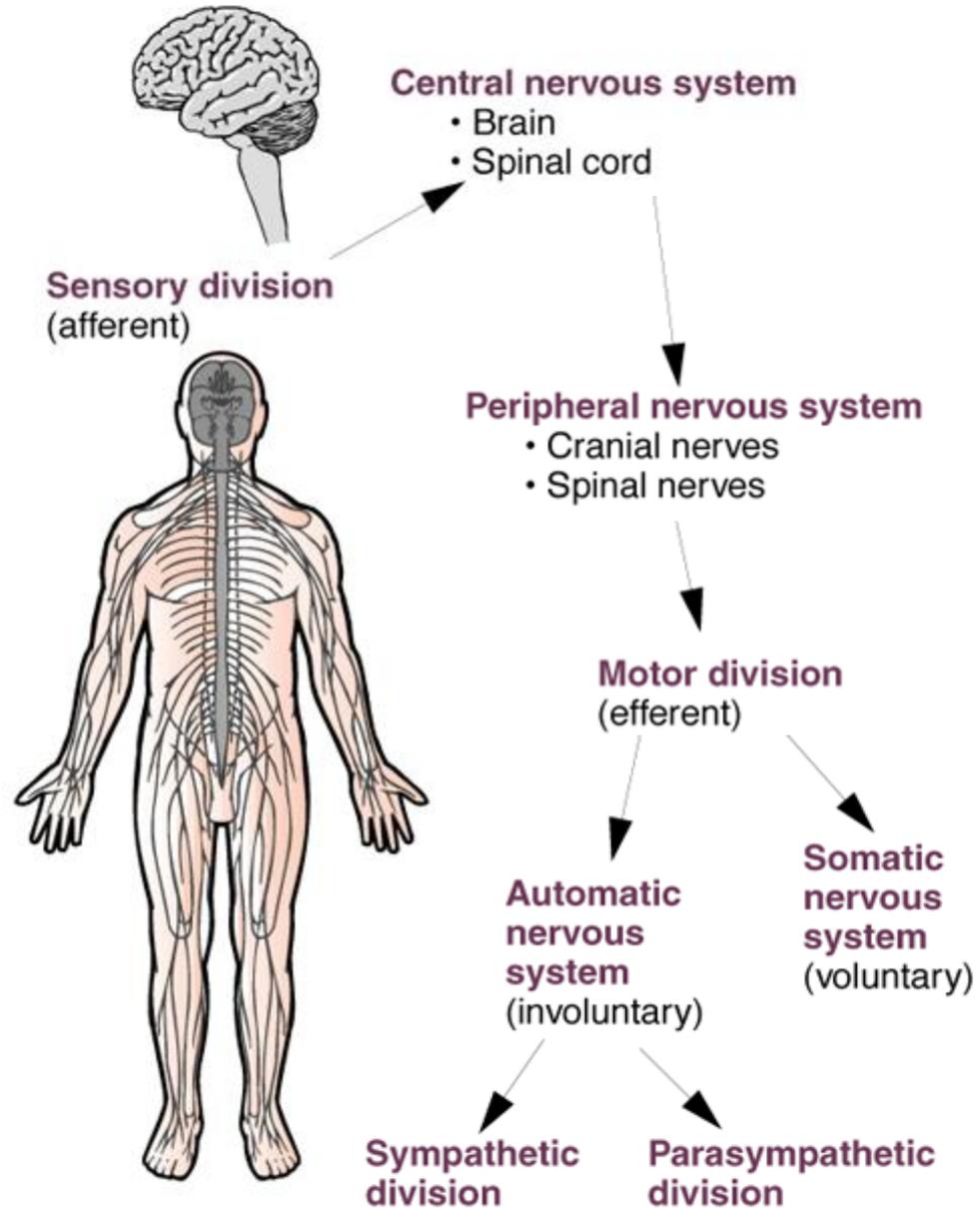




**AJUSTES CARDIOR-
RESPIRATÓRIOS E
VASCULARES AO
EXERCÍCIO FÍSICO:
ASPECTOS CLÍNICOS**



Sistema Nervoso



FUNÇÕES

- 1) O **sistema cardiovascular** proporciona aos tecidos uma corrente contínua de oxigênio e nutrientes;
- 2) É responsável também pela remoção dos co-produtos do metabolismo;
- 3) Regulação homeostática do organismo por distribuição de hormônios.

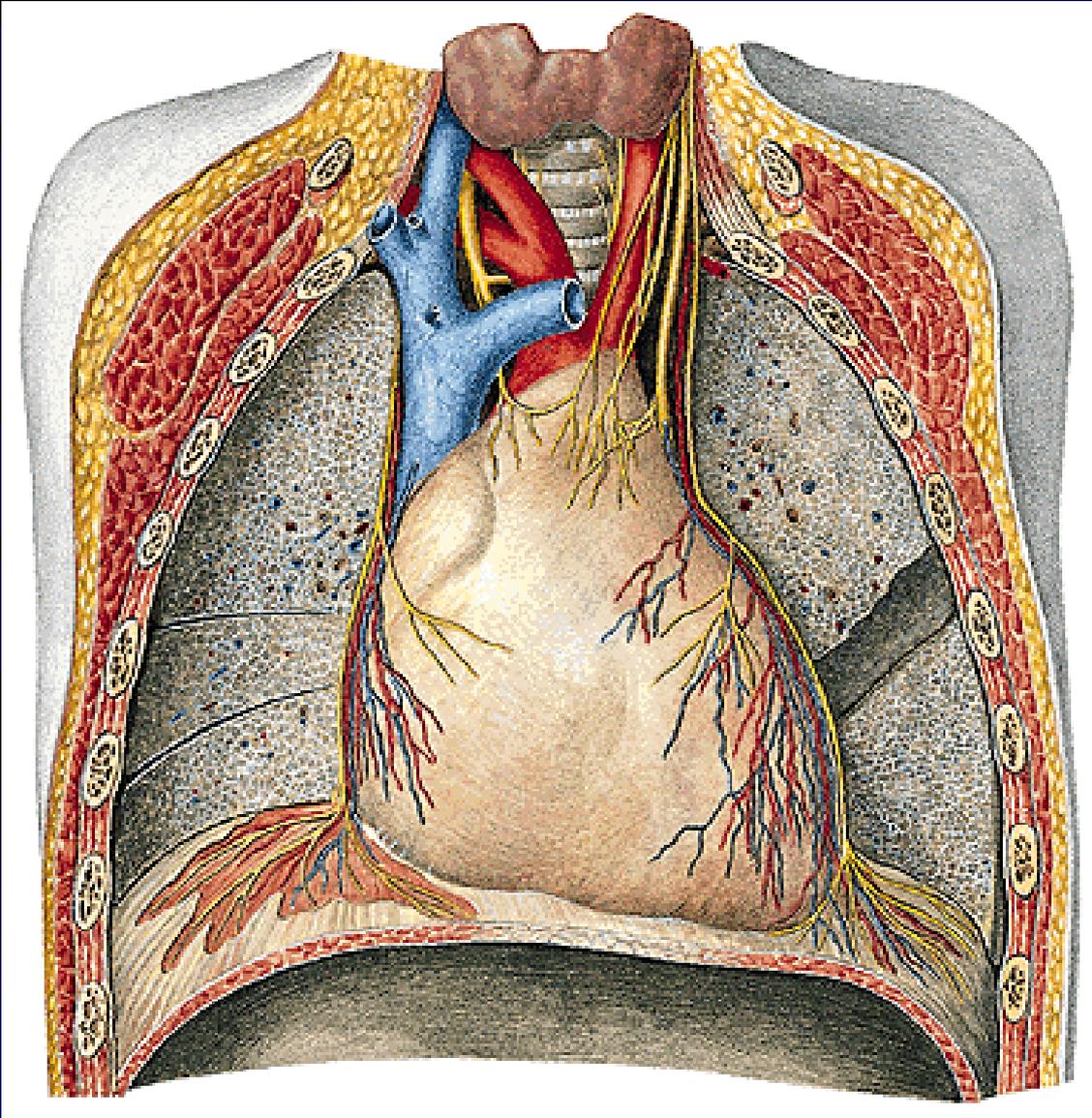
Componentes do Sistema Cardiovascular

✓ CORAÇÃO

✓ SANGUE

✓ SISTEMA VASCULAR

Coração

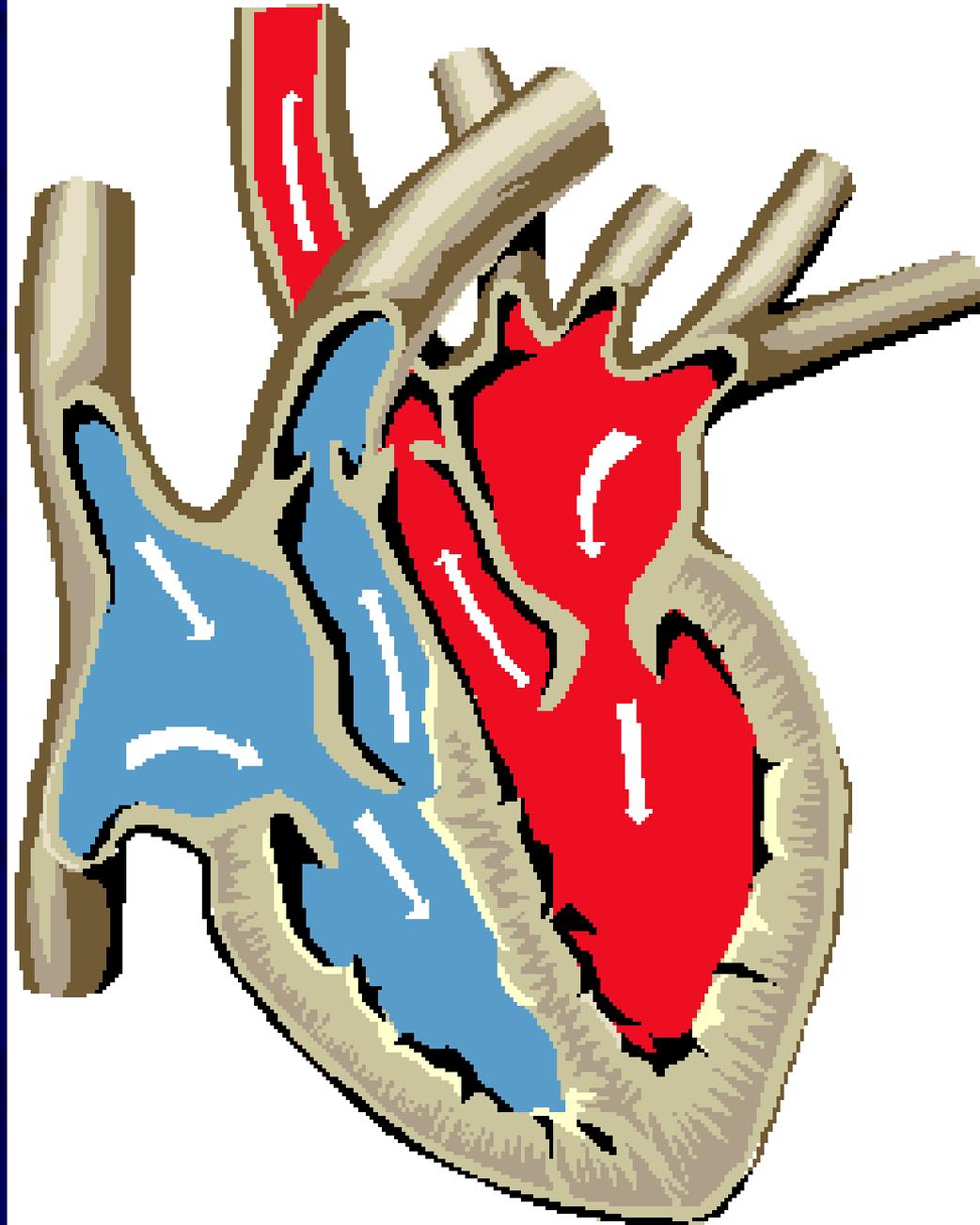


Situado no mediastino
médio

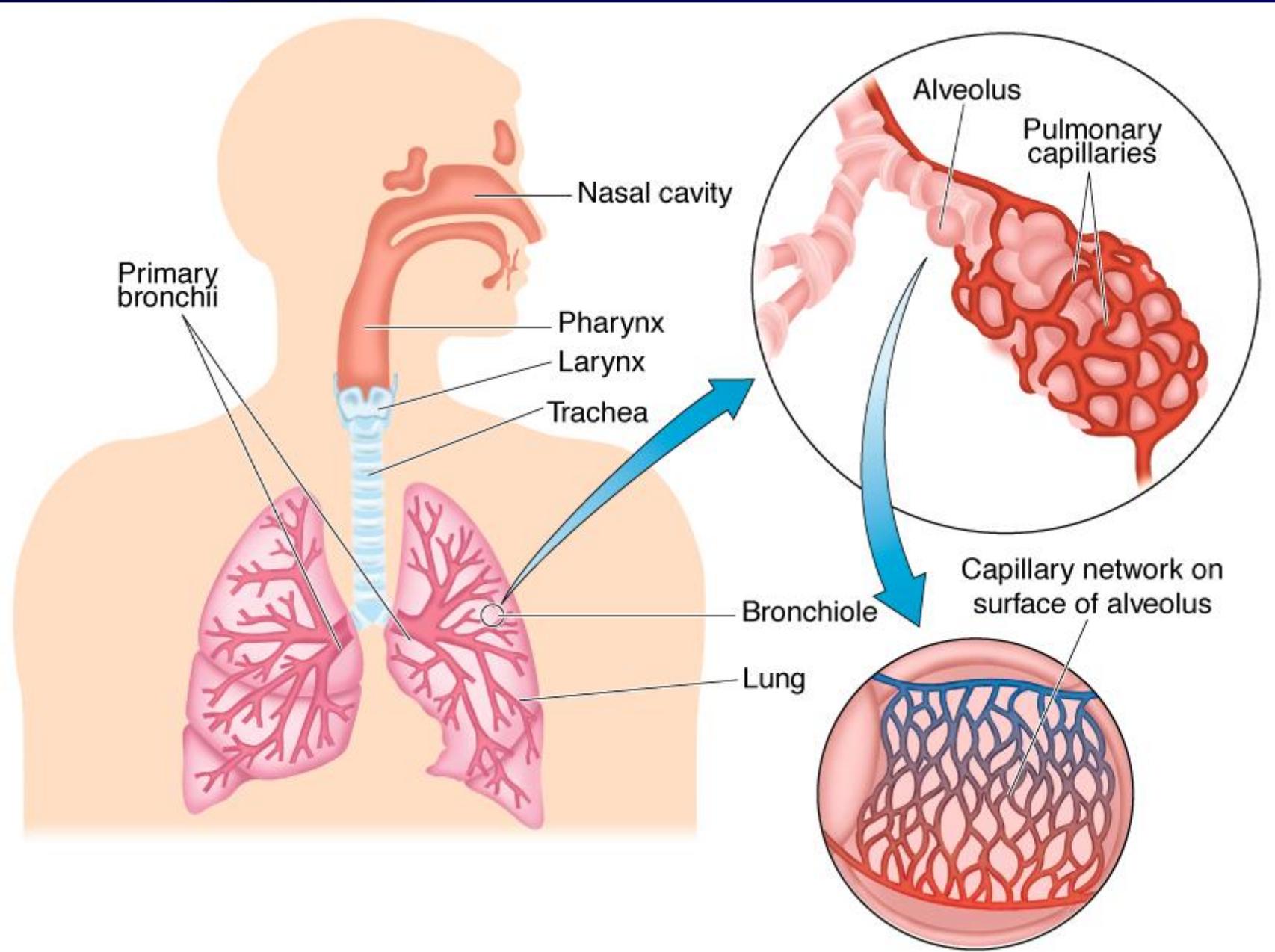
Predominantemente com
seu
ápice voltado para
esquerda

