 32, 51-59.

KATHOLIEKE UNIVERSITEIT
LEUVEN

Doctoraat in 1984

Op basis van 8 artikelen
+ 1 in bijlage

KATHOLIEKE UNIVERSITEIT LEUVEN
Groep Biomedische Wetenschappen
Instituut Lichamelijke Opleiding

CARDIALE EN HUMORALE AANPASSINGEN AAN FYSIEKE TRAINING BIJ PATIENTEN MET ISCHEMISCH HARTLIJDEN

door

Luc VANHEES

Proefschrift aangeboden tot het
verwerven van de graad van
Doctor in de Motorische Revalidat
en Kinesitherapie

KATHOLIEKE UNIVERSITEIT
LEUVEN

Doelstelling van doctoraat

1. Effect van training op inspanningsparameters

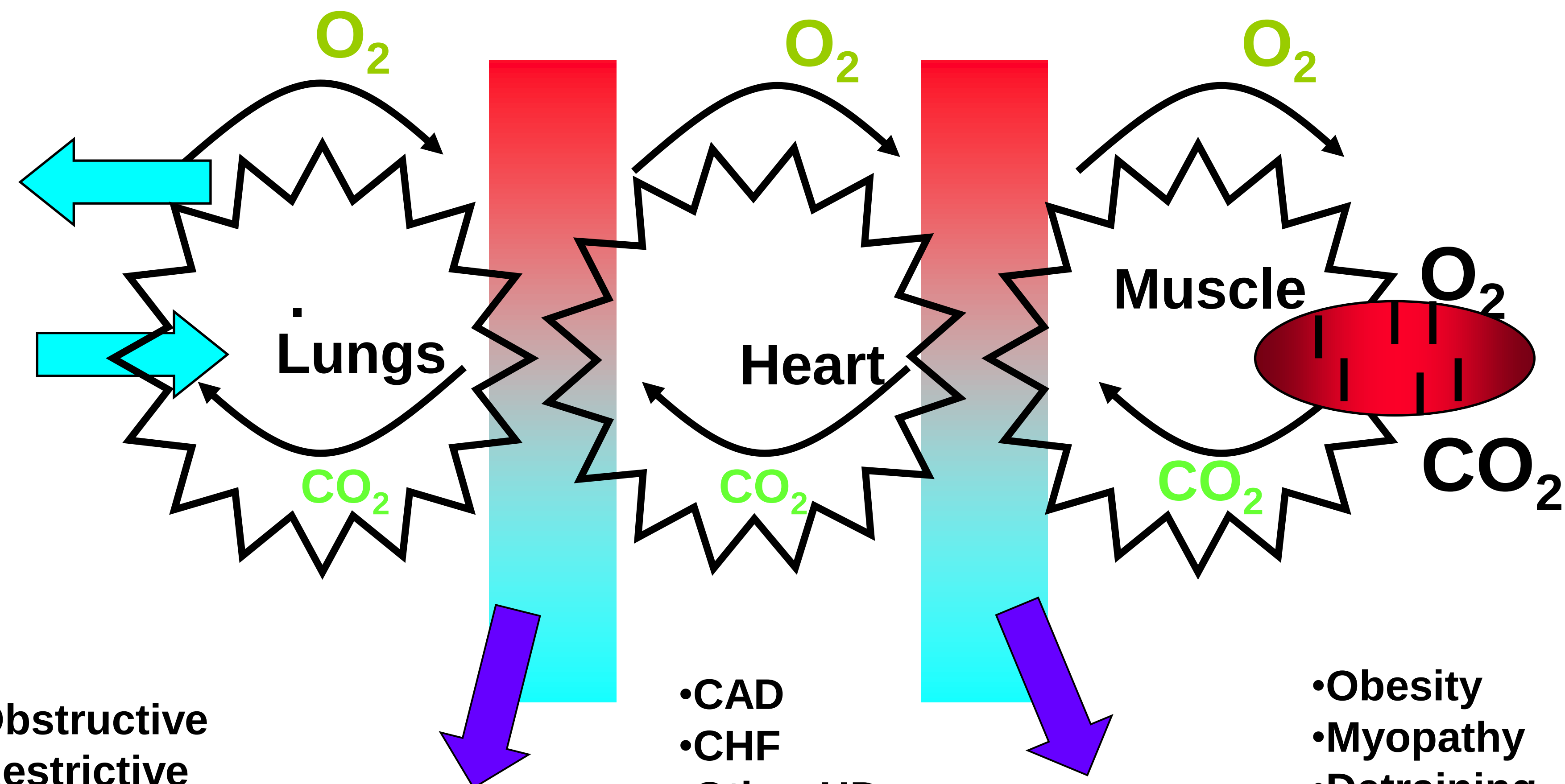
Br Heart J 1982; **48**: 33–8

Influence of beta adrenergic blockade on effects of physical training in patients with ischaemic heart disease

L VANHEES, R FAGARD, A AMERY

From the Hypertension and Cardiovascular Rehabilitation Unit, Department of Pathophysiology, University of Leuven (KU Leuven), Leuven, Belgium

KATHOLIEKE UNIVERSITEIT LEUVEN



- Obstructive
- Restrictive
- Infiltration
- Chest wall

- PPH
- Thrombo -embolic
- PVD

- CAD
- CHF
- Other HD
- Anaemia

- Occlusive
- Autonomic dysfunction

- Obesity
- Myopathy
- Detraining

KATHOLIEKE UNIVERSITEIT LEUVEN

Standards for the use of cardiopulmonary exercise testing for the functional evaluation of cardiac patients: a report from the Exercise Physiology Section of the European Association for Cardiovascular Prevention and Rehabilitation

Alessandro Mezzani[a], Piergiuseppe Agostoni[b], Alain Cohen-Solal[d], Ugo Corrà[a], Anna Jegier[f], Evangelia Kouidi[g], Sanja Mazic[h], Philippe Meurin[e], Massimo Piepoli[c], Attila Simon[i], Christophe Van Laethem[j] and Luc Vanhees[k]

European Journal of Cardiovascular Prevention and Rehabilitation 2009, 16:249–267

KATHOLIEKE UNIVERSITEIT
LEUVEN

Review

Methodological approach to the first and second lactate threshold in incremental cardiopulmonary exercise testing

Ronald K. Binder[a], Manfred Wonisch[b], Ugo Corra[c], Alain Cohen-Solal[d], Luc Vanhees[e], Hugo Saner[a] and Jean-Paul Schmid[a]

Determination of an 'anaerobic threshold' plays an important role in the appreciation of an incremental cardiopulmonary exercise test and describes prominent changes of blood lactate accumulation with increasing workload. Two lactate thresholds are discerned during cardiopulmonary exercise testing and used for physical fitness estimation or training prescription. A multitude of different terms are, however, found in the literature describing the two thresholds. Furthermore, the term 'anaerobic threshold' is synonymously used for both, the 'first' and the 'second' lactate threshold, bearing a great potential of confusion. The aim of this review is therefore to order terms, present threshold concepts, and describe methods for lactate threshold determination using a three-phase model with reference to the historical and physiological background to facilitate the practical application of the term 'anaerobic threshold'. *Eur J Cardiovasc Prev Rehabil* 15:726–734

KATHOLIEKE UNIVERSITEIT LEUVEN

Joint statement ESC/AHA

EUROPEAN SOCIETY OF CARDIOLOGY®

European Heart Journal (2012) **33**, 2917–2927
doi:10.1093/eurheartj/ehs221

POSITION STATEMENT

EACPR/AHA Joint Scientific Statement

Clinical recommendations for cardiopulmonary

EACPR/AHA Scientific Statement

Clinical Recommendations for Cardiopulmonary Exercise Testing Data Assessment in Specific Patient Populations

WRITING COMMITTEE

EACPR: Marco Guazzi, Co-Chair,[1]* Volker Adams,[2] Viviane Conraads,[3] Martin Halle,[4] Alessandro Mezzani,[5] Luc Vanhees[6]

AHA: Ross Arena, Co-Chair,[7] Gerald F. Fletcher,[8] Daniel E. Forman,[9] Dalane W. Kitzman,[10] Carl J. Lavie,[11,12] Jonathan Myers[13]

Circulation. 2012;126:2261-2274

KATHOLIEKE UNIVERSITEIT LEUVEN

Doelstelling van doctoraat

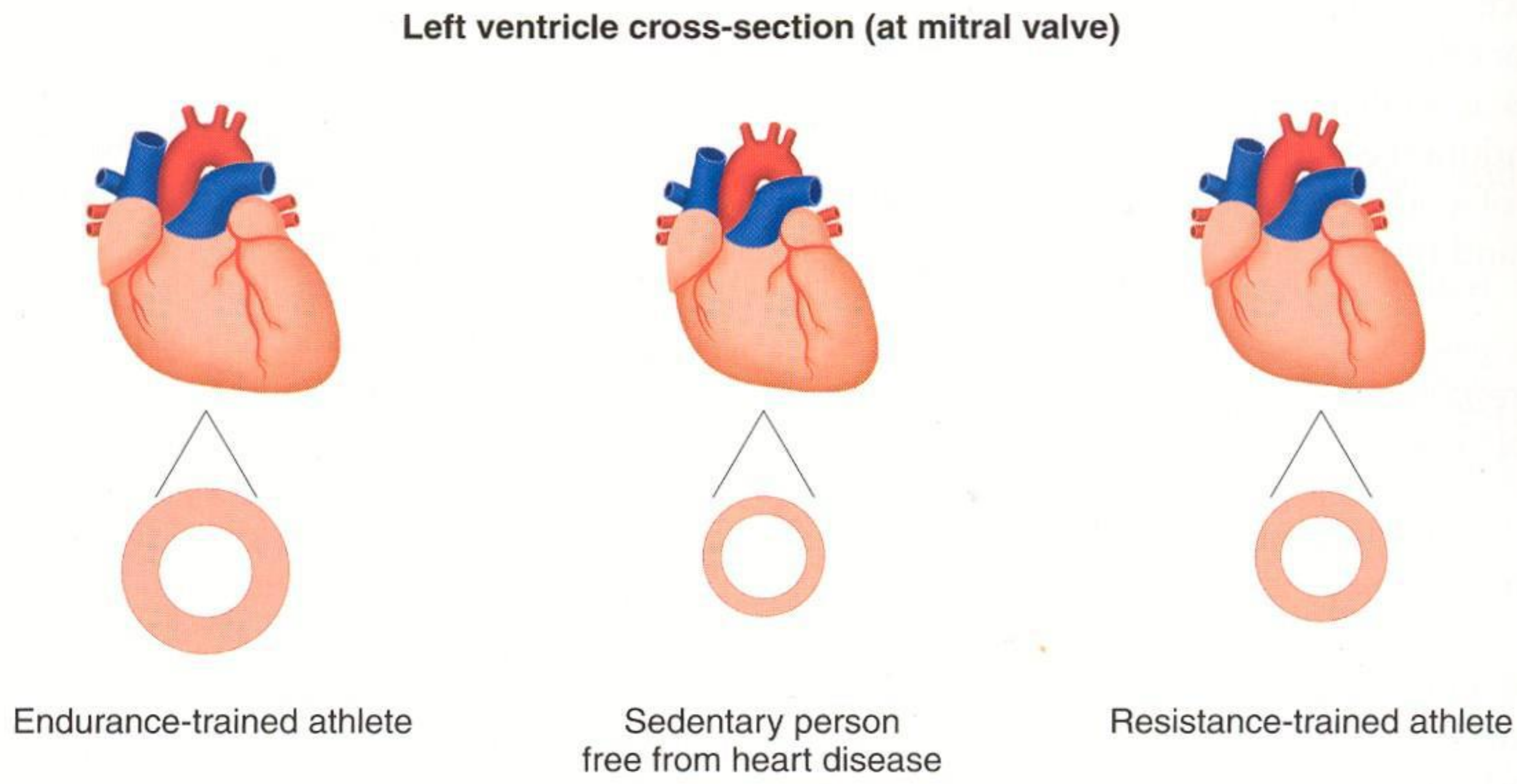
Effect van training op

1. Inspanningsparameters
2. Hartstructuur

Noninvasive Assessment of Cardiac Function and Structure After Physical Training in Patients with Ischemic Heart Disease