Anatomia Funcional do Coração

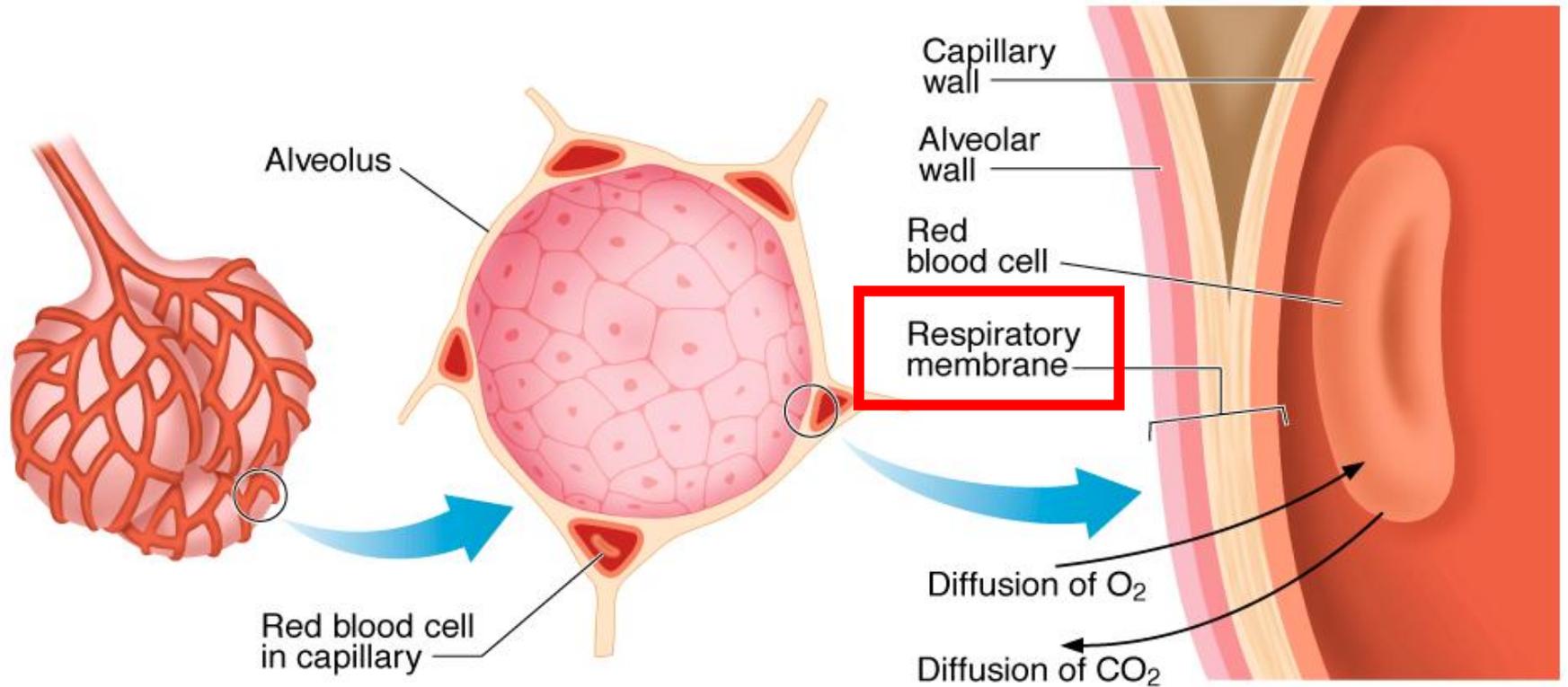
Visa garantir um fluxo unidirecional



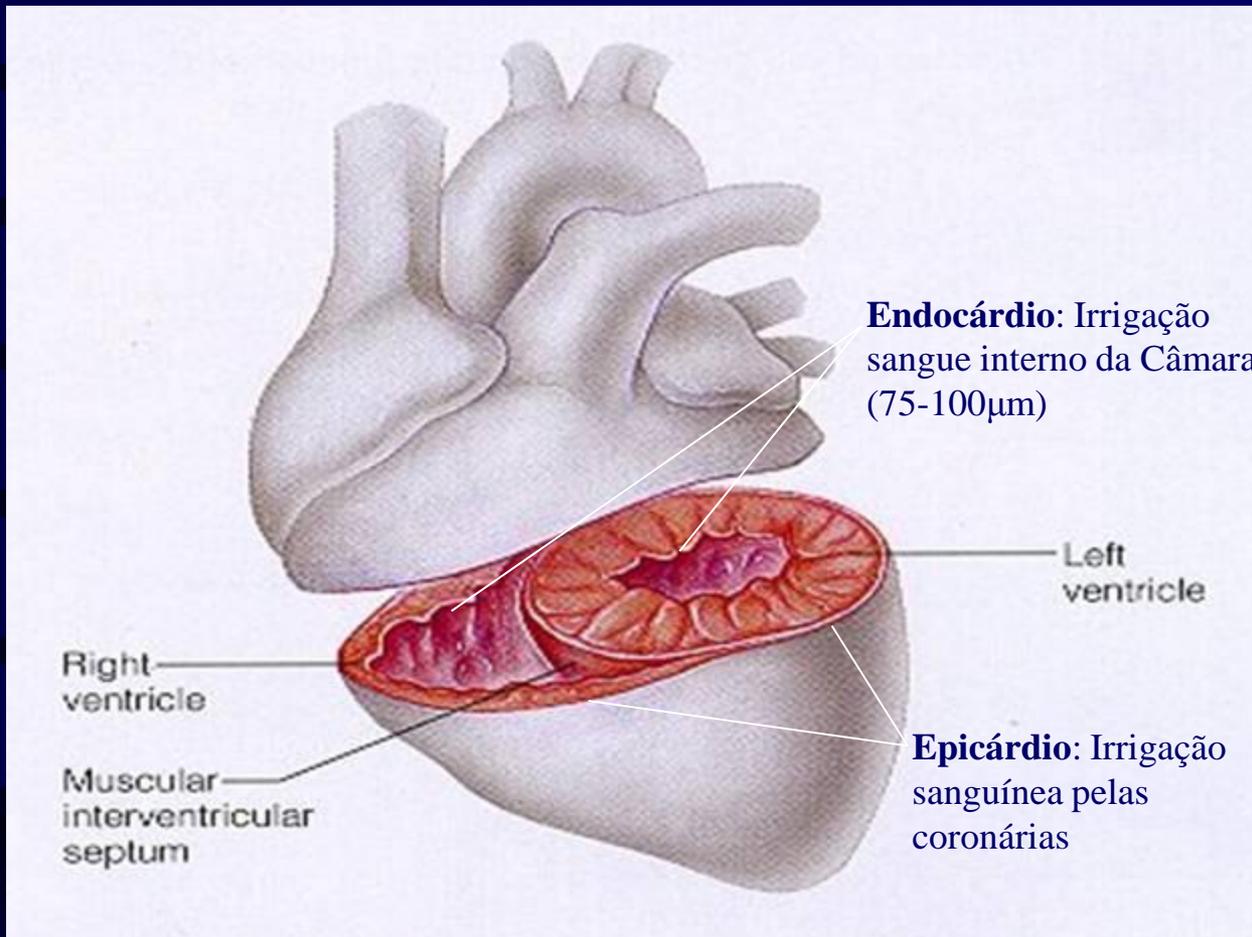
CARDIAC CYCLE



Membrana alveolar - capilar



Anatomia Funcional do Coração



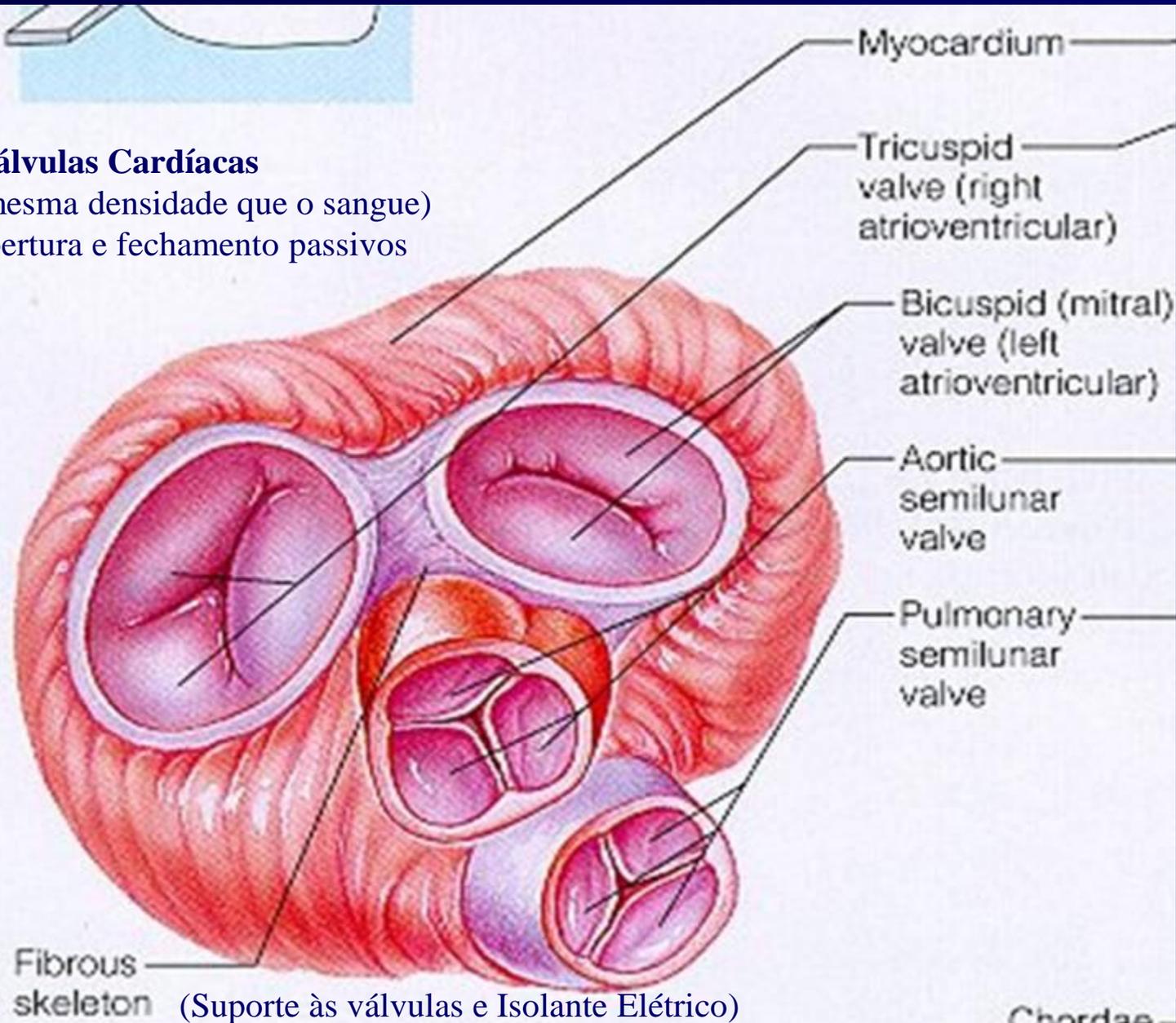
VE: >massa muscular; câmara circular; >força; gera >s pressões; Grande Circulação.

VD: <massa muscular; câmara triangular; <força; gera <s pressões; Pequena Circulação.

Anatomia Funcional do Coração

Válvulas Cardíacas

(mesma densidade que o sangue)
abertura e fechamento passivos



CONTROLE DO CORAÇÃO PELO SISTEMA NERVOSO AUTÔNOMO

Regulação Extrínseca

- *Centros neurais*

SNS (noradrenalina e adrenalina)

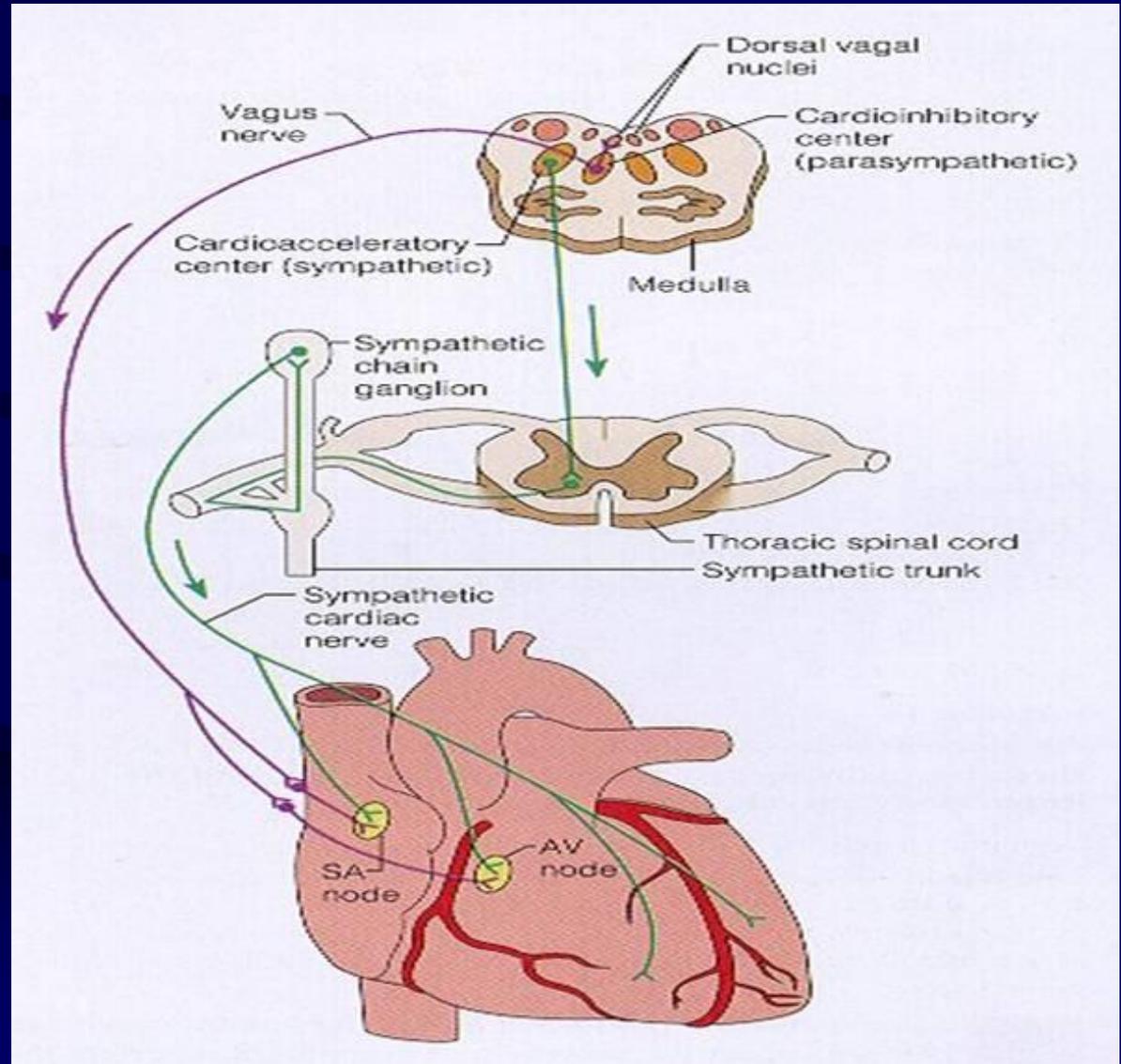
Efeitos: Taquicardia e
Força de contração

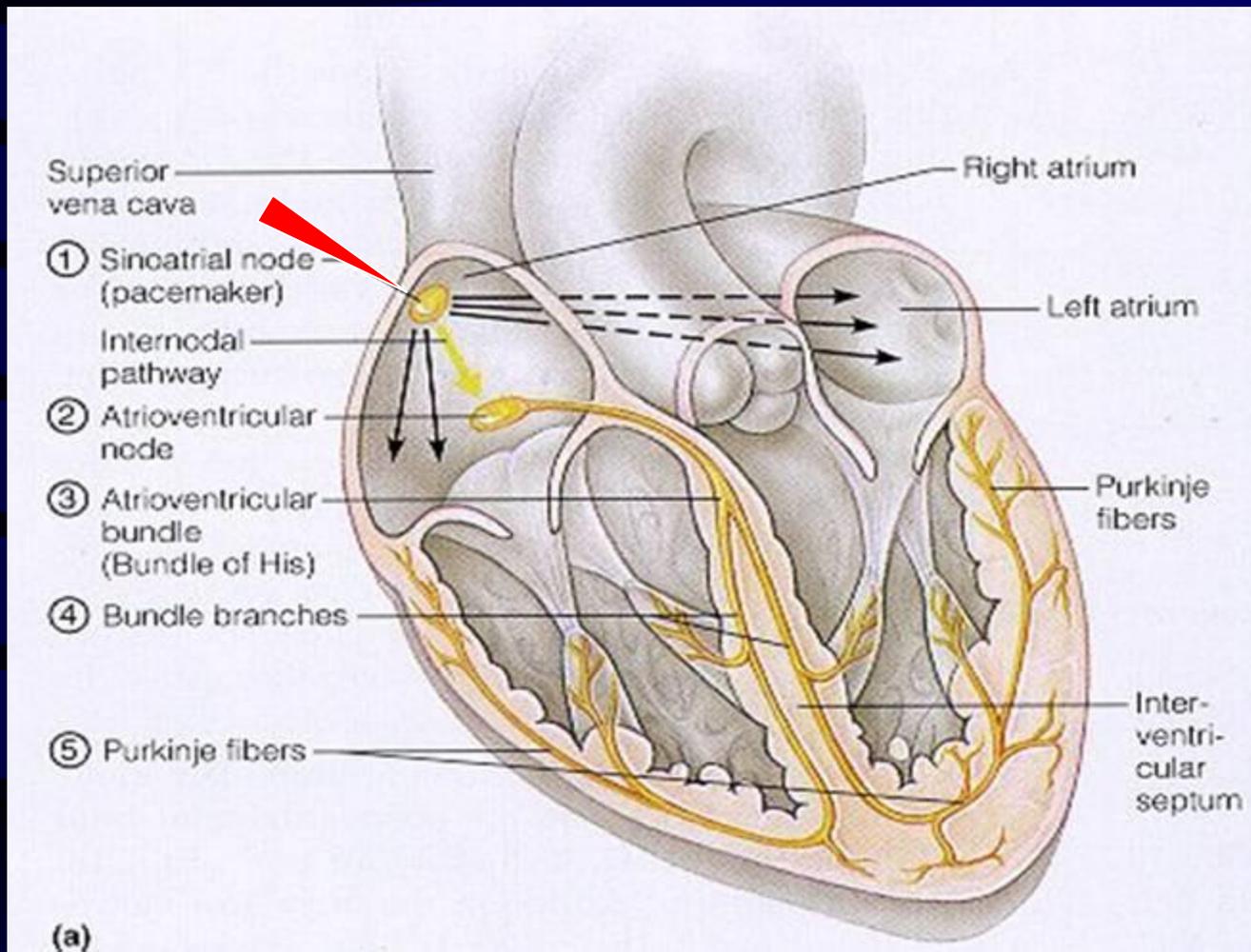
SNPS (acetilcolina)

Efeitos: Bradicardia e
Força de contração

Regulação Intrínseca

Distensão da câmara cardíaca (volume de sangue que chega ao coração).



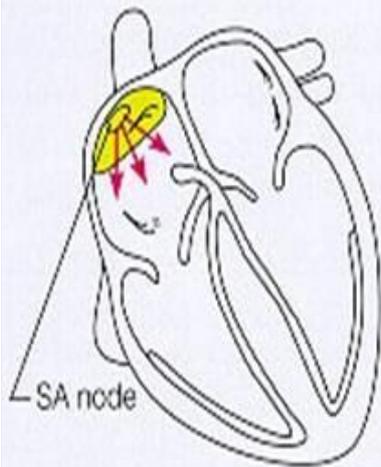


Fibra Nodal:
 Auto-geração de potenciais de ação
 (*cronotropismo cardíaco*)

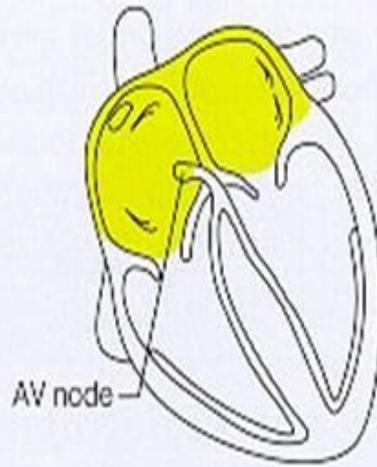
Nodo Sino-atrial (marca-passo normal-110 bpm):
 3mm x 1cm na parede átrio D sob o tônus simpático e parassimpático (± 70 bat/min).

ATIVIDADE ELÉTRICA DO CORAÇÃO

SA node generates impulse, atrial excitation begins



Impulse delayed at AV node



Impulse passes to heart apex; ventricular excitation begins



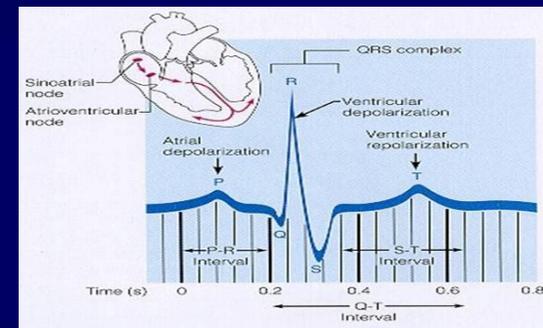
Ventricular excitation complete



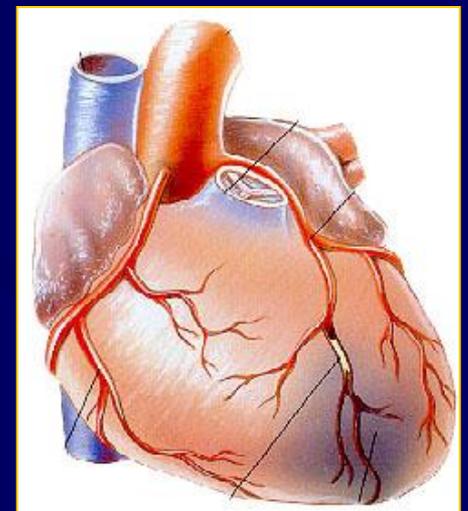
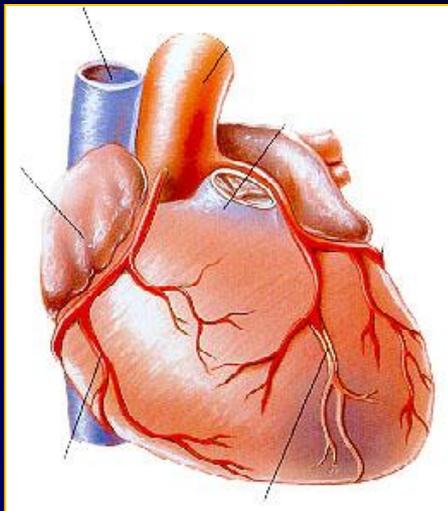
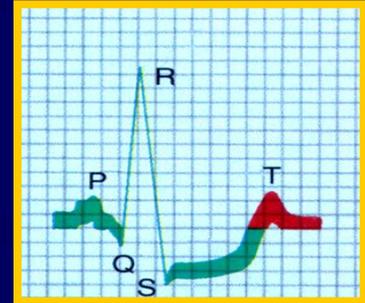
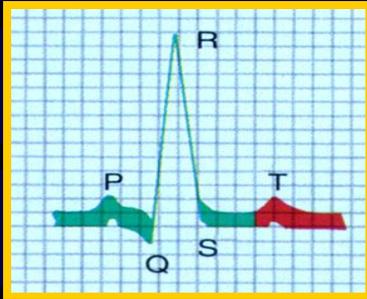
ELETROCARDIOGRAMA

O registro gráfico da atividade elétrica do coração é denominado eletrocardiograma (ECG);

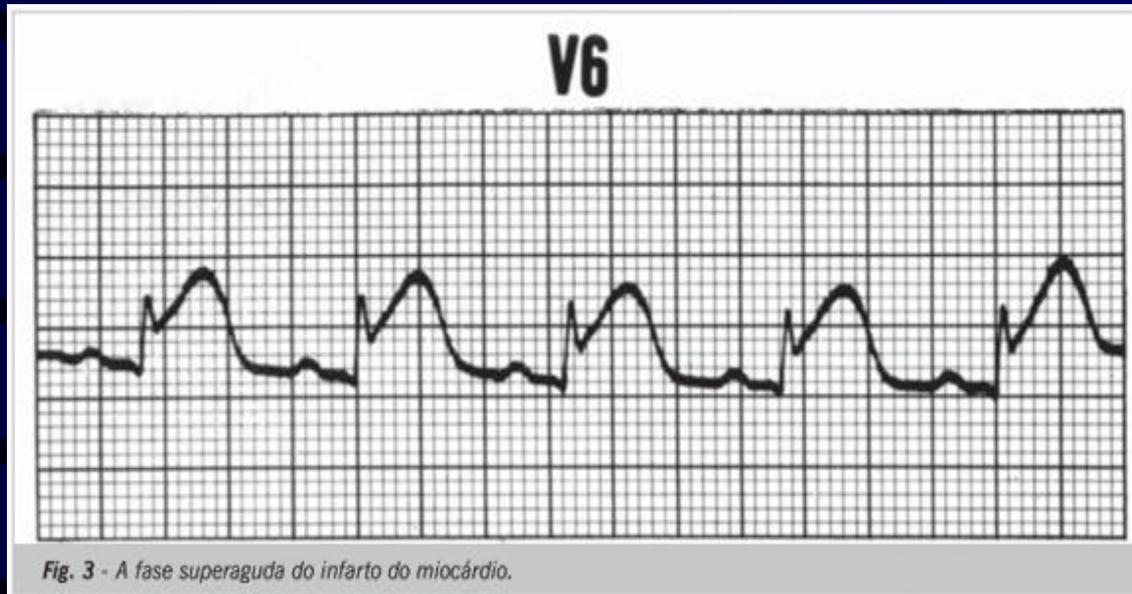
O ECG permite a monitorar a FC, e evidenciar anormalidades da função cardíaca (ritmo e condução cardíaca, e fornecimento de O₂).



ISQUEMIA



ELETROCARDIOGRAMA



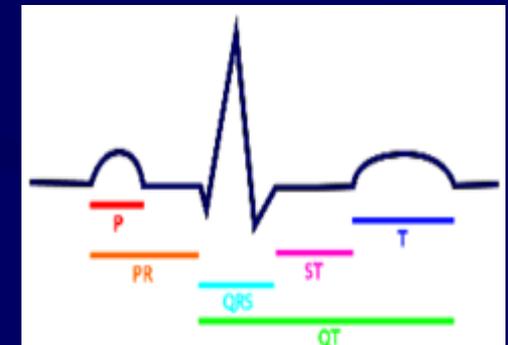
Fase superaguda do infarto do miocárdio.

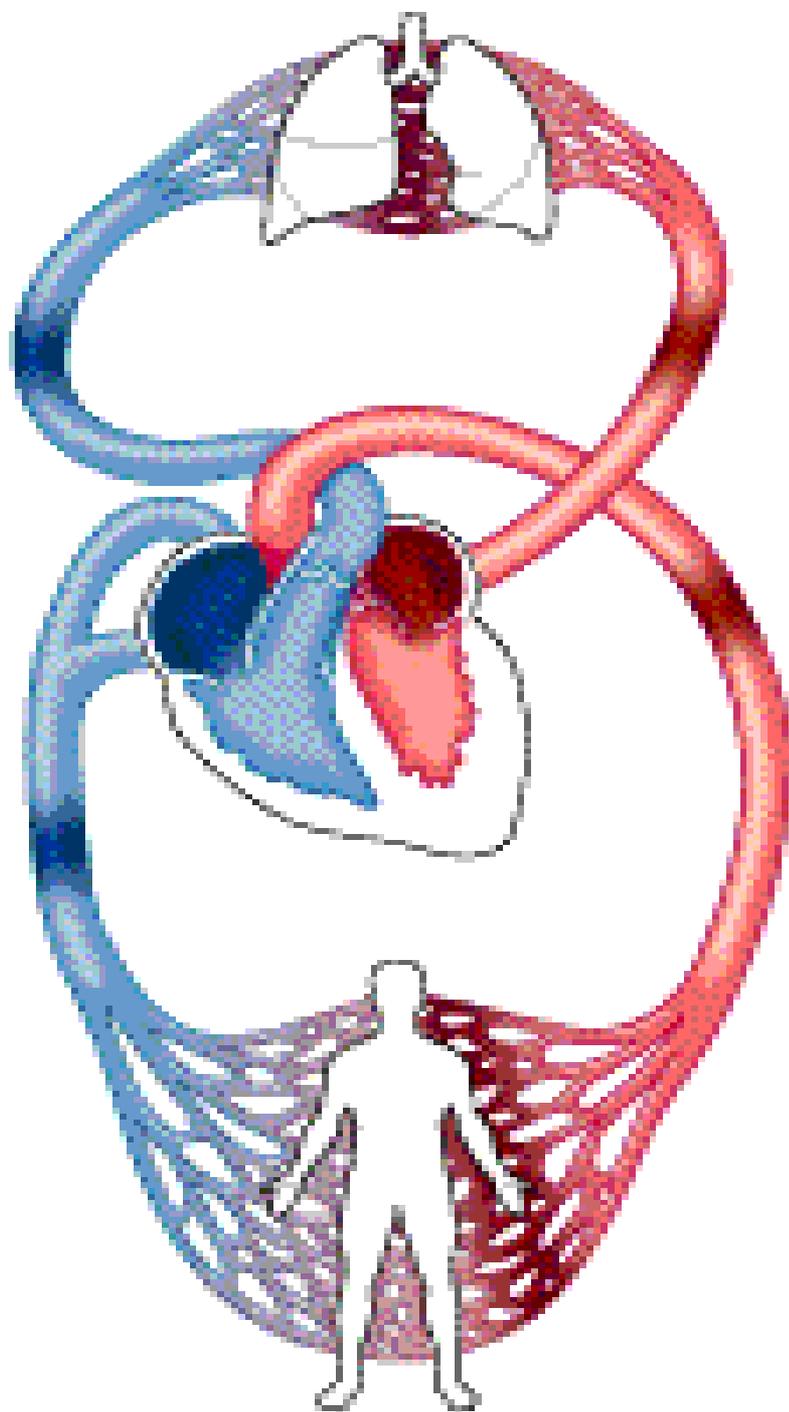
Onda P = despolarização atrial

Complexo QRS = despolarização ventricular

Onda T = repolarização ventricular

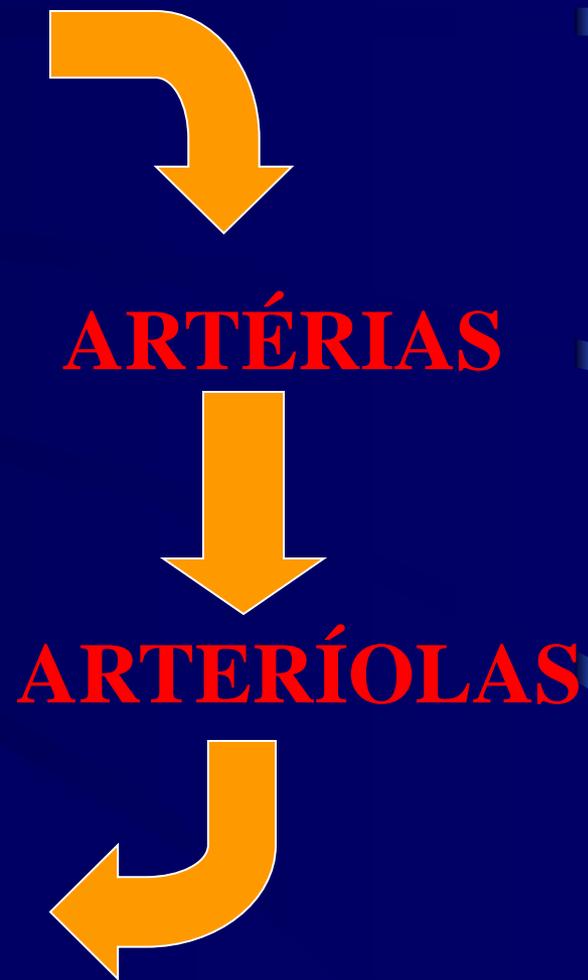
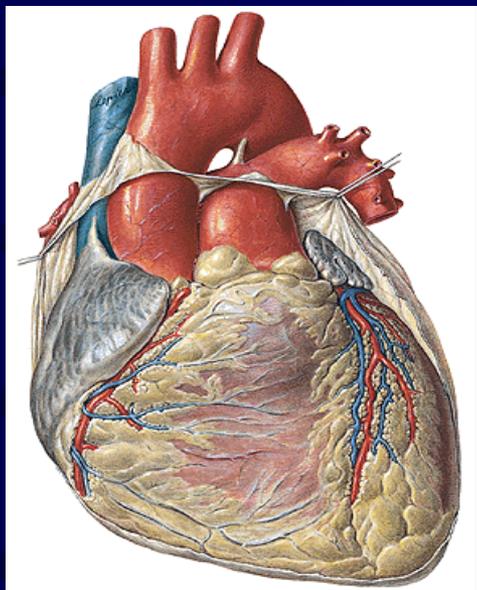
Onda Ta (não visível) = repolarização atrial





**Pequena circulação
PULMONAR**

**Grande circulação
SISTÊMICA**



CAPILARES

Terminologias

****Ciclo Cardíaco** – O Ciclo da circulação sanguínea aliado aos eventos elétricos e mecânicos que ocorrem enquanto o sangue entra e é ejetado pelo coração (*em 1 min representa a FC*).