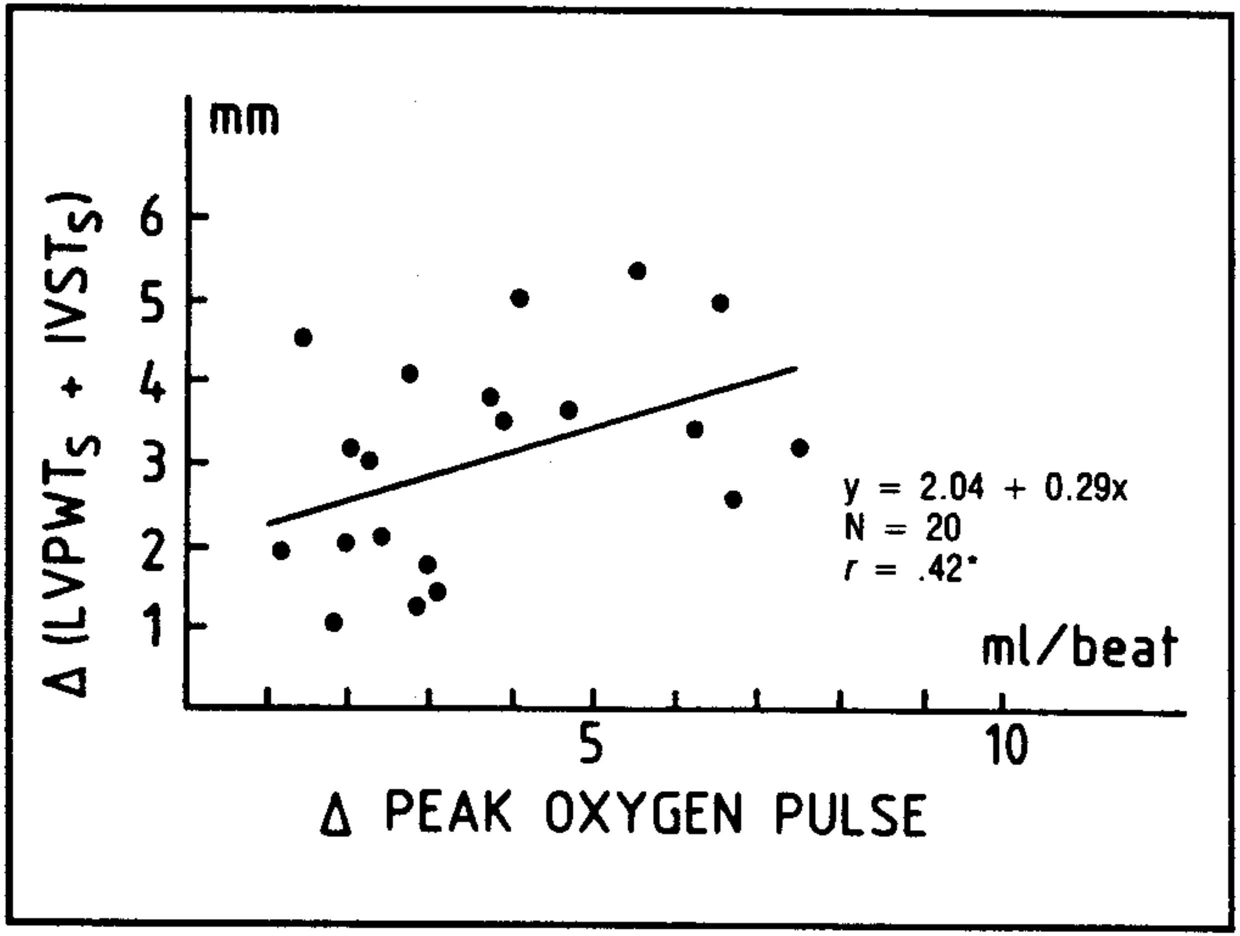
Luc Vanhees, DSc, Robert Fagard, MD, Hilaire De Geest, MD, Antoon Amery, MD

LV structure and training



KATHOLIEKE UNIVERSITEIT LEUVEN

Cardiac structure and training: echocardiographic data



Vanhees et al, JCR, 1984

Doelstelling van doctoraat

Effect van training op

1. Inspanningsparameters
2. Hartstructuur
3. Hartfunctie

KATHOLIEKE UNIVERSITEIT LEUVEN

Vanhees L, Fagard R, Amery A. The effect of physical training on the left apexcardiogram. Acta Cardiol. 1983;38(6):555-63.

Influence of beta-adrenergic blockade on the hemodynamic effects of physical training in patients with ischemic heart disease. Am Heart J. 1984 Aug;108(2):270-5.

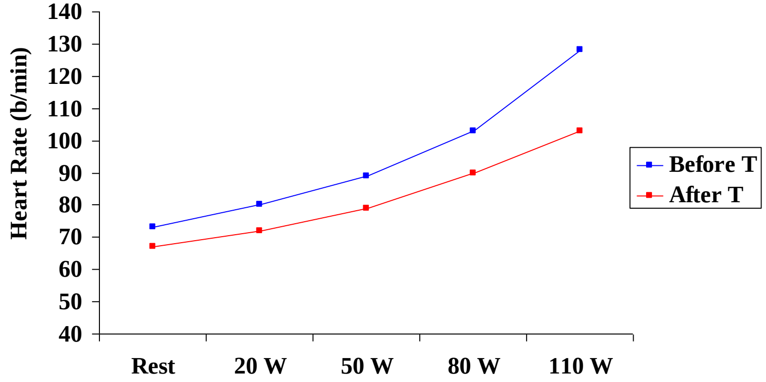
Vanhees L et al. Noninvasive assessment of cardiac function and structure after physical training in patients with ischemic heart disease. Journal of Cardiac Rehabilitation 1984 vol:4:290-296

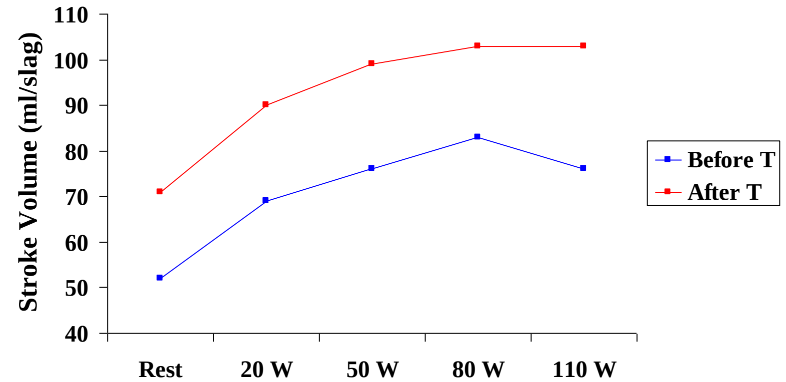
Vanhees L et al. Changes in systolic time intervals during physical training in patients with ischemic heart disease. Effect of beta-blockade. Cardiology. 1984;71(4):207-14.

Vanhees L et al. Systolic time intervals in coronary heart disease at rest and during exercise: effect of physical training with and without beta blockade. Am J Cardiol. 1984 Sep 1;54(6):508-13.

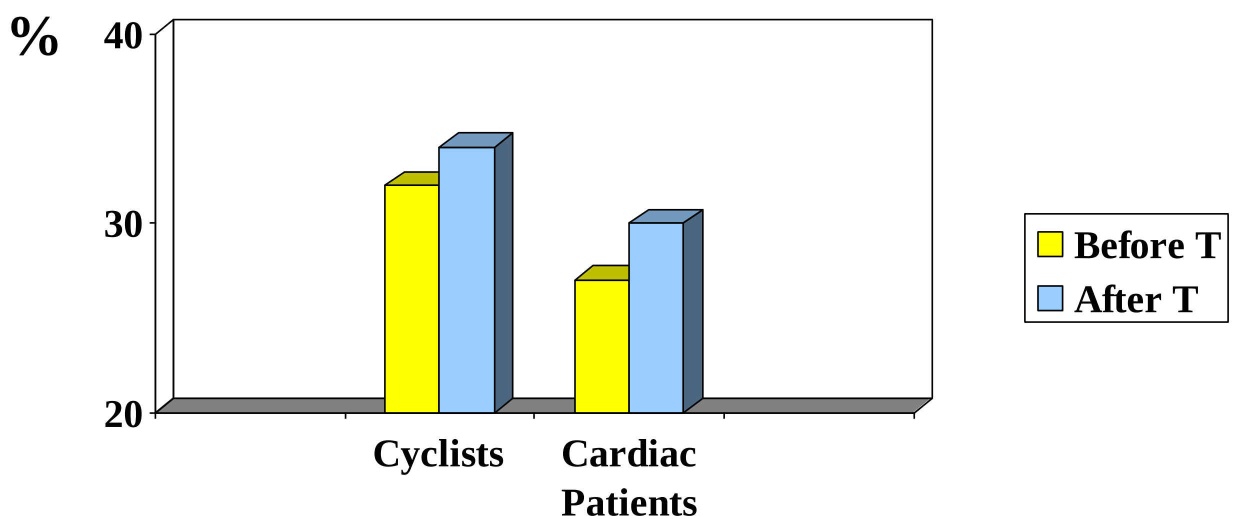
KATHOLIEKE UNIVERSITEIT LEUVEN

Cardiac Rehabilitation Heart Rate – Stroke Volume – Pump function





% Shortening of LVID



Vanhees et al, 1984a & 1984b

Doelstelling van doctoraat

Effect van training op

1. Inspanningsparameters
2. Hartstructuur
3. Hartfunctie
4. Bloeddrukregelende mechanismen

KATHOLIEKE UNIVERSITEIT
LEUVEN

Effect op BD en RAAS

Vanhees L et al Influence of physical training on blood pressure, plasma renin, angiotensin and catecholamines in patients with ischaemic heart disease. Eur J Appl Physiol Occup Physiol.1984;53(3):219-24.

Vanhees L et al. Renin release: beta 1- or beta 2-receptor mediated? N Engl J Med. 1985 Jan 10;312(2):123-4.

KATHOLIEKE UNIVERSITEIT LEUVEN

Doelstelling van doctoraat

Effect van training op

1. Inspanningsparameters
2. Hartstructuur
3. Hartfunctie
4. Bloeddrukregelende mechanismen
5. Effect van β-blokkeerders op trainingseffect

Effect van β-blokkering en training

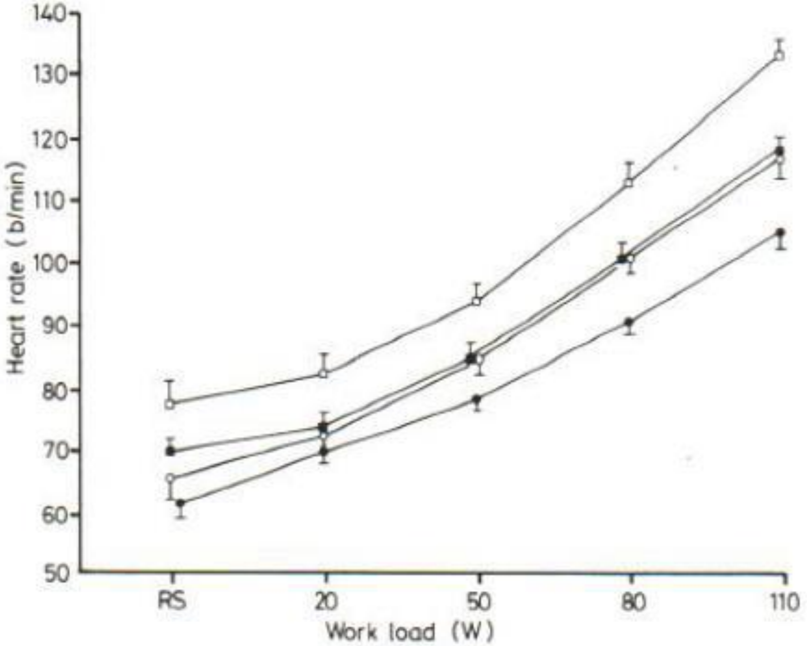


Fig. 1 *Heart rate before (open signs) and after training (closed signs) in patients treated with beta blockers (circles) and in those without beta blockers (squares) at rest in the sitting position (RS) and at 20 W, 50 W, 80 W, and 110 W. Values are means ±SE.*

Vanhees et al, 1982

KATHOLIEKE UNIVERSITEIT LEUVEN

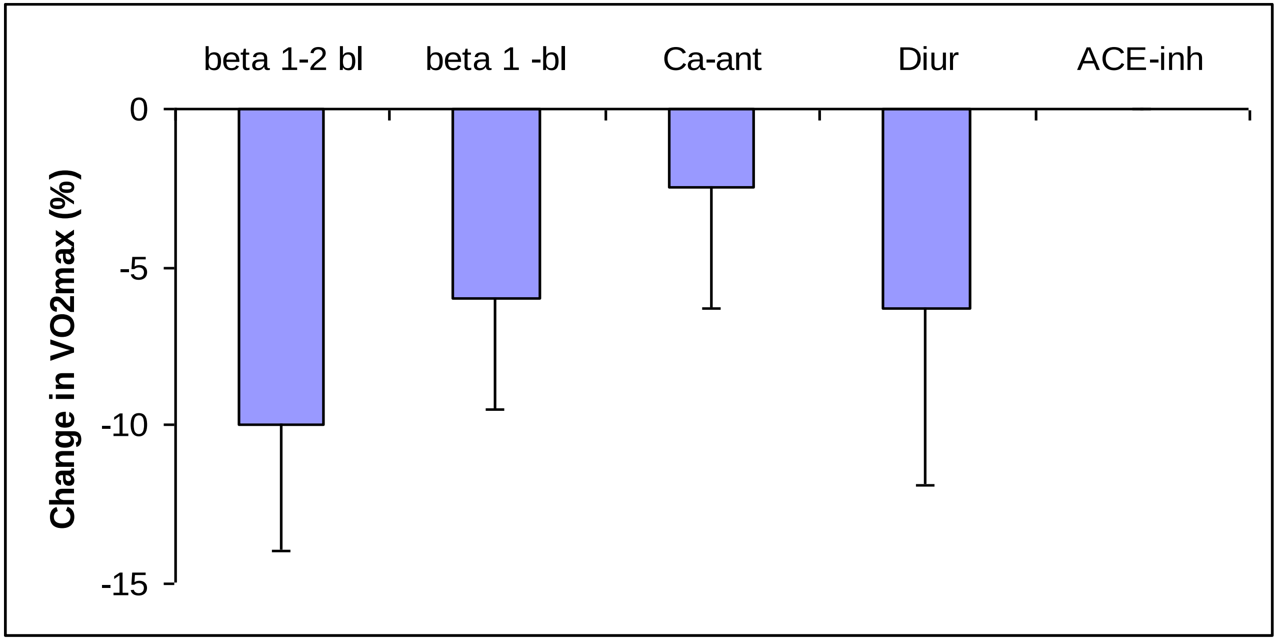
Cardiac rehabilitation: cardiac function in CAD