Volume Sistólico - volume de sangue ejetado em cada batimento pelos ventrículos.

****Débito Cardíaco** (Q) - O volume de sangue bombeado pelo coração a cada minuto ($VS \times FC$).

Diferença A-v O_2 - diferença do conteúdo de O_2 do sangue arterial e do sangue venoso.

Duplo produto – Taxa de sobrecarga ao miocárdio ($PAS \times FC$).

Terminologias

****Pré-carga** – Volume de sangue (*no final da diástole*) presente no ventrículo do coração, após seu enchimento passivo e contração **atrial**. Uma redução do retorno venoso pode reduzir a pré-carga.

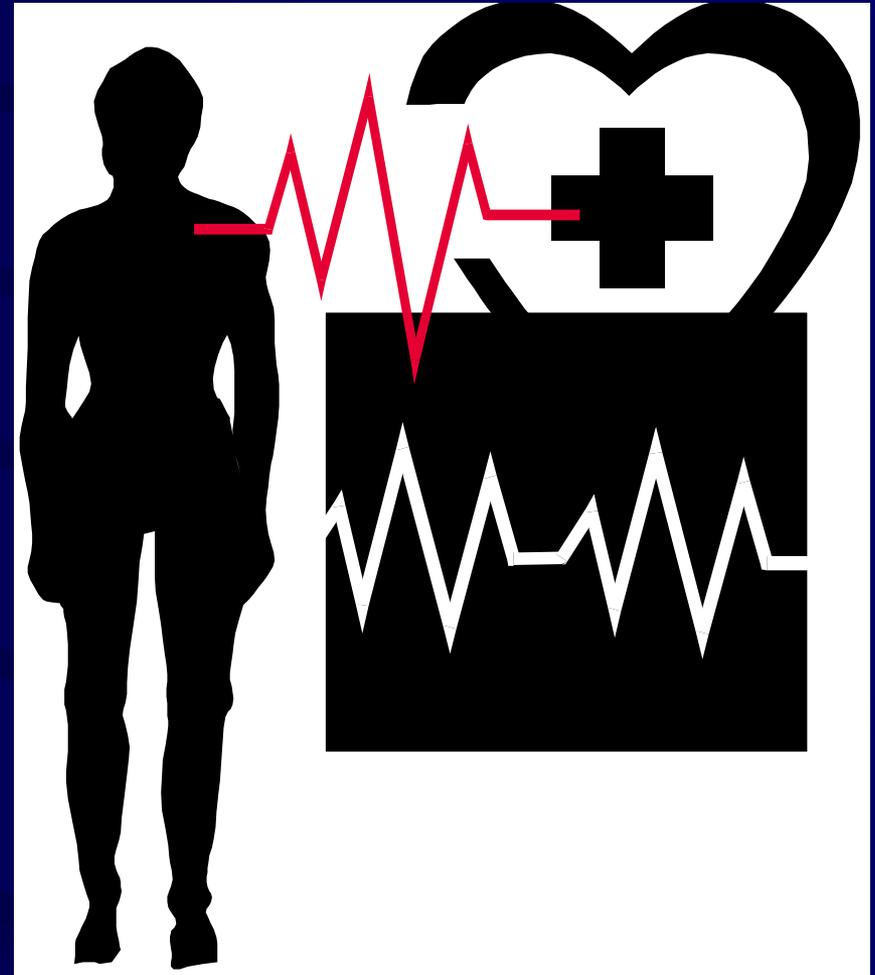
****Pós-carga** – É a *resistência contrária* a ejeção ventricular. A resistência ao fluxo sanguíneo na saída do ventrículo determina essa variável. A redução da RVPT pode reduzir a pós-carga.

****Contratilidade** – Capacidade de contração do miocárdio na ausência de alterações na pré e pós-carga. Representa a *potência do músculo cardíaco*.³⁰

Frequência Cardíaca (FC)

· Número de vezes que ocorre o ciclo cardíaco durante 60 segundos.

- A FC é um dos indicadores para avaliação, prescrição e acompanhamento do treinamento aeróbio.



DIFERENTES NOMENCLATURAS

- FC -

- ♥ **FC basal**: menor número de bpm quando se está em repouso completo e não interrompido;
- ♥ **FC repouso**: número de bpm quando se está em repouso;
- ♥ **FC máxima**: maior número de contrações cardíacas por minuto;
- ♥ **FC reserva**: diferença entre a FCmáxima e a FCrepouso;
- ♥ **FC trabalho**: identificada para prescrição do exercício;

DIFERENTES NOMENCLATURAS

- FC -

- ♥ **FC limiar anaeróbio**: corresponde a FC na qual ocorre equilíbrio entre a produção e a remoção de lactato durante o exercício;
- ♥ **FC VO_2 máx.**: FC na qual se atinge a maior captação de oxigênio;
- ♥ **FC recuperação**: número de bpm no pós-exercício.

O que significa a FCrep e o minuto "1" da recuperação (pós-exercício) da FC?

Heart rate recovery after exercise is related to the insulin resistance syndrome and heart rate variability in elderly men

Lars Lind, MD, PhD, and Bertil Andrén *Uppsala, Sweden*

Objective We investigated the associations between heart rate recovery after exercise (as a suggested measure of vagal activity), heart rate variability, and measurements of the insulin resistance syndrome.

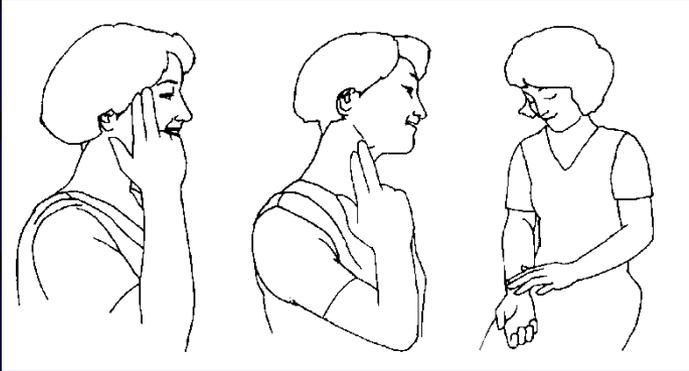
Material and Methods Seventy men aged 70 years were examined with a symptom-limited bicycle exercise test, a 24-hour heart rate variability test, and different measurements of different components of the insulin resistance syndrome.

Results Heart rate recovery after exercise (mean \pm SD 20 ± 9 beats during the first minute) was related to both the SD of the R-R interval and the low frequency power at the heart rate variability analyses ($r = 0.39$, $P < .002$ for both). Furthermore, heart rate recovery after exercise was related to insulin sensitivity at the hyperinsulinemic euglycemic clamp ($r = 0.28$, $P < .03$), and to high-density lipoprotein cholesterol and exercise capacity, and inversely to obesity and insulin and glucose levels 2 hours after an oral glucose load ($P < .05$ for all). Heart rate recovery after exercise was not related to left ventricular mass measured by means of echocardiography or to the number of ventricular premature complexes at a 24-hour Holter recording.

Conclusion Heart rate recovery 1 minute after exercise was related to measurements of 24-hour heart rate variability. Furthermore, heart rate recovery after exercise was related to several of the major components of the insulin resistance syndrome, thereby establishing a link between this syndrome and cardiac autonomic nervous activity. (Am Heart J 2002; 144:666-72.)

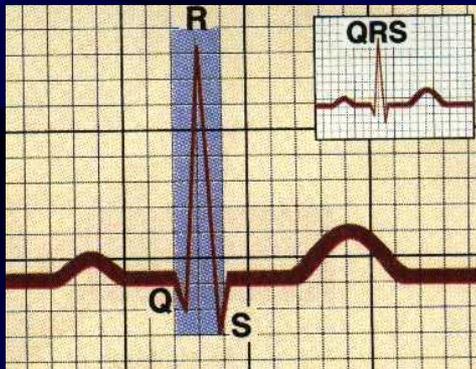
FORMAS DE MEDIÇÃO

As formas mais comuns de medição da frequência cardíaca são:



Manual - apesar da simplicidade da sua utilização, esta forma de medição não apresenta resultados seguros.

Tomada da frequência do pulso nas artérias temporal, carótida (limitação) e radial.

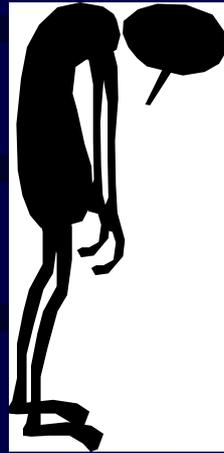


Eletrocardiograma - um aparelho detecta e registra graficamente os impulsos elétricos gerados pelo coração.

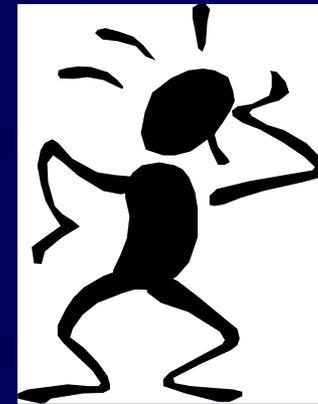


Monitor de frequência cardíaca - uma cinta torácica com dois eletrodos registram as mudanças elétricas no coração, transmitindo-as através de um campo eletromagnético para um monitor de pulso.

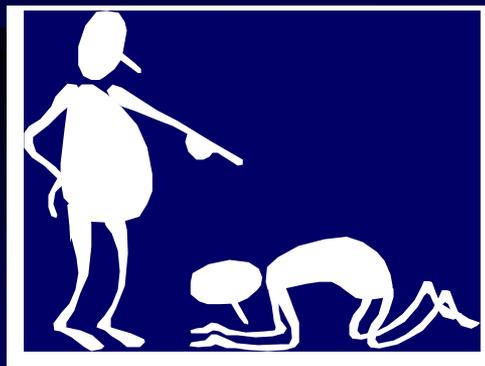
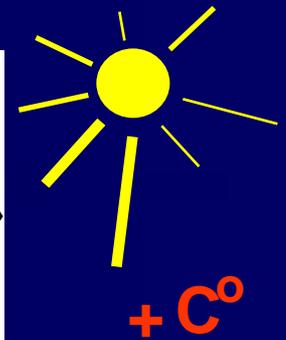
ALGUNS FATORES QUE ALTERAM A FC



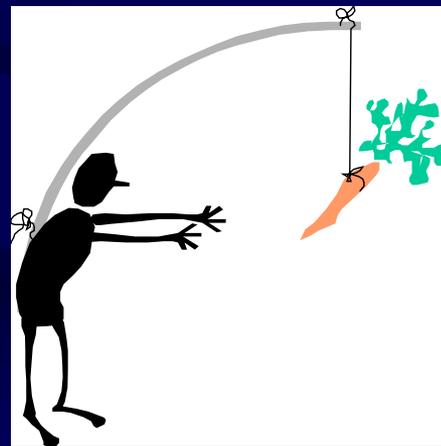
FADIGA



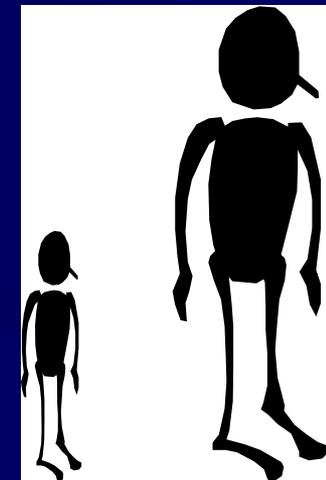
CALOR



POSIÇÃO



MOTIVAÇÕES



IDADE

Relação VO_2 x FC

Notem o comportamento da FC para uma mesma quantidade de VO_2 após período de treinamento

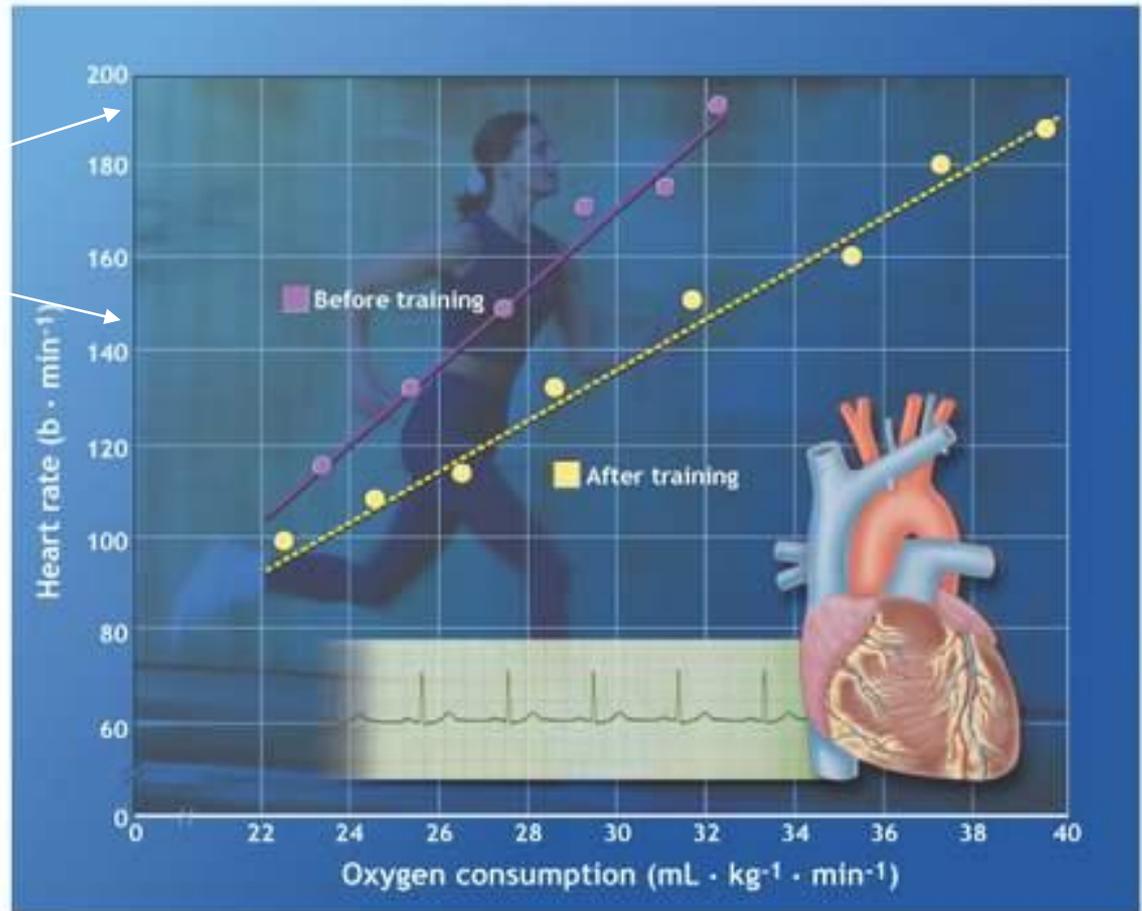
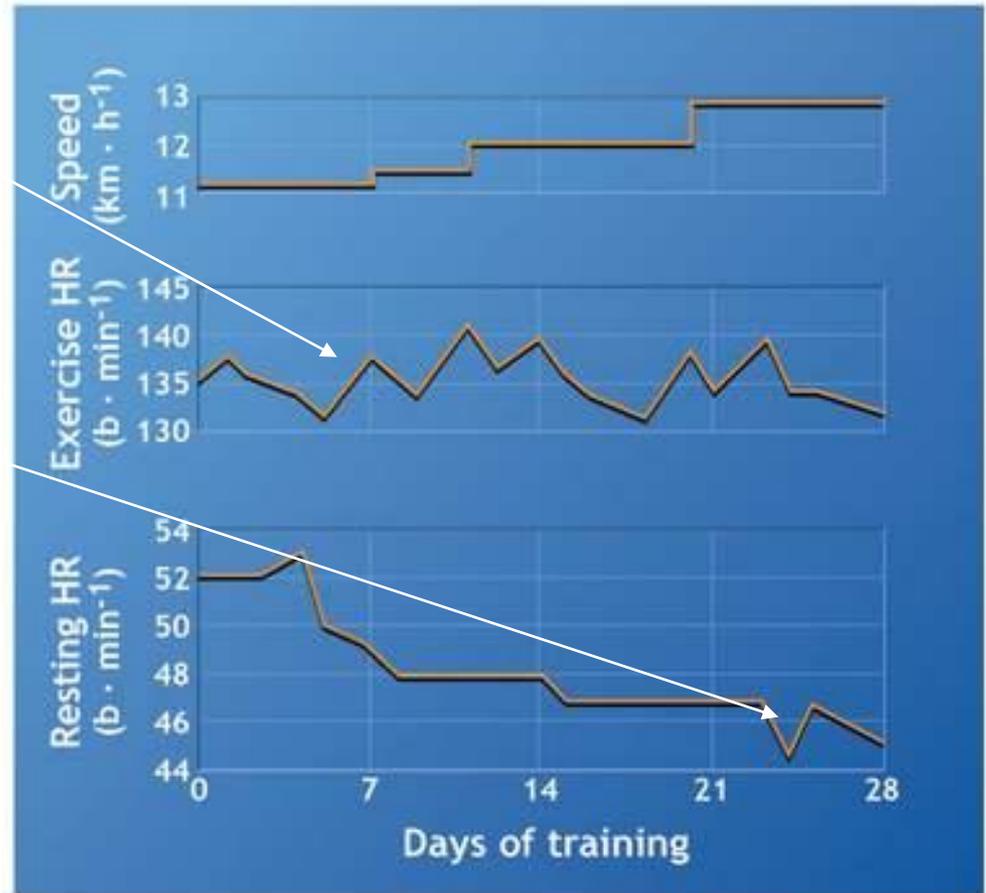


Figure 21.17. Improvements in heart rate response with aerobic training in relation to oxygen consumption. A significant reduction in exercise heart rate with training usually reflects an enhanced stroke volume.

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Aprimoramento
fisiológico...

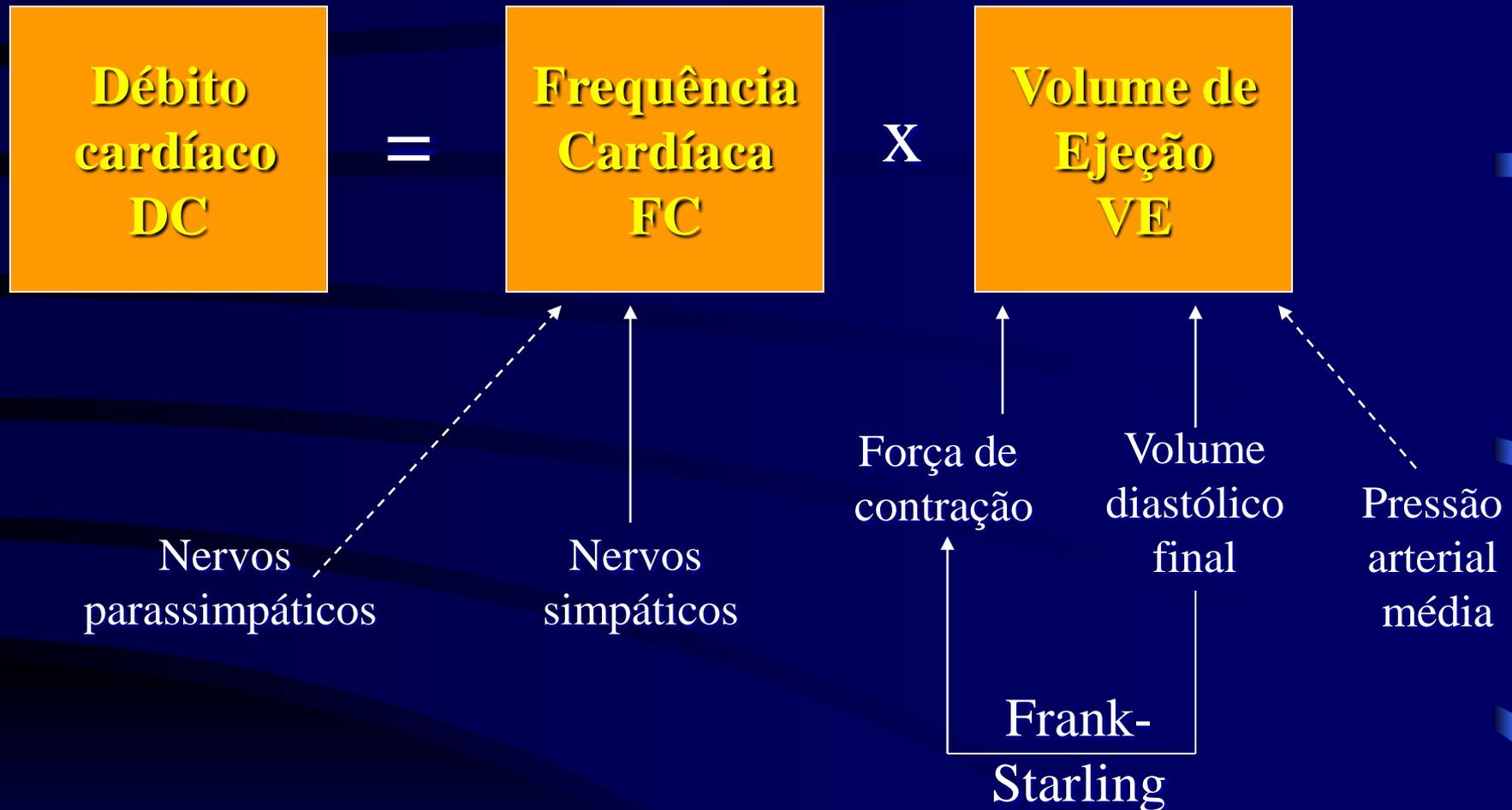
Notem a
redução da FC
de repouso ao
longo de 28
dias de
treinamento



unfig 15.1. The concept and computations developed by Karvonen for establishing effective training intensity threshold using HR significantly impacted the study of exercise training.

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FATORES QUE REGULAM O DÉBITO CARDÍACO



Observe:

Variáveis que estimulam o débito cardíaco = setas contínuas

Variáveis que reduzem o débito cardíaco = setas tracejadas

DÉBITO CARDÍACO

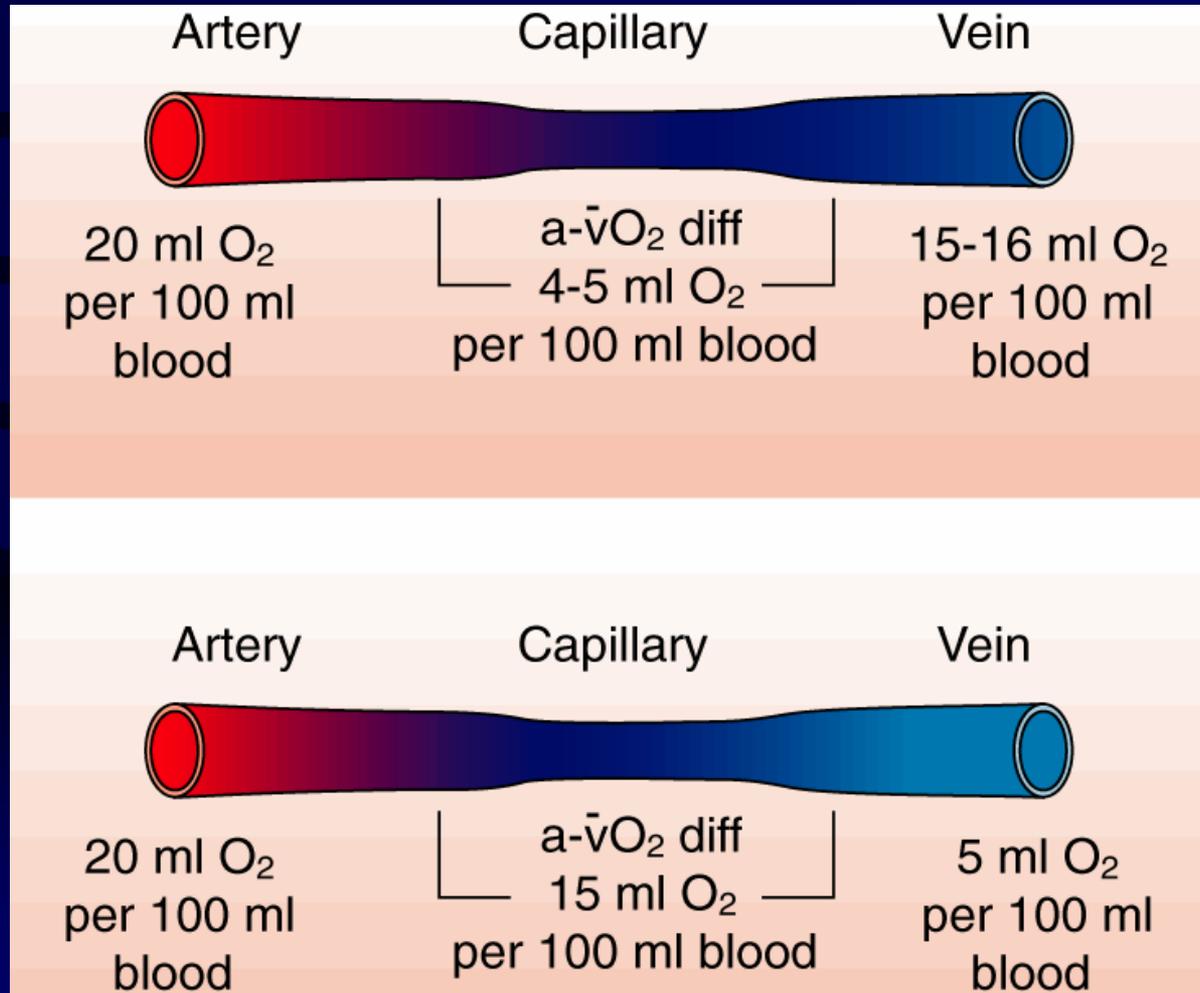
$$Q \text{ (L/min)} = VE \text{ (ml)} \times FC \text{ (b/min)}$$

Exemplo:

	Repouso		
	DC =	FC	x VE
Destreinados	5.000 =	70bpm	x 71ml
Treinados	5.000 =	50bpm	x 100ml