	Beta-blockers (n=15)			Non Beta-blockers(n=14)		
	Pre	Post	**% Diff.**	**Pre**	**Post**	**% Diff.**
VO_2 (l/min)	1.56±.95	2.14±.08***	**+37.8%**	1.59±.07	2.13±.09 ***	**+34.0%**
Q (l/min)	10.3 ± 0.6	12.8± 0.5**	**+24.3%**	10.7±0.6	13.3 ±.7 ***	**+24.3%**
HR (beats/min)	110 ± 4	121 ± 6*	**+10.0%**	133±5	146±5 **	**+9.0%**
SV (ml/beat)	94.0 ± 6	109.6±6**	**+16.6%**	80.4 ± 2	91.4 ± 5 **	**+13.7%**
(a-v) O_2 diff (ml/l)	155 ± 7	163 ± 7*	**+5.2%**	148 ± 5	158 ± 5 *	**+6.8%**

Vanhees et al, AHJ, 1984

KATHOLIEKE UNIVERSITEIT LEUVEN

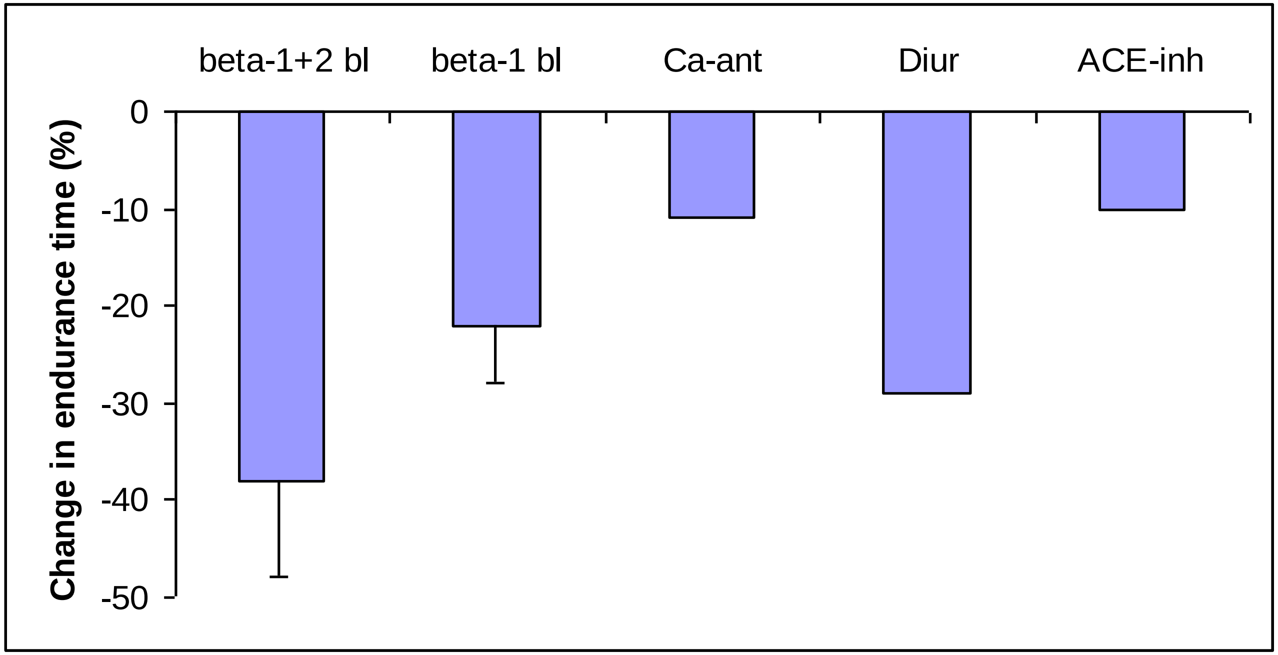
Hypertension, medication and VO_2max



Change in maximal oxygen consumption (VO_2max) (%) after administration of antihypertensive agents. Mean ± SD of studies: β1+2-blocking agents (n=19), β1-blocking agents (n=21), calcium antagonists (n=13), diuretics (n=7) and ACE inhibitors (n=3).

Van Baak M et al. Int. J. Sports Med. Hypertension, beta-adrenoceptor blocking agents and exercise. Int J Sports Med. 1994;15(3):112-5. Review.

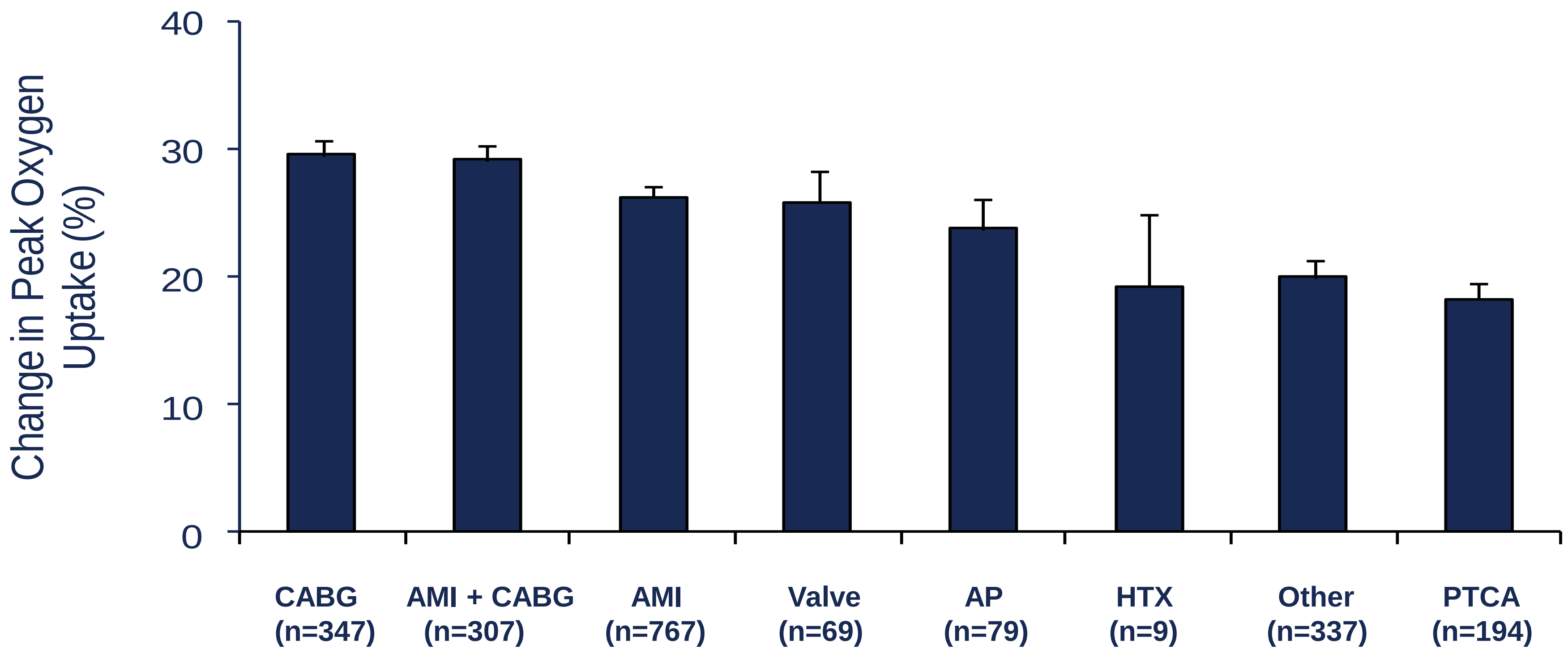
Hypertension, medication and endurance exercise capacity



Change in endurance performance (%) after administration of antihypertensive agents. Mean ± SD of studies: β_{1+2}-blocking agents (n=10), β_1-blocking agents (n=10), calcium antagonists (n=2), diuretics (n=1) and ACE inhibitors (n=2).

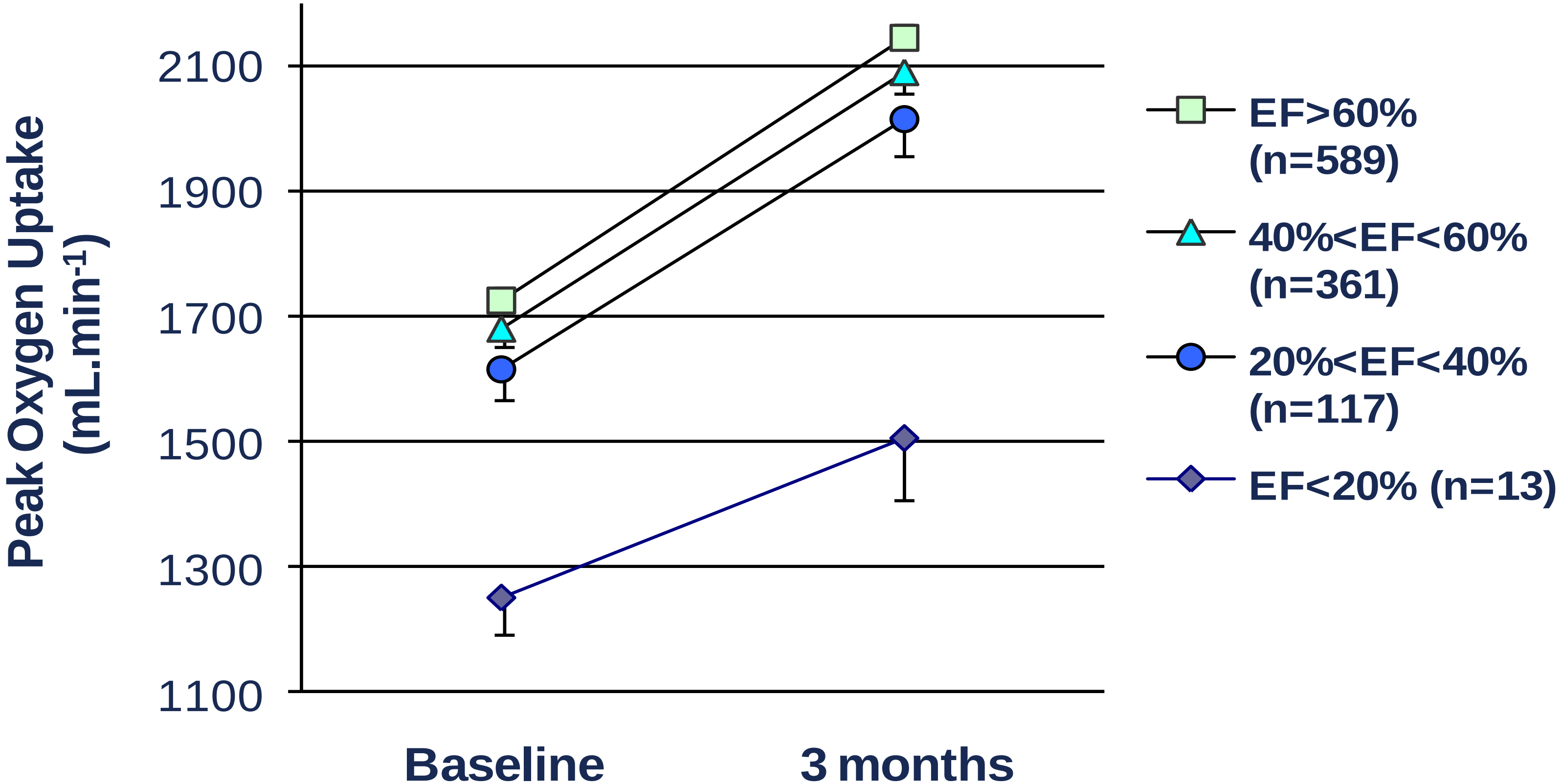
Van Baak M et al. Int. J. Sports Med. Hypertension, beta-adrenoceptor blocking agents and exercise. Int J Sports Med. 1994;15(3):112-5. Review.