Terminologia

Extração de Oxigênio: Diferença $a-vO_2\Delta$



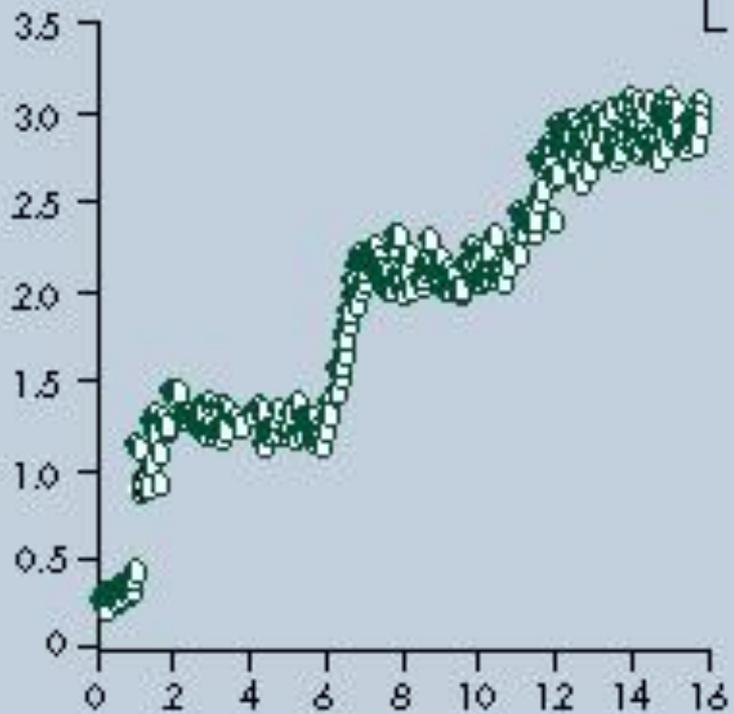
$\dot{V}O_2$



DC

Dif a-v O_2

Consumo de O₂ L/min

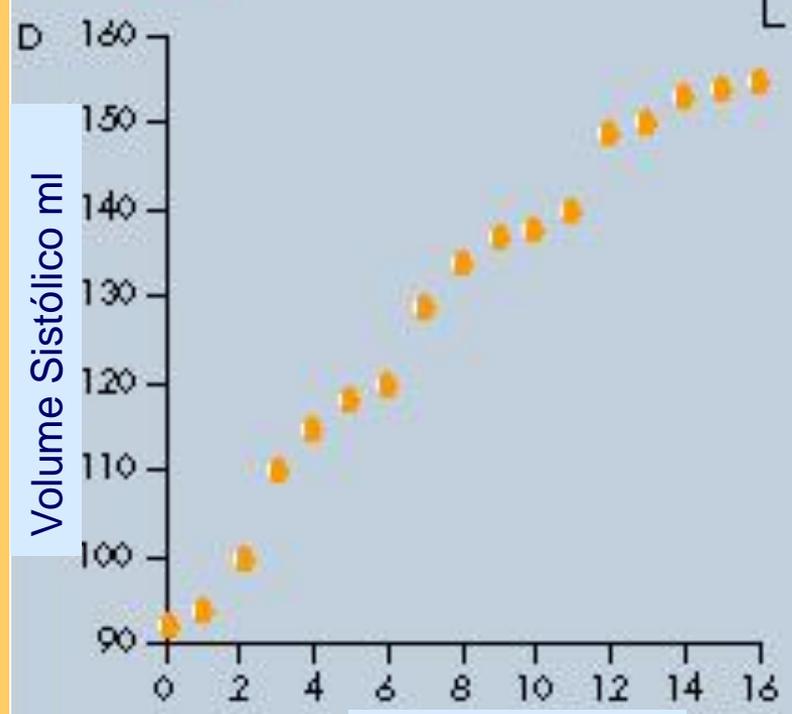


Tempo min

Frequência Cardíaca bpm

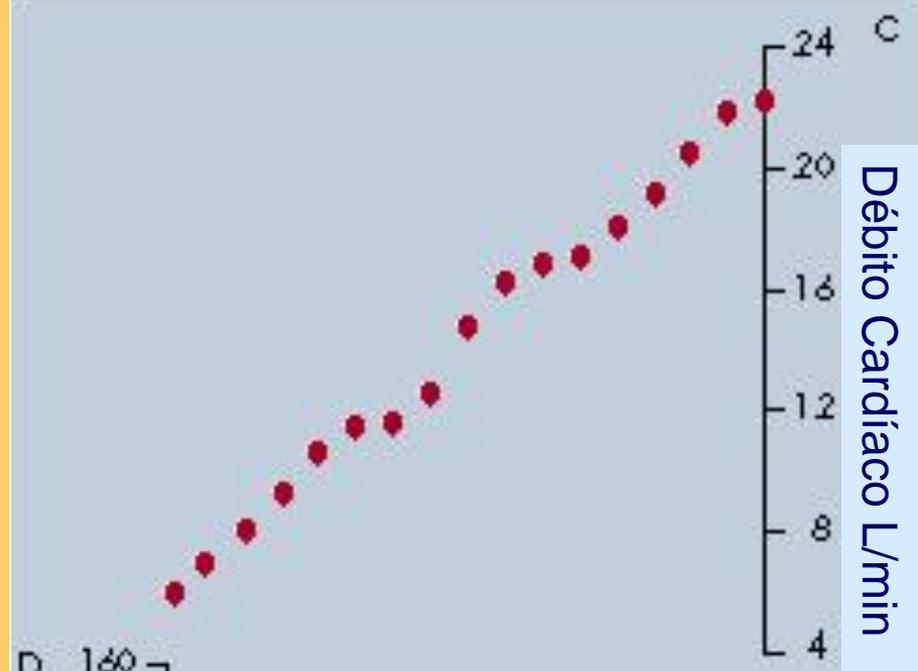


Volume Sistólico ml



Tempo min

Débito Cardíaco L/min



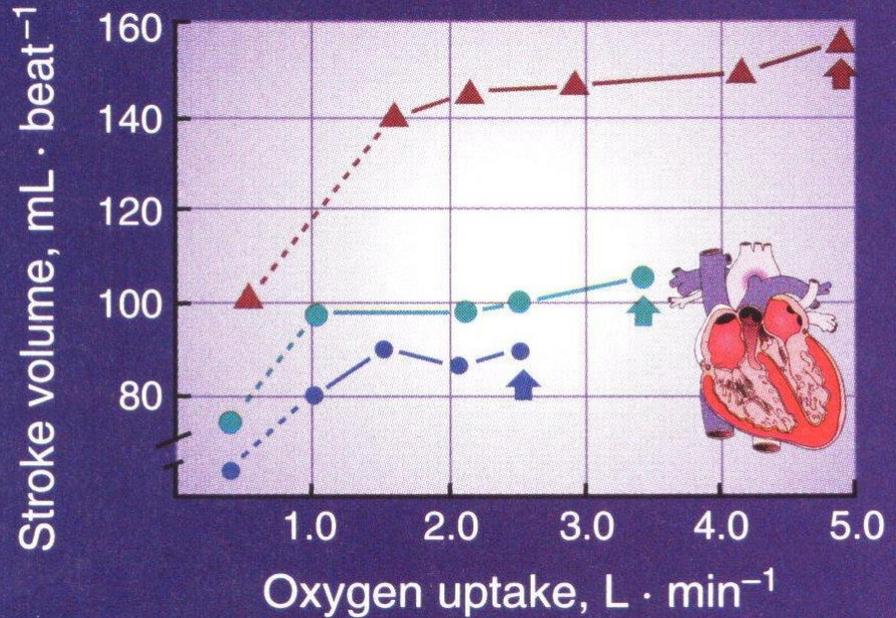
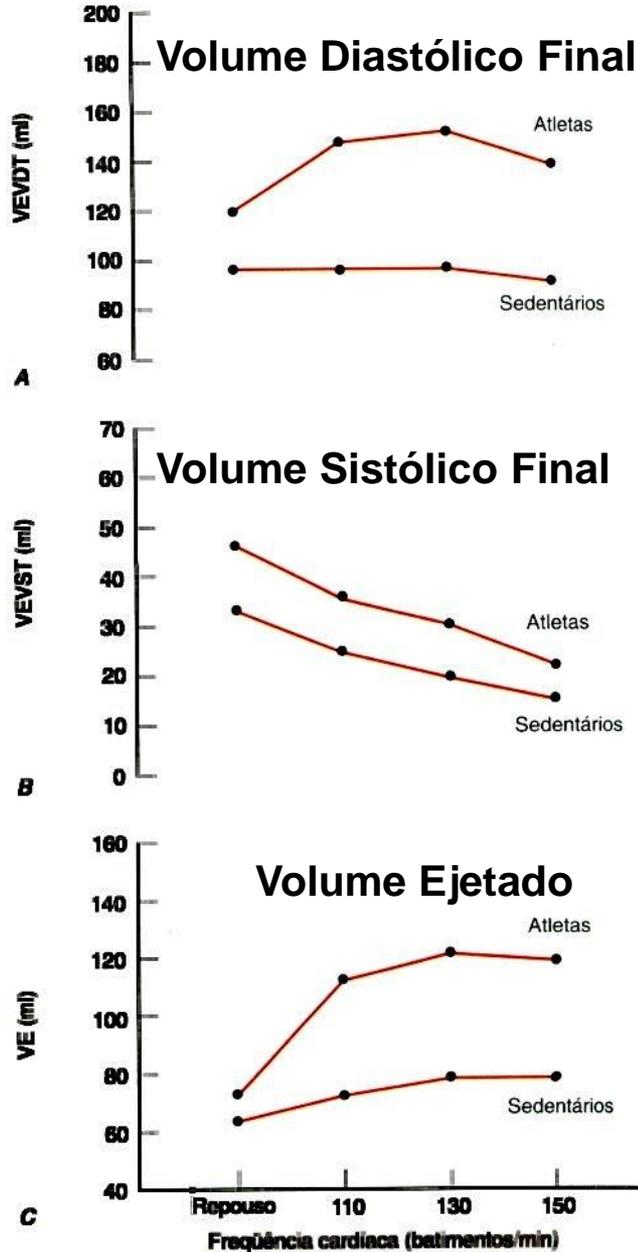
C

Volume Ejetado (Vej) (ml)

▲ Fundista

● Jovem (pré-T)

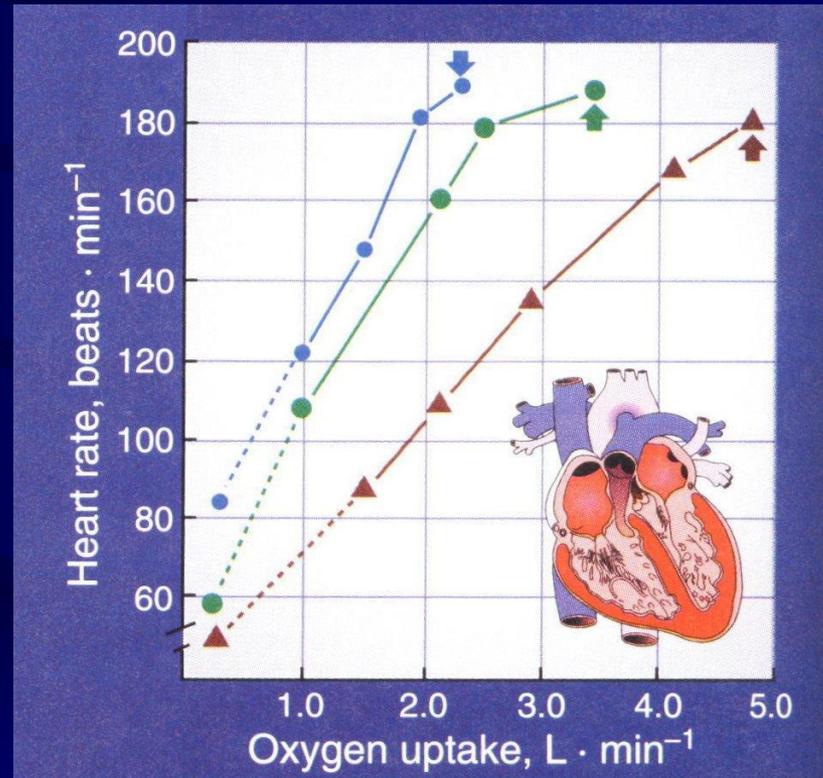
● Jovem (pós-T)



Frequência Cardíaca (FC)

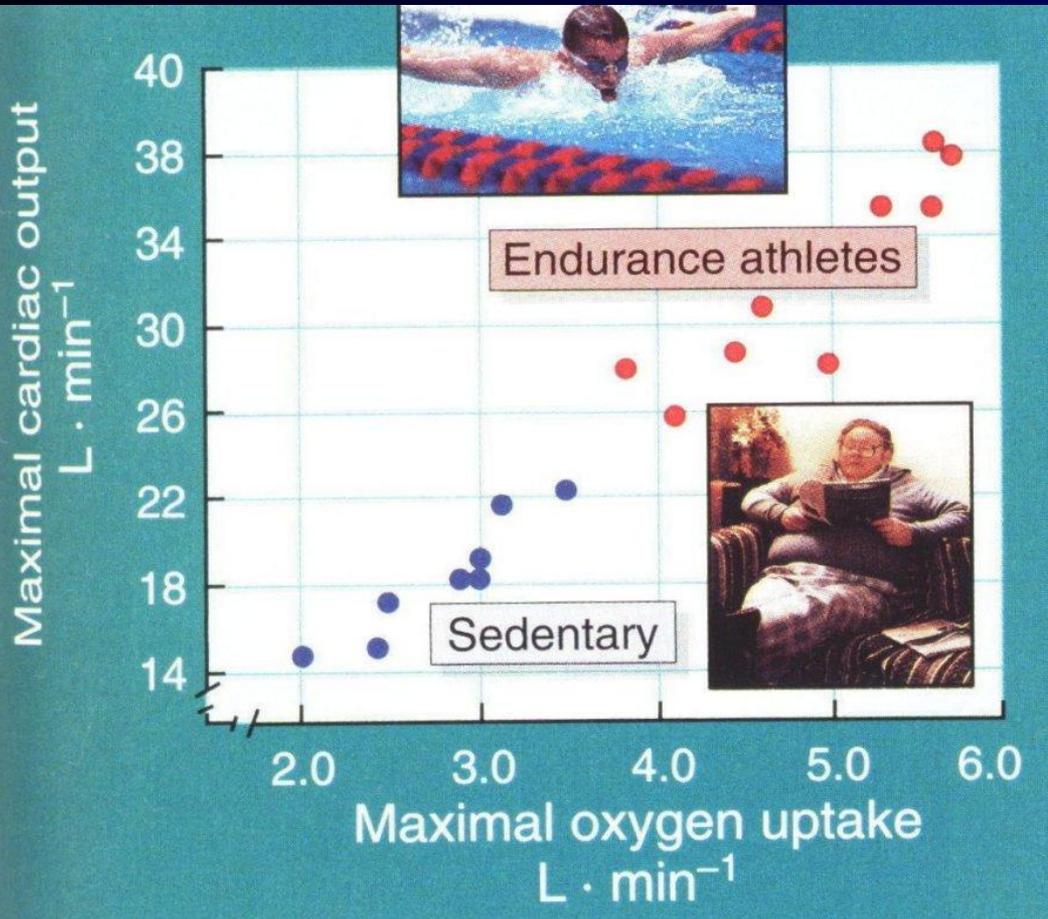
(bpm)

- ▲ Fundista
- Jovem (pré-T)
- Jovem (pós-T)



Débito Cardíaco Máximo*

(DCmáx)
(l/min)



Ventilação (V_E)

➤ Volume de ar mobilizado pelos **pulmões** por um processo de fluxo, expresso em Litros/minuto.

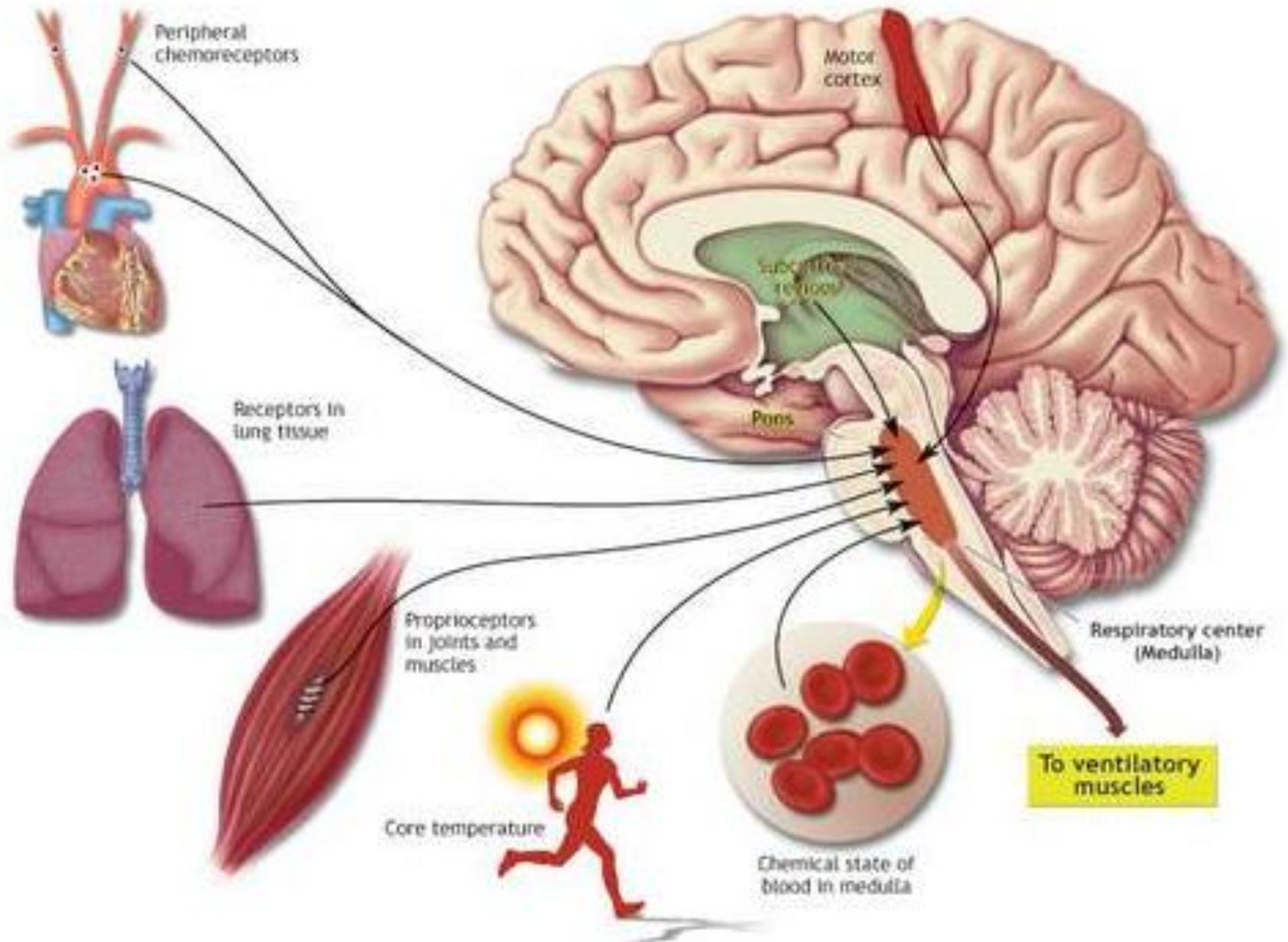
➤ Depende da profundidade e da frequência da respiração;

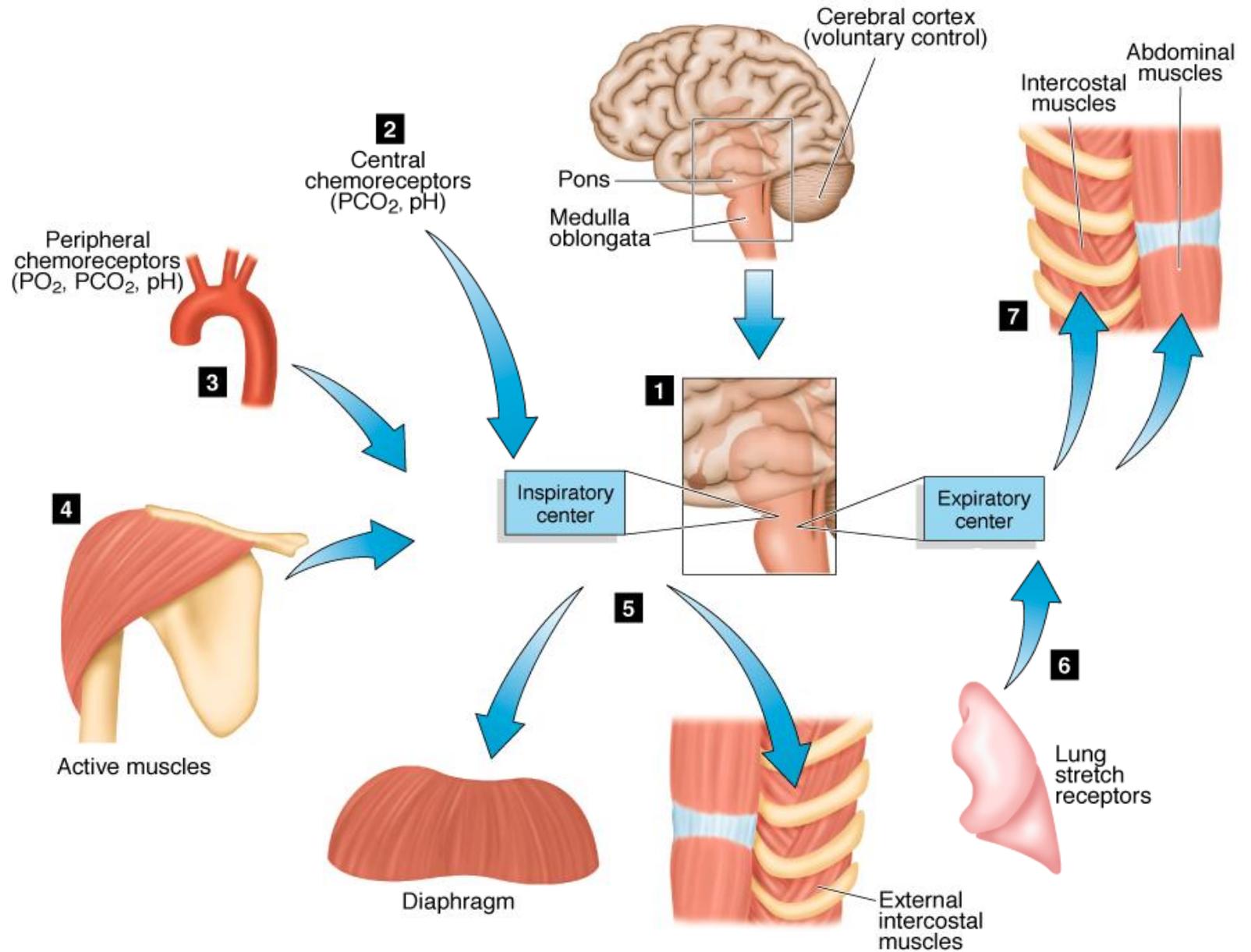
➤ V_E (L/min) = Volume Corrente (L) x Frequência Respiratória (frm);

Repouso: V_E (L/min) = 12 (frm) x 0.5 (L) = 6 L/min

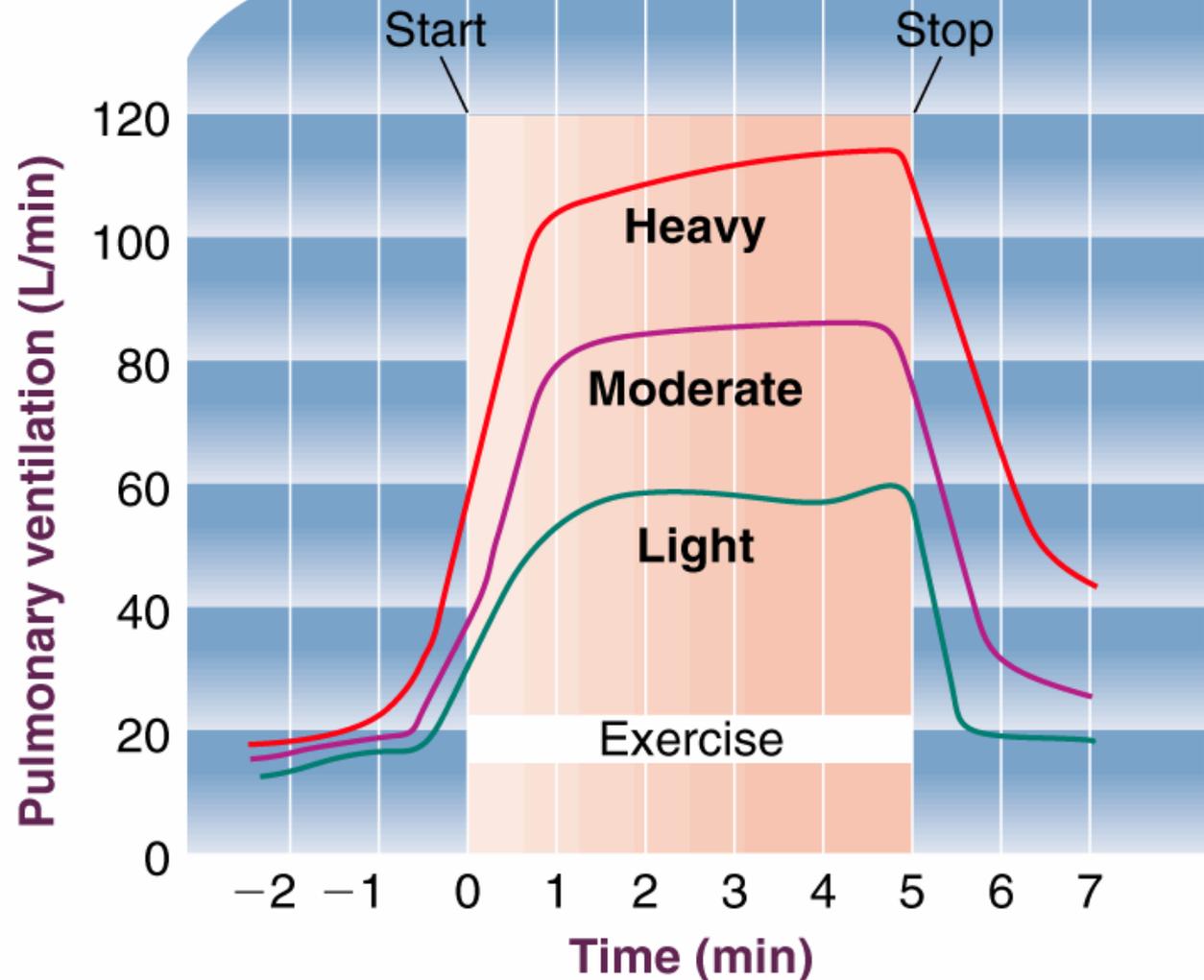
Exercício máximo: V_E (L/min) = 60 (frm) x 3.0 (L) = 180 L/min

➤ Exercícios submáximos aumentam V_E predominantemente por aumento do VC, e intensos por aumentos da FR.





RESPOSTA VENTILATÓRIA AO EXERCÍCIO

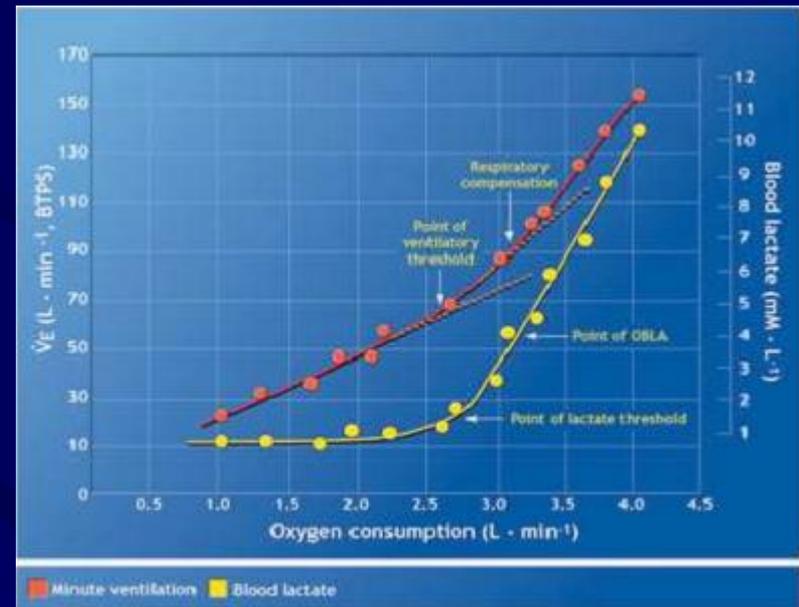
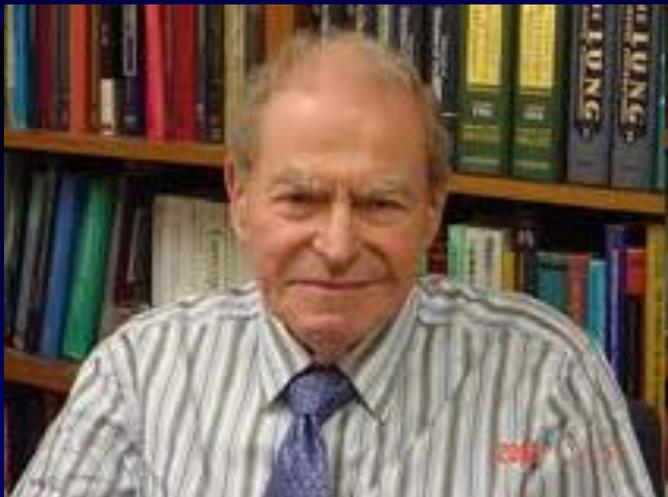


Pesquisa Clínica na EF

Detecting the Threshold of Anaerobic Metabolism in Cardiac Patients During Exercise*

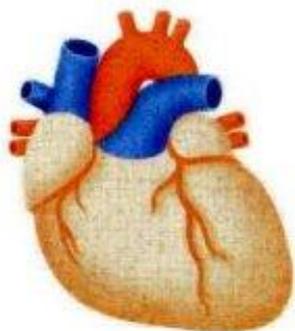
KARLMAN WASSERMAN, M.D.† and MALCOLM B. McILROY, M.D.‡
Palo Alto and San Francisco, California

Am J Cardiol. 1964; 14: 844-852.

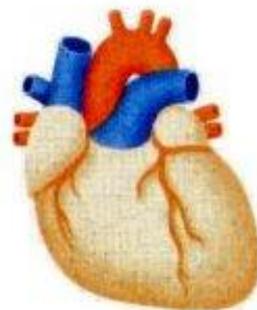


Dimensões do Coração

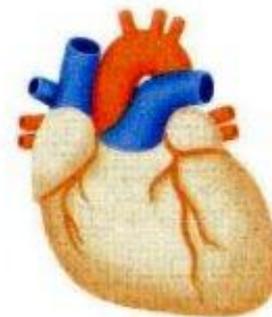
SEÇÃO TRANSVERSAL DO VENTRICULO ESQUERDO



FUNDISTA



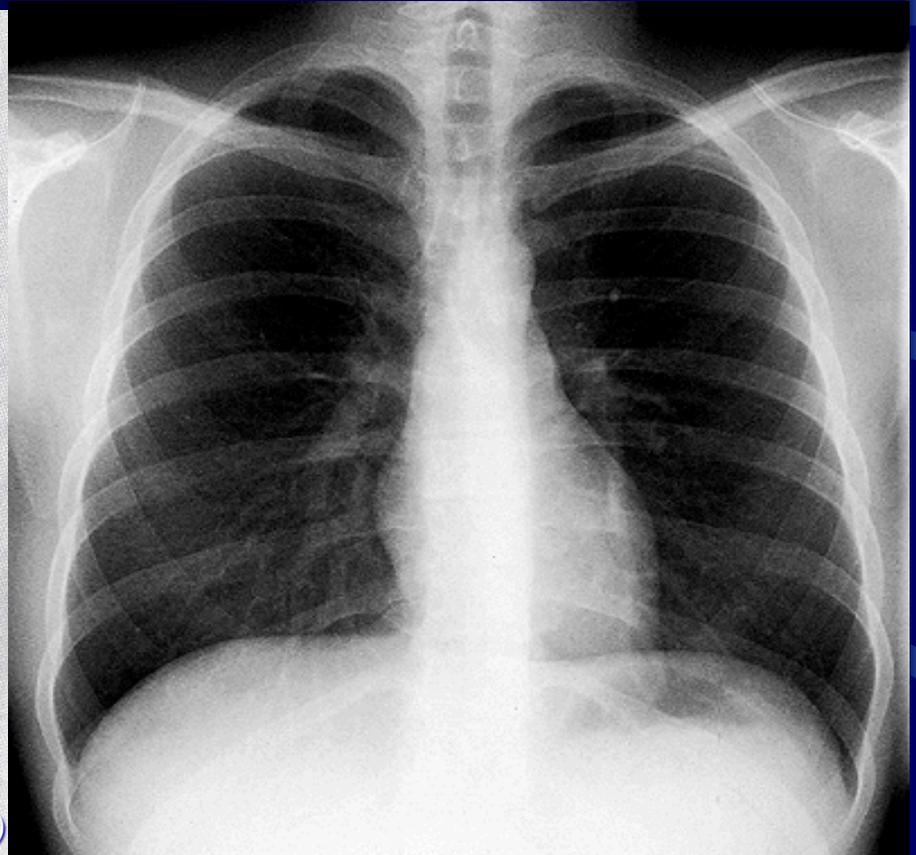
**SEDENTÁRIO
SAUDÁVEL**



HALTEROFILISTA

Massa do Ventrículo Esquerdo

Rikvan Steenbergen (ciclista)



Maiores coração com vol. cardíaco de 1700 ml, sem nenhuma patologia.

VO₂ Máximo (VO₂max)

Table 13.1 $\dot{V}O_2$ max values measured in healthy and diseased populations

Population	Males	Females
Cross-country skiers	84	72
Distance runners	83	62
Sedentary: young	45	38
Sedentary: middle-aged adults	35	30
Post myocardial infarction patients	22	18
Severe pulmonary disease patients	13	13

Values are expressed in ml · kg⁻¹ · min⁻¹. Taken from Saltin and Astrand (34), Astrand and Rodahl (3), and Howley and Franks (21).

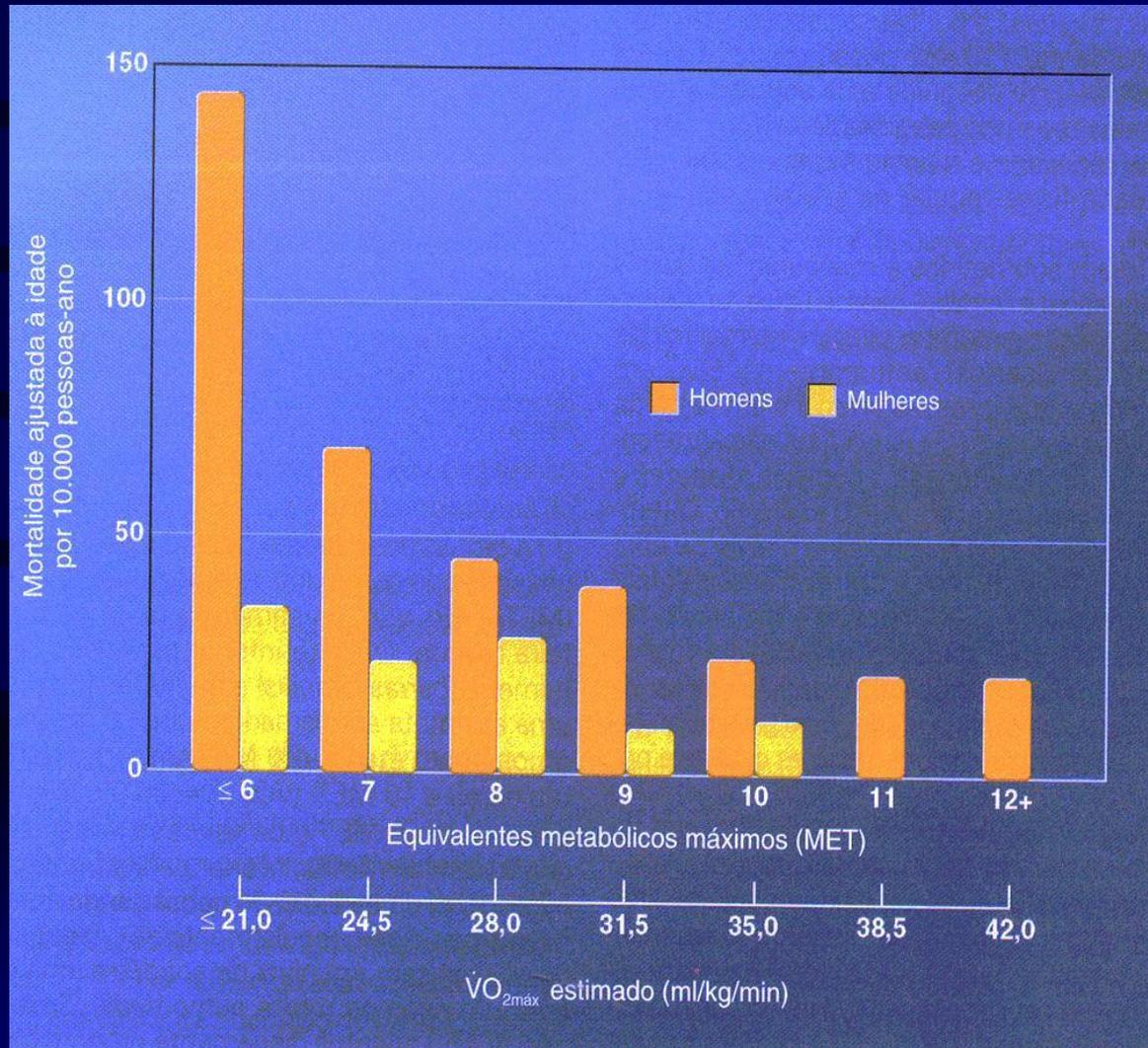
VO₂ Máximo (VO₂max)