Effect van training bij verschillende cardiovasculaire aandoeningen



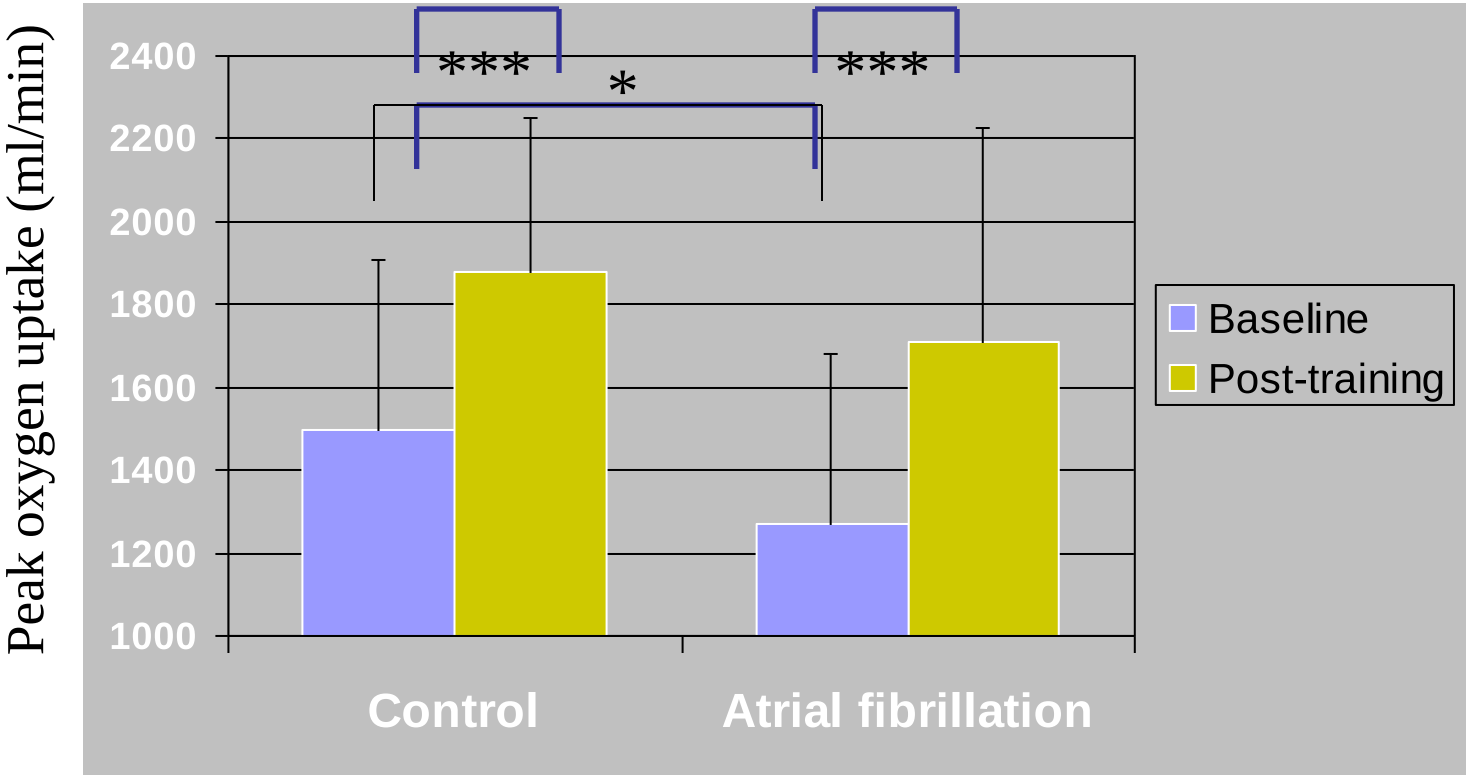
Vanhees L et al., Eur J Cardiovasc Prev Rehabil 2004; 11:304-312

Comparison of training effect for peak VO_2 according to left ventricular function



Vanhees L et al., Eur J Cardiovasc Prev Rehabil 2004; 11:304-312

Physical training in patients with chronic atrial fibrillation



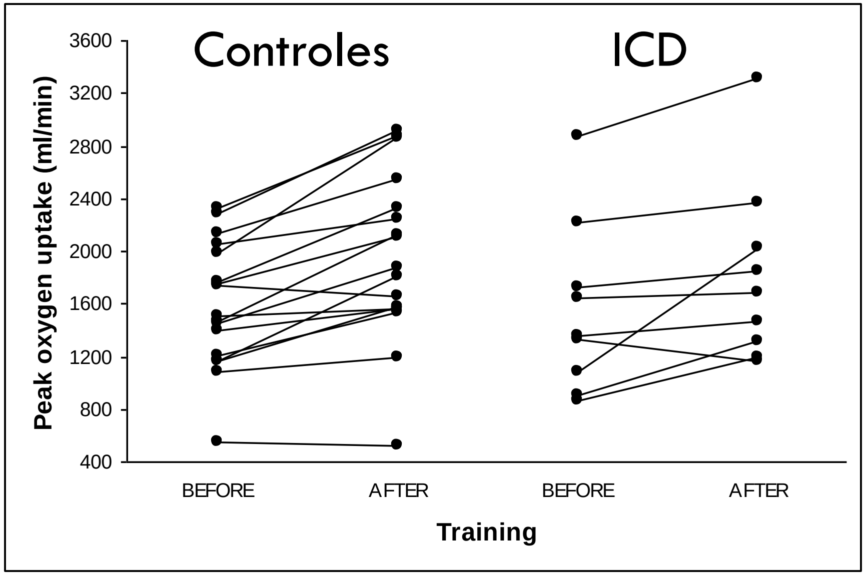
* p < 0.05; *** p < 0.001

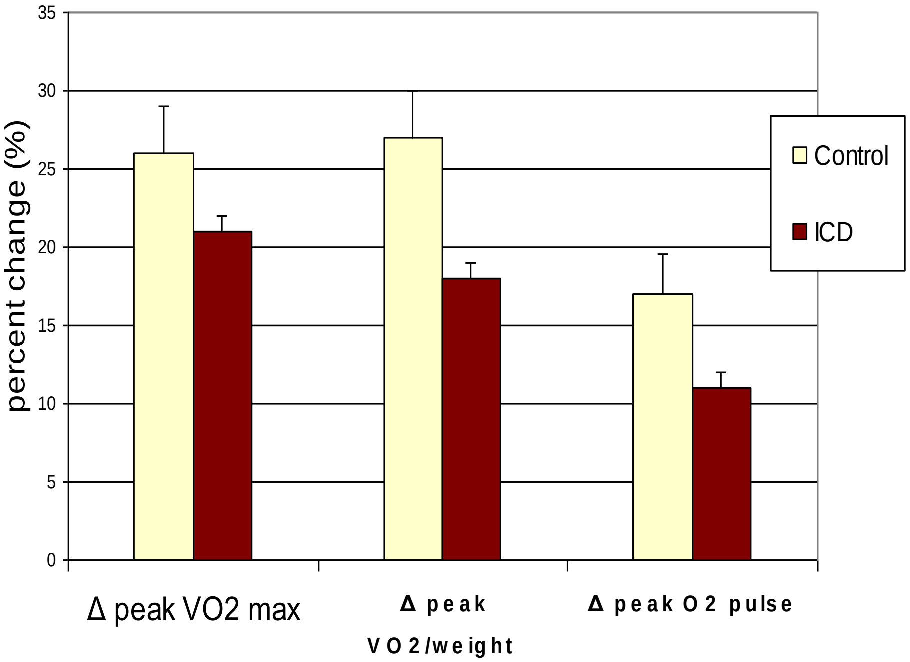
Vanhees et al, JCPR, 2000

KATHOLIEKE UNIVERSITEIT LEUVEN

Inspanningsevaluatie en fysieke training bij patiënten met een ICD

n ptn ICD = 106

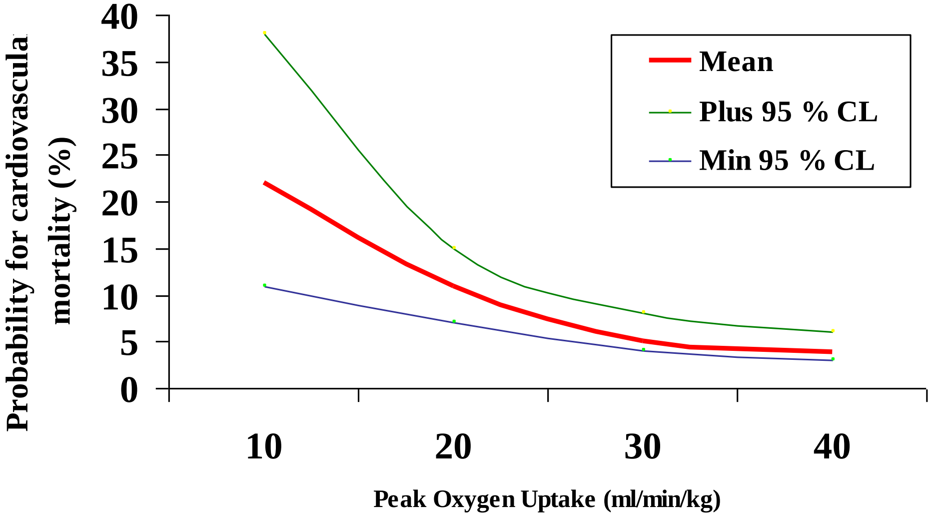


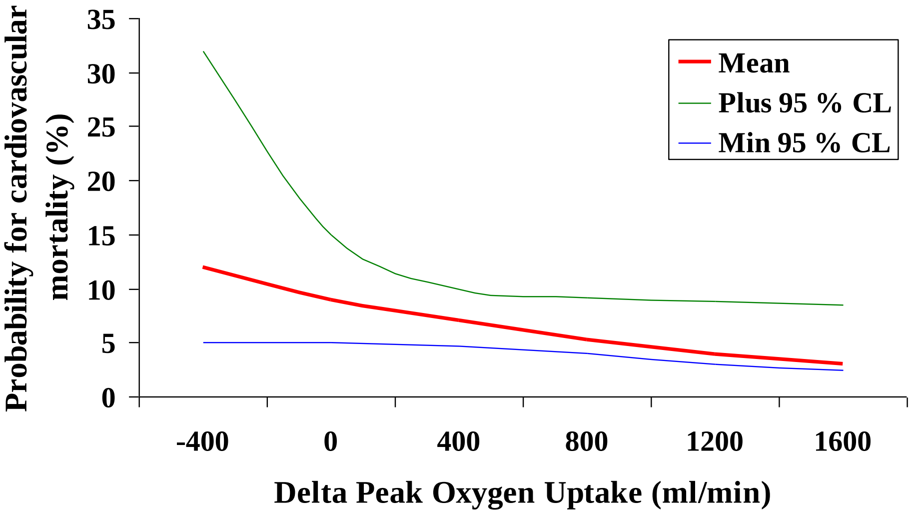


Vanhees et al, Am J Cardiol 2001.

Vanhees et al, Eur Heart J. 2004

Exercise capacity and it's change by ET on CV mortality





L. Vanhees et al. JACC, 1994

L. Vanhees et al. Am J Cardiol 1995

Potential cardioprotective effects of regular physical activity

Anti-atherosclerotic	Psychologic	Anti-thrombotic	Anti-ischemic	Anti-arrhythmic
Improved lipids	↓ Depression	↓ Platelet adhesiveness	↓ Myocardial O_2 demand	↑ Vagal tone
Lower BPs	↓ Stress	↑ Fibrinolysis	↑ Coronary flow	↓ Adrenergic activity
Reduced adiposity	↑ Social support	↓ Fibrinogen	↓ Endothelial dysfunction	↑ HR variability
↑ Insulin sensitivity		↓ Blood viscosity	↑ EPCs and CACs	
↓ Inflammation			↑ Nitric oxide*	

Exercise is medicine

Send2Press® Newswire

Exercise is medicine

Exercise works, but on which target?
What are the aims, outcomes or targets for exercise training?What are the mechanisms?

KATHOLIEKE UNIVERSITEIT LEUVEN

Possible Aims of Exercise Training

- **Target:**
  - Higher level of functioning
  - Higher level of exercise tolerance
  - Health improvement or maintenance
    - Mortality
    - Morbidity
    - Risk factor reduction
  - Pedagogical aim
  - Therapeutical intervention
    - Decrease impact of surgery
    - Counteract decline in functioning due to age or morbidity
    - Influence positively health related fitness

KATHOLIEKE UNIVERSITEIT LEUVEN

ExeRcise is Medicine™

Send2Press® Newswire

Exercise is medicine

Do we need the same exercise for the different targets?

Do we have only one type off pill and one dosage?

Characteristics of PA and Exercise Training

PA characteristics

- TEE (Total Energy Expenditure)

- Intensity (METs)

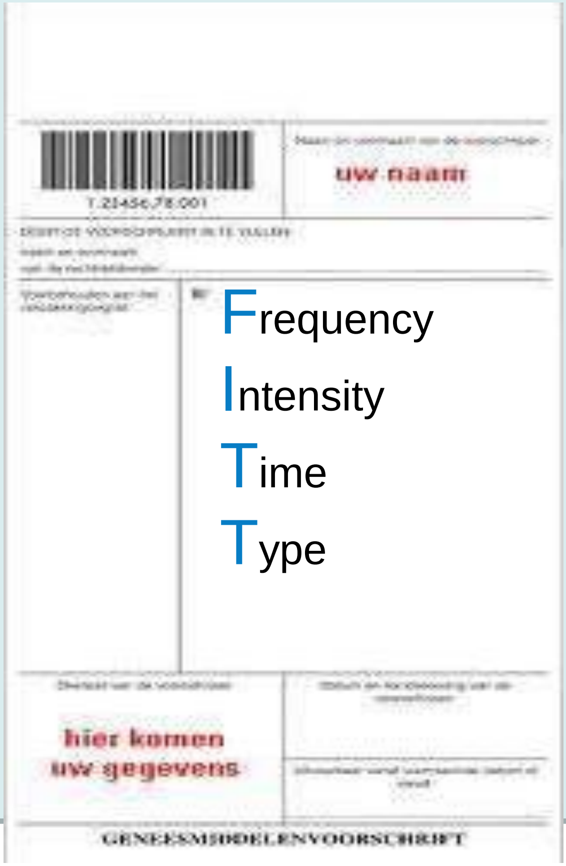
  X

- Duration (hours)

  ⬇

- Volume (METs-hours)

Exercise training characteristics



Frequency

Intensity

Time

Type

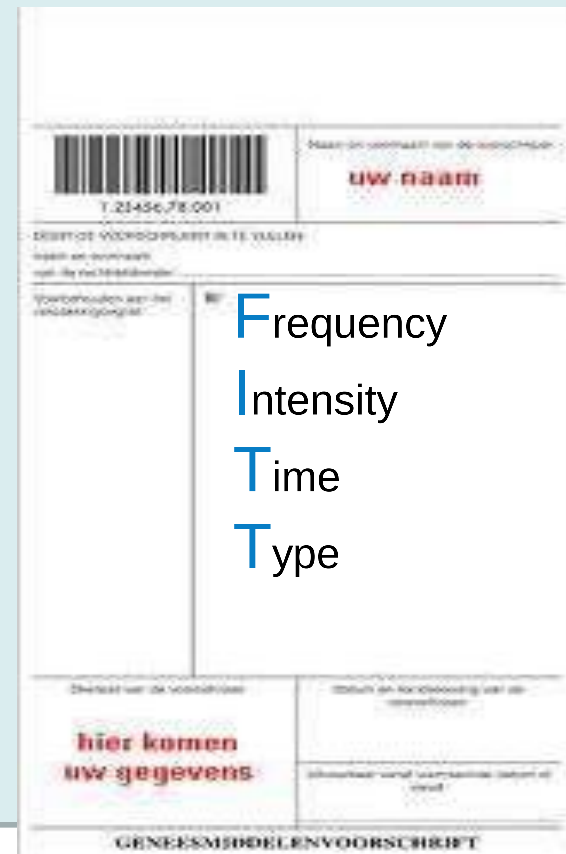
KATHOLIEKE UNIVERSITEIT LEUVEN

Characteristics of PA and Exercise Training

PA characteristics

- TEE (Total Energy Expenditure)
- Intensity (METs)
  X
- Duration (hours)
- Volume (METs-hours)

Exercise training characteristics


uw naam
hier komen uw gegevens
GENEESMIDDELENVOORSCHRIFT

Frequency
Intensity
Time
Type

Defining physical activity

"Any bodily movement produced by skeletal muscles that results in energy expenditure" (Caspersen et al., 1985)

⇨ The larger the muscle mass involved, the larger the EE

Intensities of Physical Activity

<u>Light-intensity activities</u> : 1.1 - 2.9 METs.

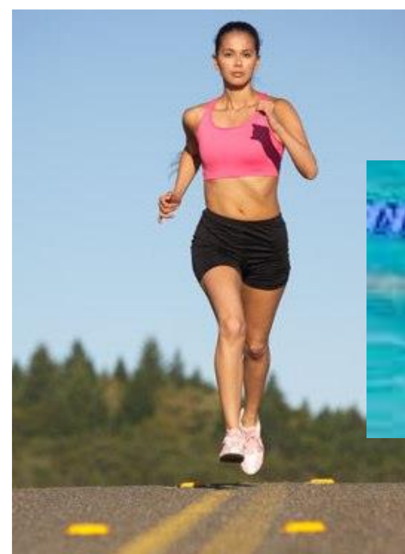
<u>Moderate-intensity activities</u> 3.0 - 5.9 METs.
Walking at 3.0 miles per hour requires 3 METs of energy expenditure and is therefore considered as moderate-intensity.

<u>Vigorous-intensity activities</u> ≥ 6.0 METs
Running at 10 min/mile (6.0 mph) is a 10 MET activity and is therefore classified as vigorous intensity.

3-4 METs

5.5 METs

4-6 METs



10 METs

Defining sedentary behavior

"Activities that do not increase energy expenditure above the resting level"






KATHOLIEKE UNIVERSITEIT LEUVEN

KATHOLIEKE UN LEUV

LIPPINCOTT WILLIAMS & WILKINS

EUROPEAN SOCIETY OF CARDIOLOGY

Original Scientific Paper

How to assess physical activity? How to assess physical fitness?

Luc Vanhees[a,d], Johan Lefevre[b], Renaat Philippaerts[c], Martine Martens[a], Wim Huygens[b], Thierry Troosters[a] and Gaston Beunen[b]

[a]Department of Rehabilitation Sciences, [b]Department of Sport and Movement Sciences, Faculty of Kinesiology and Rehabilitation Sciences, K. U. Leuven, [c]Department of Movement and Sports Sciences, Ghent University, Belgium and [d]Faculty Chair 'Health and Lifestyle', Faculty of Health Care, Utrecht, The Netherlands.

Received 6 January 2005 **Revised** 15 February 2005 **Accepted** 17 February 2005

Regular aerobic physical activity (PA) increases exercise capacity and physical fitness (PF), which can lead to many health benefits. Accurate quantification of PA and PF becomes essential in terms of health outcome and effectiveness of intervention programmes. In this manuscript we present a review regarding the assessment of physical activity and fitness. Three types of PA assessment methods can be distinguished: criterion methods, objective methods and subjective methods. Criterion methods like doubly labelled water, indirect calorimetry and direct observation are the most reliable and valid measurements against which all other PA assessments methods should be validated, but they also hold important drawbacks. Objective PA assessment methods include activity monitors (pedometers and accelerometers) and heart rate monitoring. Finally, questionnaires and activity diaries are considered subjective methods. For the assessment of PF, we distinguish field tests and laboratory tests. The Eurofit for Adults is a test battery that is designed to assess health-related fitness of individuals, communities, sub-populations and populations. It is mainly used for evaluating the morphological component, the muscular component, the motor component and the cardio-respiratory component. In the laboratory, exercise capacity is preferentially assessed through maximal incremental exercise testing. Cardio-pulmonary exercise testing is a well-established procedure that provides a wealth of clinically diagnostic and prognostic information. The peak oxygen uptake is the gold standard in the assessment of exercise tolerance. When maximal exercise is contraindicated or not achievable, the VAT or the submaximal slopes provide reasonable alternatives. *Eur J Cardiovasc Prev Rehabil* 12:102–114 © 2005 The European Society of Cardiology

KATHOLIEKE UNIV
LEUV

LIPPINCOTT
WILLIAMS & WILKINS

EUROPEAN
SOCIETY OF
CARDIOLOGY

Original Scientific Paper

How to assess physical activity? How to assess physical fitness?

Luc Vanhees[a,d], Johan Lefevre[b], Renaat Philippaerts[c], Martine Martens[a], Wim Huygens[b], Thierry Troosters[a] and Gaston Beunen[b]

[a]Department of Rehabilitation Sciences, [b]Department of Sport and Movement Sciences, Faculty of Kinesiology and Rehabilitation Sciences, K. U. Leuven, [c]Department of Movement and Sports Sciences, Ghent University, Belgium and [d]Faculty Chair 'Health and Lifestyle', Faculty of Health Care, Utrecht, The Netherlands.

Received 6 January 2005 **Revised** 15 February 2005 **Accepted** 17 February 2005

Regular aerobic physical activity (PA) increases exercise capacity and physical fitness (PF), which can lead to many health benefits. Accurate quantification of PA and PF becomes essential in terms of health outcome and effectiveness of intervention programmes. In this manuscript we present a review regarding the assessment of physical activity and fitness. Three types of PA assessment methods can be distinguished: criterion methods, objective methods and subjective methods. Criterion methods like doubly labelled water, indirect calorimetry and direct observation are the most reliable and valid measurements against which all other PA assessments methods should be validated, but they also hold important drawbacks. Objective PA assessment methods include activity monitors (pedometers and accelerometers) and heart rate monitoring. Finally, questionnaires and activity diaries are considered subjective methods. For the assessment of PF, we distinguish field tests and laboratory tests. The Eurofit for Adults is a test battery that is designed to assess health-related fitness of individuals, communities, sub-populations and populations. It is mainly used for evaluating the morphological component, the muscular component, the motor component and the cardio-respiratory component. In the laboratory, exercise capacity is preferentially assessed through maximal incremental exercise testing. Cardio-pulmonary exercise testing is a well-established procedure that provides a wealth of clinically diagnostic and prognostic information. The peak oxygen uptake is the gold standard in the assessment of exercise tolerance. When maximal exercise is contraindicated or not achievable, the VAT or the submaximal slopes provide reasonable alternatives. *Eur J Cardiovasc Prev Rehabil* 12:102–114 © 2005 The European Society of Cardiology

KATHOLIEKE UNIVERSITEIT LEUVEN

How to assess PA

Table 1 Overview of strengths and weaknesses of physical activity assessment methods

PA* Assessment method	Advantages	Disadvantages
Criterion methods		
Doubly labelled water (DLW)	Accurate and valid measurement of EE*. Applicable for children and adults Induces no change in PA behaviour in daily free-living conditions	Expensive Analysis requires expertise No indication of specific activities, only total (daily) EE Not appropriate for large-scale studies At least recordings over 3 days
Indirect calorimetry	Accurate and valid measurement of short term EE	Expensive Limited to laboratory setting until better portable devices become available. Indirect measurement of PA
Direct observation	Best recording of type of PA and interpretation of the activities Contextual information Applicable to children	Time consuming Potential reactivity of study participant Limited in monitoring time Subjectivity of the observer.
Objective methods		
Pedometers	Lightweight, portable around waist Simple and inexpensive Non-reactive. Free living conditions	Only walking or running steps, no recording of horizontal or upper-body movements Limited validity for EE estimation No information of specific activity, only total (daily) PA
Accelerometers	See pedometer Recording of accelerations in more than one plane and for extended period Indication of intensity of the movement. Possibility of measuring a specific activity Free living conditions	Limited validity for EE estimation. No recording of horizontal or upper-body movements, carrying a load
Heart rate monitoring	Lightweight and portable Directly related to physiological response to a physical activity Detailed data recording over extended period. Possibility of measuring a specific activity	Measurement of EE, not of PA Not suited for very low-intensity PA as heart rate is affected by non-activity related environmental factors. Individual calibration of heart rate – PA relationship required
Subjective methods		
Questionnaires	Applicable in epidemiological studies Valid for gross classification of PA level for a population (e.g., low, moderate, highly active)	Limited validity. No detailed information of PA. Depends on subject's memory, interpretation Not suited for PA assessment at the individual level

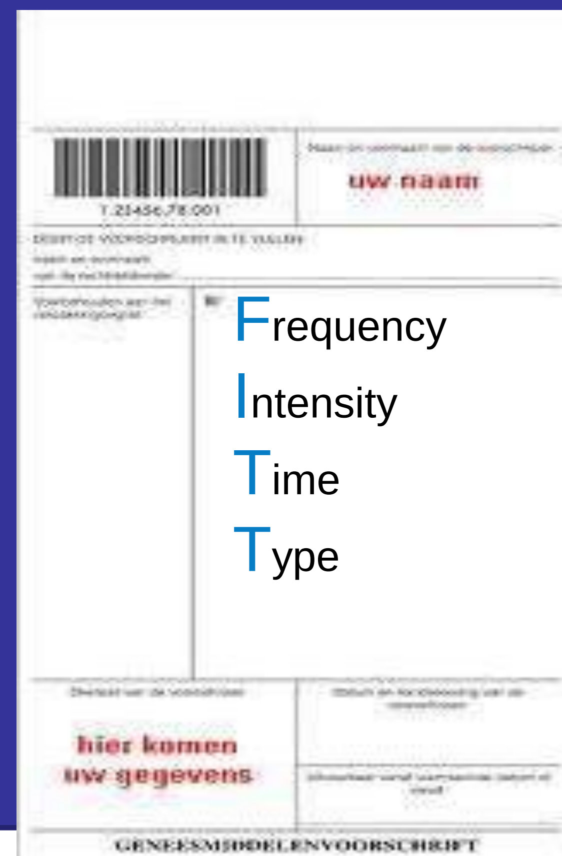
*PA, physical activity; EE, energy expenditure.

Characteristics of PA and Exercise Training

PA characteristics

- TEE (Total Energy Expenditure)
- Intensity (METs)
  X
- Duration (hours)
  ⬇
- Volume (METs-hours)

Exercise training characteristics



KATHOLIEKE UNIV
LEUV

LIPPINCOTT
WILLIAMS & WILKINS

EUROPEAN
SOCIETY OF
CARDIOLOGY

Original Scientific Paper

How to assess physical activity? How to assess physical fitness?

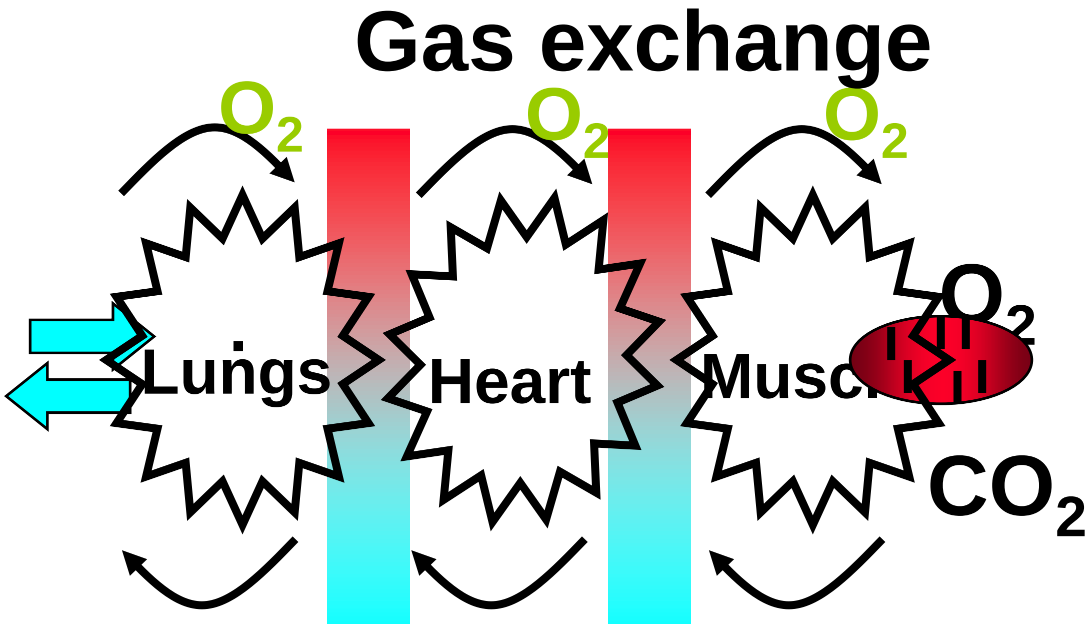
Luc Vanhees[a,d], Johan Lefevre[b], Renaat Philippaerts[c], Martine Martens[a], Wim Huygens[b], Thierry Troosters[a] and Gaston Beunen[b]

[a]Department of Rehabilitation Sciences, [b]Department of Sport and Movement Sciences, Faculty of Kinesiology and Rehabilitation Sciences, K. U. Leuven, [c]Department of Movement and Sports Sciences, Ghent University, Belgium and [d]Faculty Chair 'Health and Lifestyle', Faculty of Health Care, Utrecht, The Netherlands.

Received 6 January 2005 **Revised** 15 February 2005 **Accepted** 17 February 2005

Regular aerobic physical activity (PA) increases exercise capacity and physical fitness (PF), which can lead to many health benefits. Accurate quantification of PA and PF becomes essential in terms of health outcome and effectiveness of intervention programmes. In this manuscript we present a review regarding the assessment of physical activity and fitness. Three types of PA assessment methods can be distinguished: criterion methods, objective methods and subjective methods. Criterion methods like doubly labelled water, indirect calorimetry and direct observation are the most reliable and valid measurements against which all other PA assessments methods should be validated, but they also hold important drawbacks. Objective PA assessment methods include activity monitors (pedometers and accelerometers) and heart rate monitoring. Finally, questionnaires and activity diaries are considered subjective methods. For the assessment of PF, we distinguish field tests and laboratory tests. The Eurofit for Adults is a test battery that is designed to assess health-related fitness of individuals, communities, sub-populations and populations. It is mainly used for evaluating the morphological component, the muscular component, the motor component and the cardio-respiratory component. In the laboratory, exercise capacity is preferentially assessed through maximal incremental exercise testing. Cardio-pulmonary exercise testing is a well-established procedure that provides a wealth of clinically diagnostic and prognostic information. The peak oxygen uptake is the gold standard in the assessment of exercise tolerance. When maximal exercise is contraindicated or not achievable, the VAT or the submaximal slopes provide reasonable alternatives. *Eur J Cardiovasc Prev Rehabil* 12:102–114 © 2005 The European Society of Cardiology

How to assess PF – Laboratory tests



- VO_{2Max} = CO * AV(O2-diff)
- $VO_{2\ Max}$ = HF * SV * AV(O2-diff)
- METs = $VO_{2\ peak}$ /kg/3,5

Table 3 The variables obtained during clinical maximal incremental exercise testing

Overall exercise capacity	Oxygen consumption
Information on the cardiovascular system	Heart rate and heart-rate reserve
	Electrocardiography (arrhythmias, ST-T changes, atrio-ventricular conductance)
	Symptoms suggestive of angina
	Derived variables: O_2-pulse, RPP
	Non-invasive assessment of cardiac output and stroke volume
Information on the ventilatory system	Ventilation and ventilatory reserve
	Tidal volume and breathing frequency
	Inspiratory capacity and flow-volume loops during exercise
	Symptom scores for dyspnea
	Derived variables slope of V_E and VCO_2 relationship
Information related to gas exchange	Transcutaneous oxygen saturation
Muscular system, deconditioning	Lactic acidosis
	Symptom scores for leg fatigue
	Derived variables oxygen uptake efficiency slope

KATHOLIEKE UNIVERSITEIT LEUVEN

Recommendations from the EACPR: Part I

European Journal of Preventive Cardiology

EUROPEAN SOCIETY OF CARDIOLOGY

Review

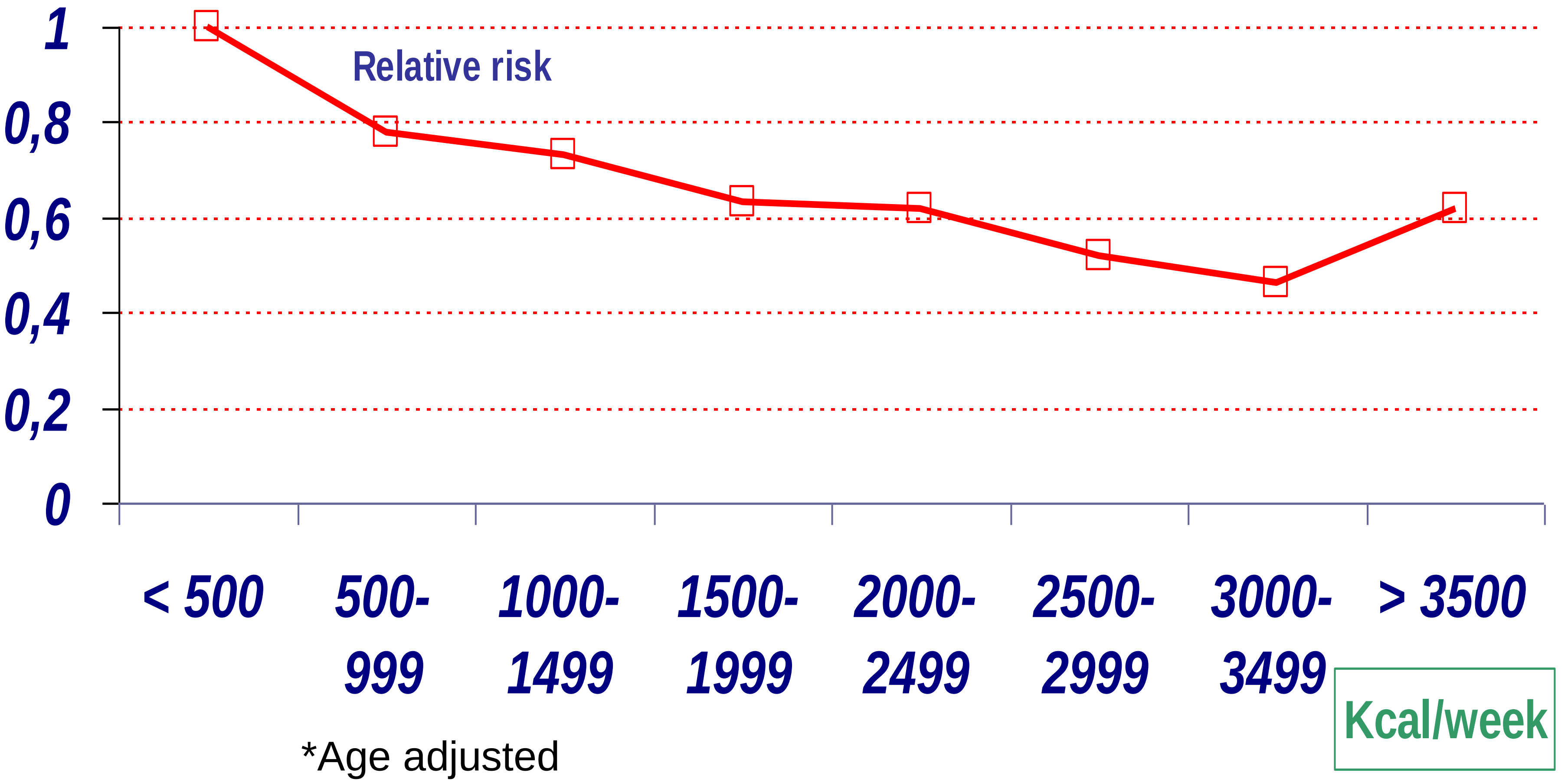
European Journal of Preventive Cardiology
19(4) 670–686

DOI: 10.1177/2047487312437059
ejpc.sagepub.com
SAGE

Importance of characteristics and modalities of physical activity and exercise in defining the benefits to cardiovascular health within the general population: recommendations from the EACPR (Part I)

L Vanhees[1], J De Sutter[2], N Geladas[3], F Doyle[4], E Prescott[5], V Cornelissen[1], E Kouidi[6], D Dugmore[7], D Vanuzzo[8], M Börjesson[9] and P Doherty[10] (on behalf of the writing group of the EACPR)

Physical activity and all cause* mortality -Paffenbarger et al. 1986



*Age adjusted

Cardiovascular mortality: -45%

KATHOLIEKE UNIVERSITEIT LEUVEN

Intensity versus duration of cycling, impact on all-cause and coronary heart disease mortality: the Copenhagen City Heart Study.

➔**Relative intensity** is more important than duration in relation to all-cause and cardiovascular mortality.

Men:

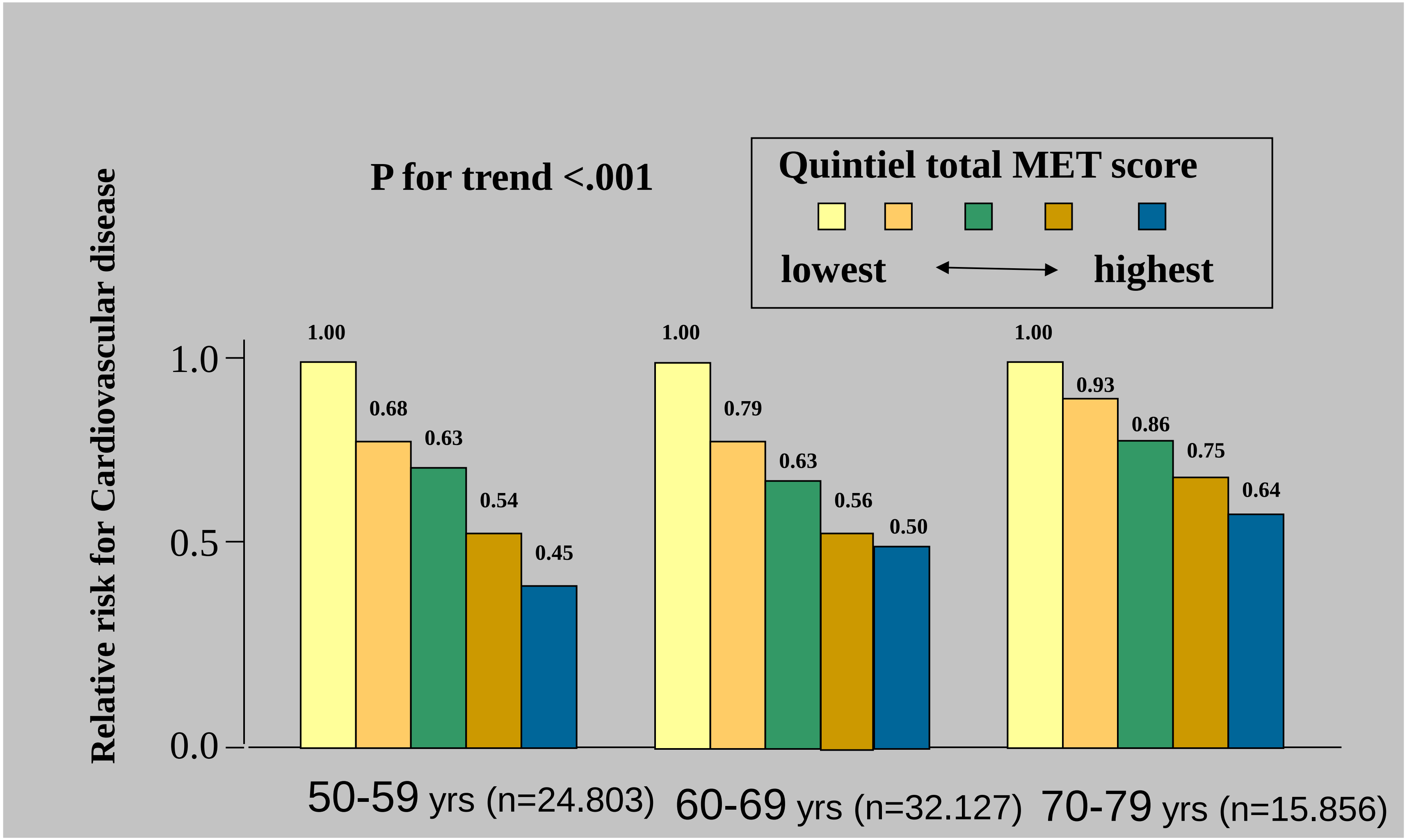
- Fast-intensity cycling survived 5.3 years longer and
- Average-intensity cycling survived 2.9 years longer than slow-intensity cylcing

Women:

- Fast-intensity cycling survived 3.9 years longer and
- Average-intensity cycling survived 2.2 years longer than slow-intensity cylcing

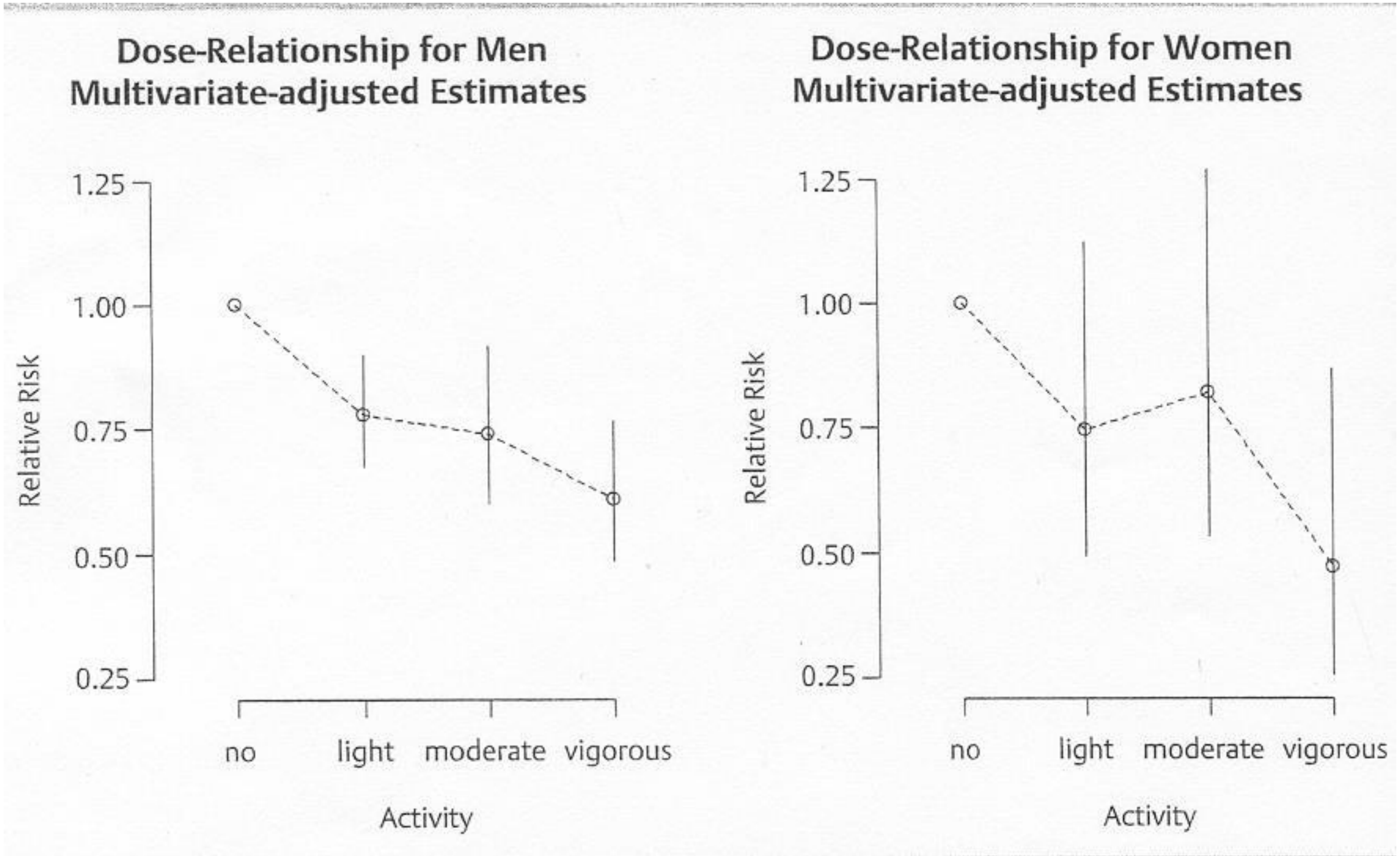
Schnohr et al, EJPC 2012

Walking compared with vigorous exercise for the prevention of cardiovascular events in women
(Manson et al. 2002)



KATHOLIEKE UNIVERSITEIT LEUVEN

Physical activity and all-cause mortality: an updated meta-analysis with different intensity categories.



H.Löllgen Int J Sports Med 2009; 30:213-224

KATHOLIEKE UNIVERSITEIT LEUVEN

Exercise intensities

Table 1. Relative intensities for aerobic physical activity

Intensity	METs	$\%VO_{2max}$	%HRR	%HRmax	RPE scale	Examples
Low intensity, light effort	2–4	28–39	30–39	45–54	10–11	Light gardening, light walking
Moderate intensity, moderate effort	4–6	40–59	40–59	55–69	12–13	Brisk walking
High intensity, vigorous effort	6–8	60–79	60–84	70–89	14–16	Jogging
Very hard effort	8–10	>80	>84	>89	17–19	Running fast
Maximal effort	>10	100	100	100	20	Maximum sprinting

HRmax, maximum heart rate; HRR, heart rate reserve; METs, metabolic equivalents (1 MET, individual metabolic resting demand when sitting quiet, about 3.5 ml oxygen per kg per min, or 1 kcal [4.2 kJ] per kg per hour in the general population); RPE, Borg rating of perceived exertion (6–20 scale).

Vanhees et al, Recommendations of the EACPR (Part I); *European Journal of Preventive Cardiology; 19 (4): 670-686*

Recommendations from the EACPR: Part II

European Journal of Preventive Cardiology
EUROPEAN SOCIETY OF CARDIOLOGY®

Review

European Journal of Preventive Cardiology
19(5) 1005–1033

DOI: 10.1177/1741826711430926
ejpc.sagepub.com
SAGE

Importance of characteristics and modalities of physical activity and exercise in the management of cardiovascular health in individuals with cardiovascular risk factors: recommendations from the EACPR (Part II)

L Vanhees[1], N Geladas[2], D Hansen[3], E Kouidi[4], J Niebauer[5], Ž Reiner[6], V Cornelissen[1], S Adamopoulos[7], E Prescott[8] and M Börjesson[9] (on behalf of the writing group)

Fitt$^+$-principle to describe PA and exercise training characteristcs

Frequency (n sessions/week)

Intensity (%VO_2 peak or % peak HR or %HRR)

Time (duration of exercise/session/programme)

Type (endurance -running, cycling, rowing, walking, swimming,....- resistance training – flexibility – balance - …)

+ Mode of training: *isometric - isotonic

*dynamic - static

*continuous – interval

*large or small muscular groups

Training prescription from GXT

Table 1. Relationship among indices of exercise intensity and training zones

Intensity	Lactate (mmol/l)	METs	VO_{2max} (%)	HRR (%)	HR_{max} (%)	RPE scale	Training zone
Low intensity, light effort	2–3	2–4	28–39	30–39	45–54	10–11	Aerobic
Moderate intensity, moderate effort	4–5	4–6	40–59	40–59	55–69	12–13	Aerobic
High intensity, vigorous effort	6–8	6–8	60–79	60–84	70–89	14–16	Lactate, aerobic, anaerobic
Very hard effort	8–10	8–10	>80	>84	>89	17–19	Lactate, aerobic, anaerobic

HR_{max}, maximum heart rate; HRR, heart rate reserve; METs, metabolic equivalents, 1 MET = individual metabolic resting demand, when sitting quiet, about 3.5 ml oxygen/kg/min or 1 kcal (4.2 kJ/kg/h in the general population; RPE, Borg rating of perceived exertion (6–20 scale).

Vanhees L, Geladas N, Hansen D, Kouidi E, Niebauer J, Reiner Z, Cornelissen V, et al.. Importance of characteristics and modalities of physical activity and exercise in the management of cardiovascular health in individuals with cardiovascular risk factors: recommendations from the EACPR. Part II. Eur J Prev Cardiol. 2012 Oct;19(5):1005-33. Review.

KATHOLIEKE UNIVERSITEIT LEUVEN

Effective exercise training for bodyweight control

Vanhees et al, EJPC, 19(5):1005-1033

Types of exercise training and body composition

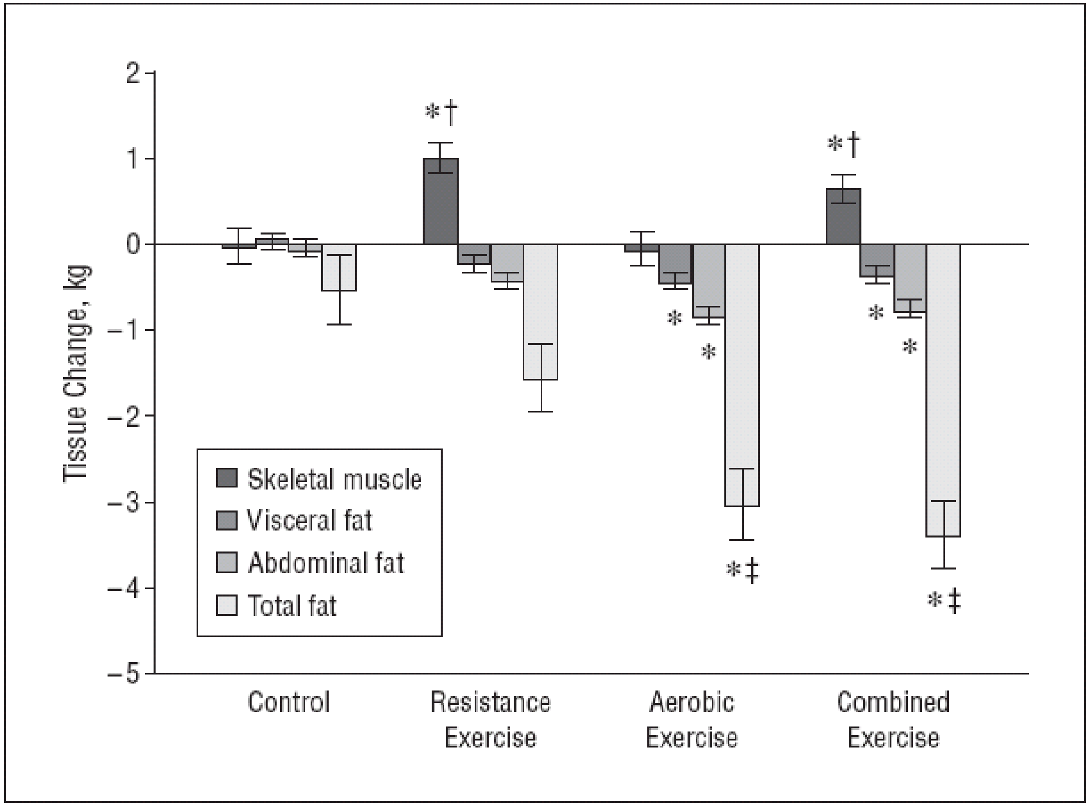


Figure 3. Absolute change in total, abdominal, and visceral fat and in skeletal muscle for each intervention group. Combined exercise indicates a combination of resistance and aerobic exercise. Data represent least squares means (limit lines are standard error) adjusted for age, sex, and baseline value. Pairwise group comparisons using Tukey studentized range tests adjusted for multiple comparisons indicate statistical differences. *$P < .05$ vs the control group. †$P < .05$ vs the aerobic exercise group. ‡$P < .05$ vs the resistance exercise group.

* P < .05 vs control group
† P < .05 vs aerobic exercise group
‡ P < .05 vs resistence exercise group

Arch Intern Med. 2009.
Davidson LE, Ross R.

KATHOLIEKE UNIVERSITEIT
LEUVEN

Intensity of exercise and anthropometric data

Weight, BMI, body fat and waist circumference decreased significantly after higher intensity (P<0.01) but <u>not after lower intensity.</u>

Reductions in weight, BMI and body fat were significantly <u>greater after higher</u> intensity compared with lower intensity

significance of change during the training period.

† $P \leq 0.01$. ‡ $P \leq 0.001$:

Table 1 Anthropometric and fitness variables at baseline and changes after lower intensity and higher intensity exercise training

	LI training			HI training			HI versus LI		
	n	Baseline	Δ Training	*n*	Baseline	Δ Training	*n*	Δ Change HI vs. change LI	Δ (*P*)
Anthropometric characteristics									
Weight (kg)	37	74.9 ± 2.76	−0.21 (−0.76, +0.35)	38	75.2 ± 2.76	−1.09 (−1.62, −0.55)‡	36	−0.88 (−1.65, −0.11)	<0.05
BMI (kg/m^2)	37	26.0 ± 0.68	−0.075 (−0.27, +0.12)	38	26.1 ± .68	−0.38 (−0.58, −0.20)‡	36	−0.31 (−0.59, −0.041)	<0.05
Body fat (%)	37	30.7 ± 1.02	−0.031 (−0.45, +0.39)	38	31.3 ± 1.02	−0.85 (−1.25, −0.44)‡	36	−0.817 (−1.40, −0.23)	<0.01
Body fat (kg)	37	23.1 ± 1.26	−0.096 (−0.60, +0.41)	38	23.8 ± 1.26	−1.16 (−1.66, −0.67)‡	36	−1.07 (−1.77, −0.36)	<0.01
Waist circumference (cm)	37	94.5 ± 2.23	−0.40 (−0.93, +0.13)	38	94.4 ± 2.23	−0.70 (−1.22, −0.19)†	36	−0.31 (−0.97, +0.36)	0.36
Fitness variables									
VO_{2max} (ml/min kg)	33	23.1 ± 0.83	+2.31 (+1.06, +3.55)‡	33	21.8 ± 0.83	+3.70 (+2.47, +4.93)‡	33	+1.39 (+0.027, +2.76)	<0.05
VO_{2max} (ml/min)	33	1758.8 ± 87.5	+145 (+38.0, +251.9)†	33	1666.5 ± 87.5	+235.8 (+129.3, +342.4)‡	33	+90.9 (−33.8, +215.5)	0.15
Maximal load (W)	33	166.6 ± 6.65	+5.40 (−0.33, +11.1)	34	160.6 ± 6.63	+21.5 (+15.8, +27.2)‡	33	+16.1 (+8.00, +24.2)	<0.001
Test duration (s)	33	461.3 ± 19.8	+22.5 (+6.30, +38.72)‡	34	448.3 ± 19.8	+65.5 (+49.4, +81.5)‡	33	+43.0 (+20.0, +65.9)	<0.001
Maximal heart rate (bpm)	33	153.5 ± 1.98	+2.21 (−0.86, +5.28)	34	154.2 ± 1.96	+1.33 (−1.71, +4.37)	33	−0.87 (−4.71, +2.96)	0.61
RER_{max} (VCO_2/VO_2)	33	1.22 ± 0.019	+0.020 (−0.0076, +0.047)	34	1.20 ± 0.019	+0.020 (−0.0074, +0.047)	33	+0.0059 (−0.029, +0.041)	0.99
Borg score at maximal exercise	33	16.6 ± 0.19	−0.20 (−0.60, +0.20)	34	16.3 ± 0.19	+0.13 (−0.27, +0.52)	33	+0.33 (−0.12, +0.77)	0.14

Cornelissen VA et al. J Hypertens. 2009 Apr

The Impact of Training Modalities on the Clinical Benefits of Exercise Intervention in Patients with Cardiovascular Disease Risk or Type 2 Diabetes Mellitus: Review

REVIEW ARTICLE

Sports Med 2010; 40 (11): 921-940
0112-1642/10/0011-0921/$49.95/0

The Impact of Training Modalities on the Clinical Benefits of Exercise Intervention in Patients with Cardiovascular Disease Risk or Type 2 Diabetes Mellitus

Dominique Hansen,[1,2,3] *Paul Dendale,*[1,2] *Luc J.C. van Loon*[4] and *Romain Meeusen*[5]

KATHOLIEKE UNIVERSITEIT LEUVEN

Effect of a few training modalities on body weight/ adipose tissue mass.

Training modality	Nr of studies	Effect parameter	effect	Conclusion
Programme duration	13	adipose tissue mass / body weight	Greater reduction with longer duration	Prolongation of exercise intervention → greater benefits
Addition resistance training	6	Adipose tissue mass (ATM)	Equal reduction	Addition of RT to endurance training does not augment adipose tissue mass
Continuous exercise intensity	4	Adipose tissue mass (ATM)	•3 studies: equal red. •1 study: greater red. in high intensity	In general, exercise intensity does not modulate ATM
High intensity interval exercise	1	Adipose tissue mass (ATM)	Equal reduction compared to moderate intensity exercise	In general, exercise intensity does not modulate ATM
Training frequency	1	Body weight	Greater reduction with higher frequency	Greater exercise freq → greater adipose tissue mass loss

Hansen et al; sports med 2012: 40(11): 921-940

KATHOLIEKE UNIVERSITEIT LEUVEN

Effective exercise training for bodyweight control

Mini summary

In general, exercise training has positive effects on bodyweight in the overweight/obese. However, it is still debated which PA is most effective e.g. mode, duration or intensity, for reducing fat mass in obesity. Endurance exercise intensity, and addition of resistance training to endurance training intervention, seems not to modulate fat mass loss, while an increase in exercise volume and programme prolongation are effective strategies to augment fat mass loss. The impact of resistance training modalities on fat mass in the obese remains obscure. Further investigation for the prevention of weight and fat mass regain after exercise intervention in the obese seems warranted.

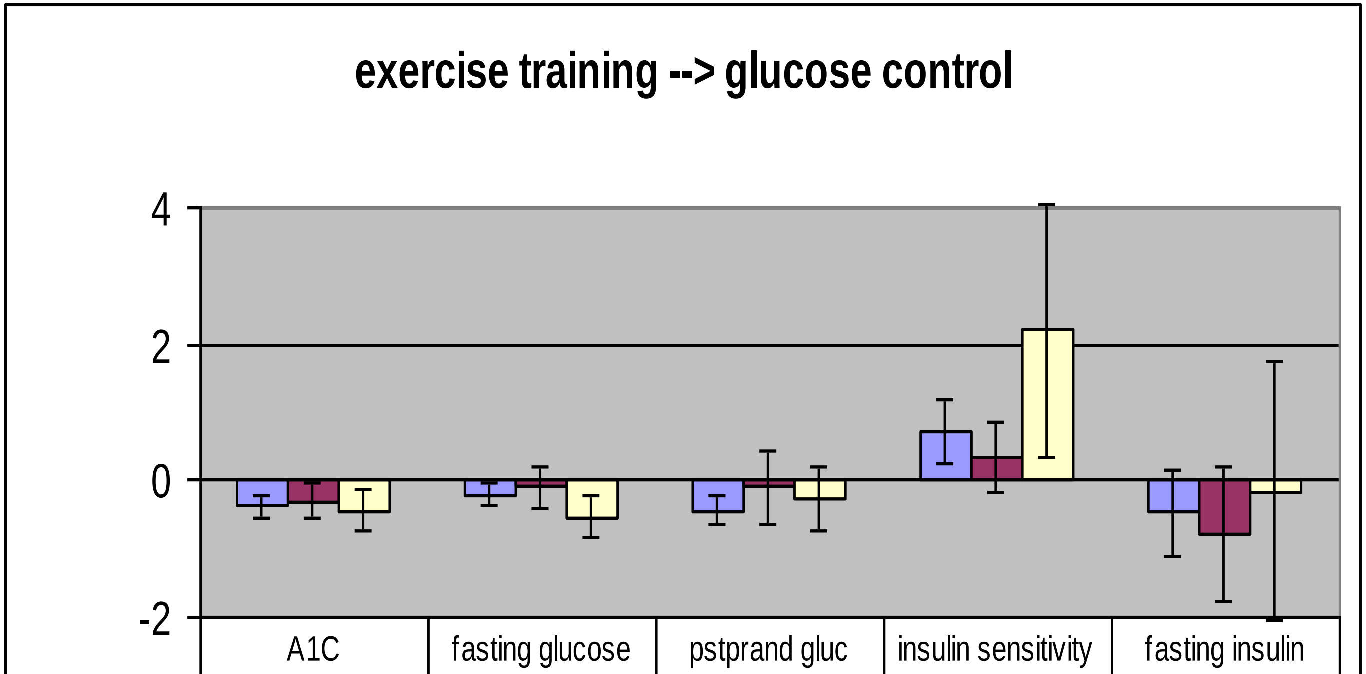
Vanhees et al, EJPC, 19(5):1005-1033

KATHOLIEKE UNIVERSITEIT LEUVEN

Effective physical activity and exercise training for control of insulin/glucose dynamics

Vanhees et al, EJPC, 19(5):1005-1033

Effect of exercise training on glucose control in type 2 diabetes



	A1C	fasting glucose	pstprand gluc	insulin sensitivity	fasting insulin
aerobic	-0,37	-0,2	-0,44	0,74	-0,47
resistance	-0,29	-0,1	-0,1	0,34	-0,78
combined	-0,43	-0,53	-0,28	2,2	-0,15

Meta-analysis:

- 27 trials
- 1003 type 2 diabetes patients
- 5-104 weeks ET

Snowling and Hopkins, Diabetes care 2006

Combined exercise improves insulin resistance

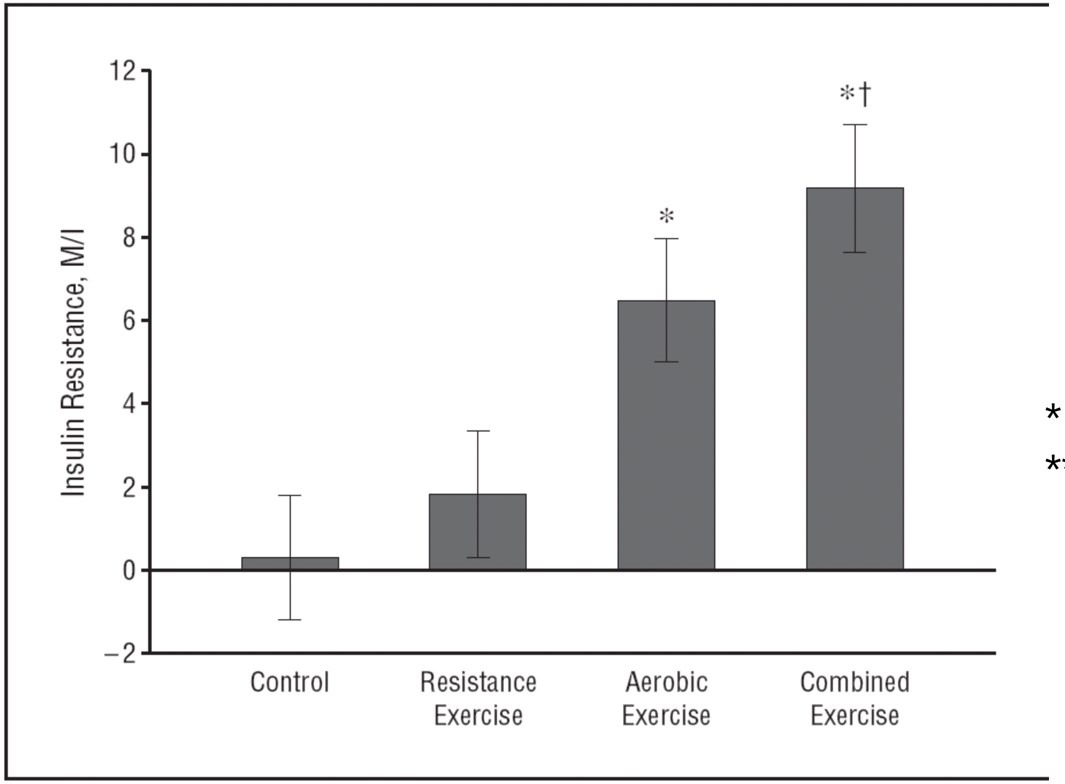


Figure 2. Absolute improvement in insulin resistance for each intervention group. Combined exercise indicates a combination of resistance and aerobic exercise. Data represent least squares means (SEs) adjusted for age, sex, and baseline value and are expressed as M/I (the rate of glucose uptake per unit of insulin per kilogram of skeletal muscle per minute × 100). Pairwise group comparisons using Tukey studentized range tests adjusted for multiple comparisons indicate statistical differences. *$P < .05$ vs the control group. †$P < .05$ vs the resistance exercise group.

* P < .05 vs control group

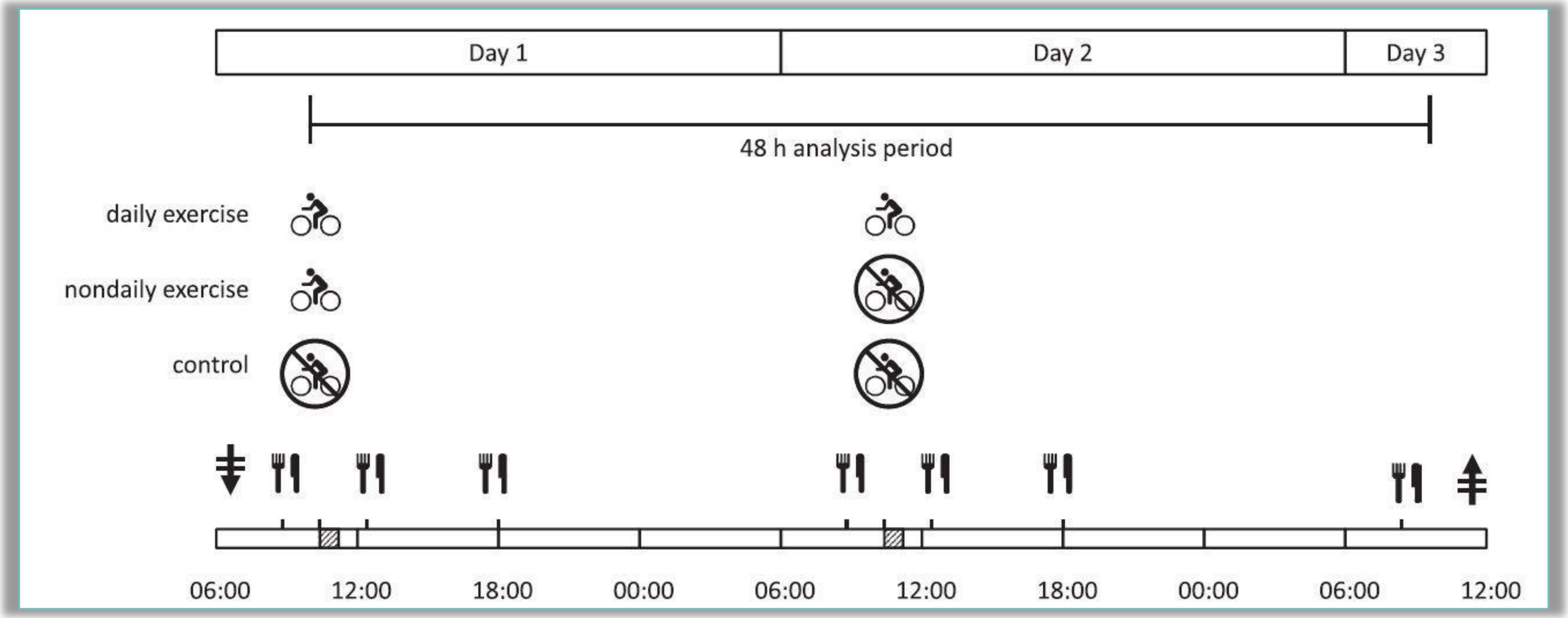
** P < .05 vs resistence exercise group

Davidson LE, Ross R Arch Intern Med. 2009.

KATHOLIEKE UNIVERSITEIT LEUVEN

Exercise prescription: FREQUENCY

Every day or once every 2 days?



Van Dijck et al. Diabetes Care 2012

Recommendations on training

	Training mode	Intensity range	Exact intensity	Duration/sets/repetitions
ACSM (2000)	Endurance training	Low – moderate	40–60% VO_{2max}, RPE 11–13	40–60 min, 3–5 days/week
	Strength training			
	Circuit training	Low–moderate		8–10 repetitions (up to 20), 1–3 sets, 2–3 days/week
	Interval training			
	Free weights			
	Stretching	Moderate		10–30 s/exercise, 2–3 days/week
ADA (2009)	Endurance training	Moderate–high	40–60% VO_{2max}, 50–70% HR_{max}	150 min/week, 3 days/week
			>60% VO_{2max}, >70% HR_{max}	90 min/week, 3 days/week
	Strength training	Moderate		8–10 repetitions, 1–3 sets, 3 days/week
AHA (2009)	Endurance training	Moderate–high	<70% VO_{2max}	150 min/week
			>70% VO_{2max}	90 min/week
	Strength training	Moderate		8–10 repetitions, 3 sets, 3 days/week
ESC (2010)	Endurance training	Moderate		30 min, 5 days/week

ACSM, American College of Sports Medicine;[127] ESC, European Society of Cardiology;[128] ADA, American Diabetes Association;[125] AHA, American Heart Association.[126]; HR_{max}, maximal heart rate; RPE, Borg rating of perceived exertion (6–20 scale); VO_{2max}, maximal oxygen uptake.

Vanhees et al, Recommendations of the EACPR (Part II); *European Journal of Preventive Cardiology; 2012,* 19(5), 1005–1033.