Table 19-2. Standard Values for $\dot{V}O_{2max}$ in mL/kg/min*

Rating	Age (yrs)				
	20-29	30-39	40-49	50-59	60+
Men					
Excellent	>51	>48	>46	>42	>40
Good	49-51	46-48	44-46	40-42	38-40
Average	42-48	39-45	37-43	33-39	31-37
Fair	39-41	36-38	34-36	30-32	28-30
Poor	<39	<36	<34	<30	<28
Women					
Excellent	>42	>39	>37	>33	>33
Good	40-42	37-39	35-37	31-33	31-33
Average	33-39	31-36	29-34	25-30	25-30
Fair	30-32	28-30	26-28	22-24	22-24
Poor	<30	<28	<26	<22	<22

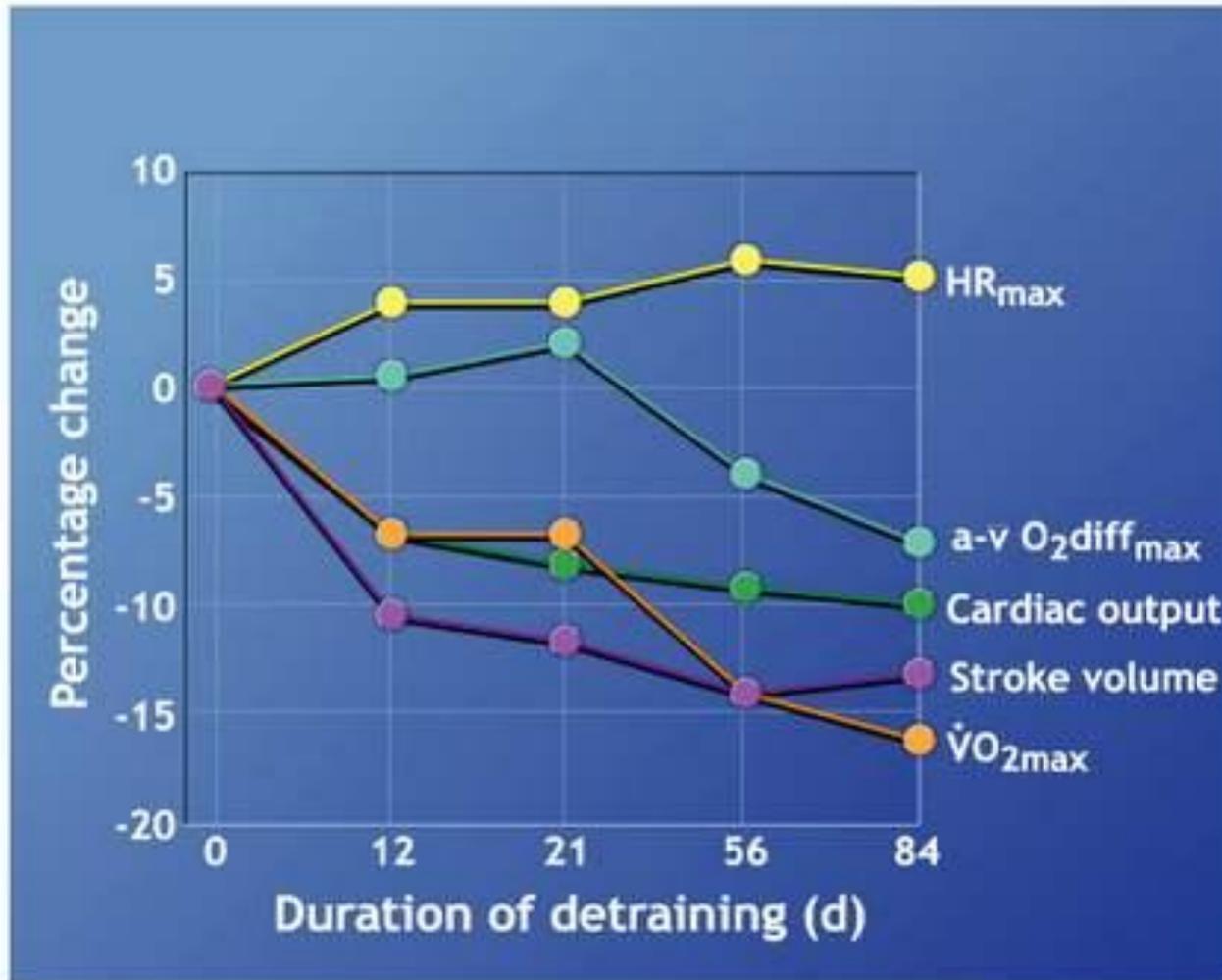
* With permission from Gettman LR: Personal Fitness Profile Database. National Health Enhancement Systems, Phoenix, AZ, 1987.

VO₂ Máximo (VO₂max)



(Blair et al. - JAMA, 1989)

Destreinamento



unfig 17.1. Average changes in maximum heart rate (HR_{max}), stroke volume, arteriovenous oxygen differences ($a-v O_2 \text{ diff}_{max}$), cardiac output, and $\dot{V}O_{2max}$ over 84 days of detraining.



↑ Consumo de oxigênio

↑ Extração de oxigênio

↑ Fluxo sanguíneo muscular

↑ $\Delta a-v O_2$

↑ Débito cardíaco

↓ Resistência vascular muscular

↑ Volume de ejeção

↑ Frequência cardíaca

↑ Respiração celular

↑ Volume diastólico final

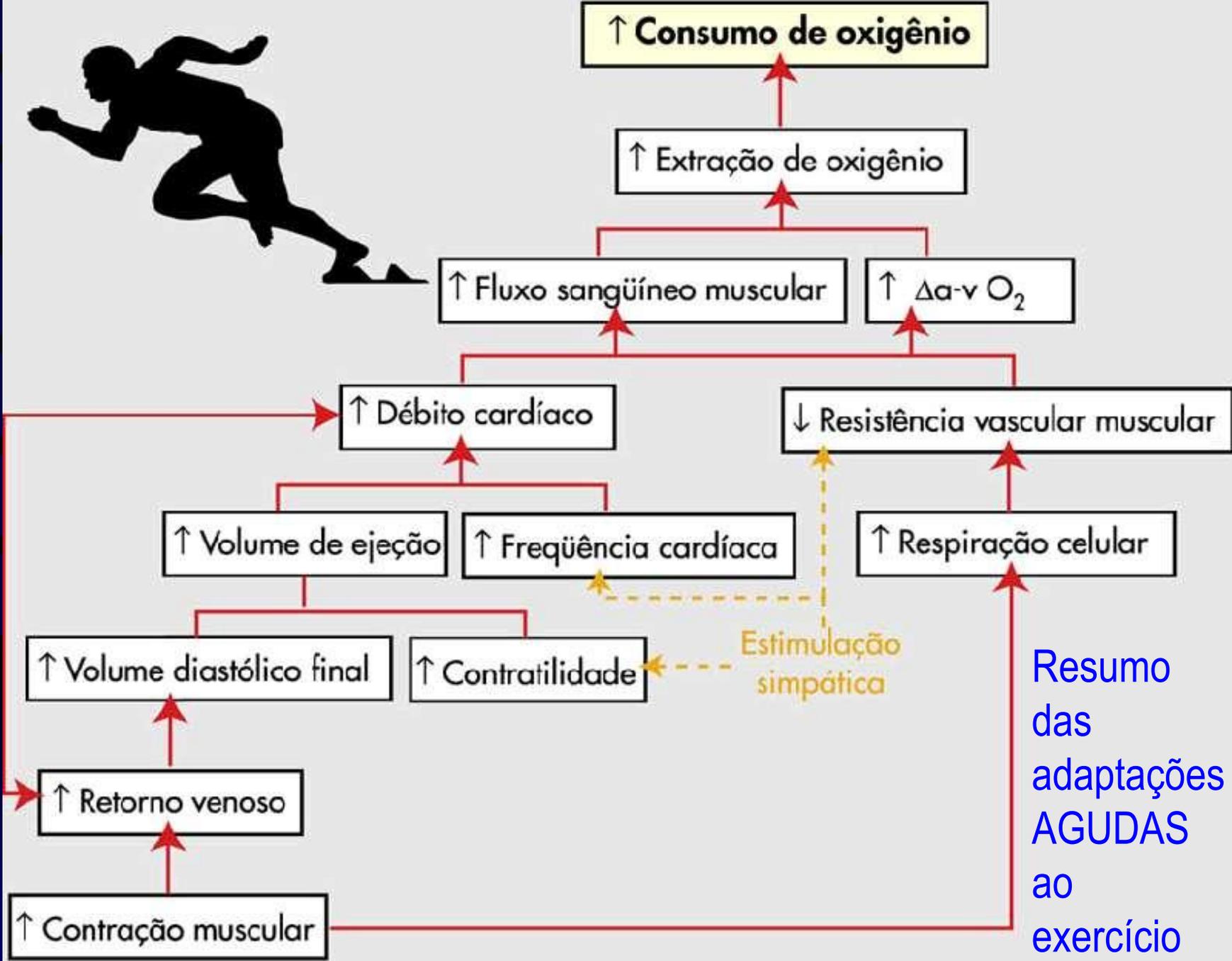
↑ Contratilidade

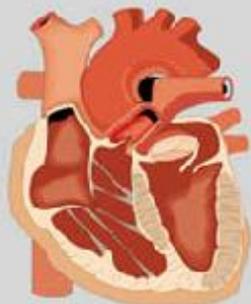
Estimulação simpática

↑ Retorno venoso

↑ Contração muscular

Resumo das adaptações AGUDAS ao exercício





Exercício no VO_2 máx.

Exercício submáximo em estado estável

↑ VO_2 máx.

↓ Frequência cardíaca

↑ Distribuição de oxigênio

↑ Volume de ejeção

↓ Estimulação simpática

↑ Fluxo sanguíneo muscular máximo

↑ Volume diastólico final

↑ Débito cardíaco máximo

↑ Densidade dos capilares do músculo

↑ Retorno venoso

↑ Volume ventricular

↑ Volume de ejeção máximo

↑ Volume sanguíneo

↑ Volume diastólico final

↑ Volume plasmático

↑ Massa das células vermelhas

↑ Retorno venoso

↑ Volume ventricular

↑ Volume sanguíneo

Treinamento de resistência muscular de longa duração



↑ Volume plasmático

↑ Massa das células vermelhas

Treinamento de endurance por longo período de tempo

Effects of High-Intensity Endurance Training on Maximal Oxygen Consumption in Healthy Elderly People

Håvard Østerås
Sør-Trøndelag University College

Jan Hoff

Jan Helgerud

Norwegian University of Science and Technology

2005

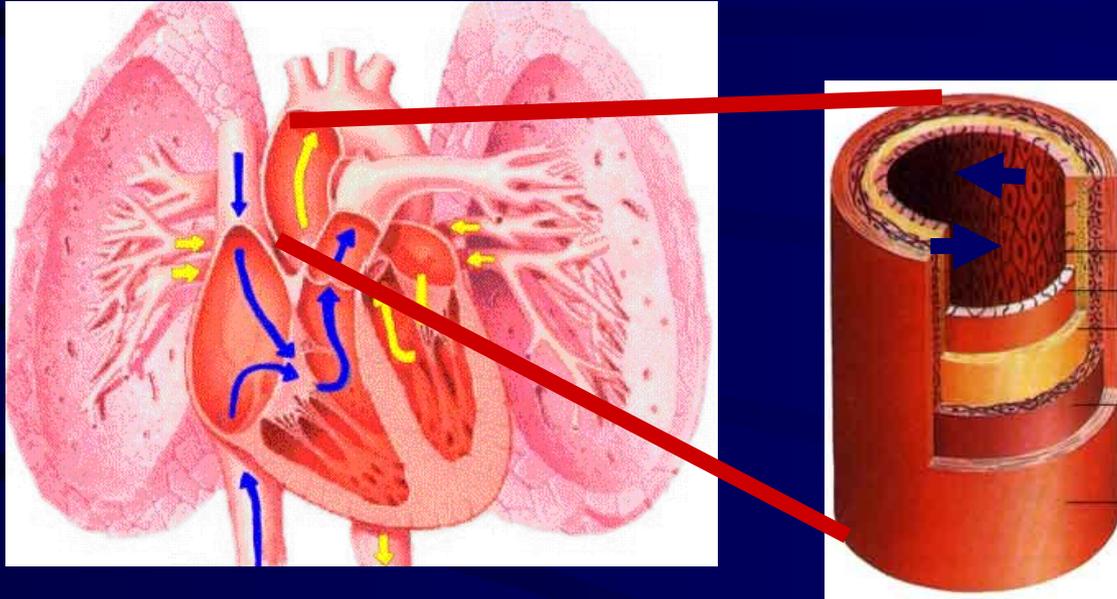
Table 2. Results From Endurance Testing Before and After 10 Weeks of High-Intensity Training

Variable	Experimental Group (n = 10)				Control Group (n = 11)			
	Pretest		Posttest		Pretest		Posttest	
	M	SD	M	SD	M	SD	M	SD
VO _{2max} (l × min ⁻¹)	1.89	0.39	2.14*	0.40	1.94	0.54	1.95	0.53
VO _{2max} (ml × kg ⁻¹ × min ⁻¹)	24.2	2.5	27.8*	2.3	26.7	6.4	26.2	6.2
VO _{2max} (ml × kg ^{-0.75} × min ⁻¹)	71.5	8.9	82.3*	8.6	77.8	18.6	77.7	18.3
C _w (ml × kg ^{-0.75} × m ⁻¹) (4.5 km × h ⁻¹)	0.81	0.11	0.77	0.09	0.78	0.09	0.77	0.08
C _w (ml × kg ^{-0.75} × m ⁻¹) (5.5 km × h ⁻¹)	0.76	0.12	0.74	0.09	0.75	0.10	0.75	0.10
Body mass (m _b) (kg)	76.6	10.4	76.4	9.7	72.9	12.2	73.4	12.3
Respiratory exchange ratio	1.07	0.05	1.08	0.05	1.09	0.06	1.08	0.06

13,2%

- 21 idosos (69,7)
- Exercício (n = 10)
- Controle (n = 11)
- Sessão: 60 min
- 3 x por semana
- 10 semanas
- 4 sessões 85-95 FC_{máx}
- descanso = 4min

Pressão Arterial



✓ É a tensão que o sangue exerce sobre a parede das artérias.

Sintomas PA alta

- ✓ Sensação de peso na nuca;
- ✓ Cefaléia;
- ✓ Tonturas;
- ✓ Visão turva;
- ✓ A maioria dos casos “ASSINTOMÁTICOS”

Classificação Hipertensão

Primária/Essencial

- Não identificado o fator causal;
- 90-95% casos (genética e ambiente).

Secundária (pode ser curada)

- Fator causal conhecido;
- 5-10% casos.



VI Diretrizes Brasileiras de Hipertensão

Recomenda-se a avaliação médica antes do início de um programa de treinamento estruturado e sua interrupção na presença de sintomas. Em hipertensos, a sessão de treinamento não deve ser iniciada se as pressões arteriais sistólica e diastólica estiverem superiores a 160 e/ou 105 mmHg respectivamente.

Tabela 6 - Classificação da pressão arterial de acordo com a medida casual no consultório (> 18 anos)

Classificação	Pressão sistólica (mmHg)	Pressão diastólica (mmHg)
Ótima	< 120	< 80
Normal	< 130	< 85
Limitrofe*	130–139	85–89
Hipertensão estágio 1	140–159	90–99
Hipertensão estágio 2	160–179	100–109
Hipertensão estágio 3	≥ 180	≥ 110
Hipertensão sistólica isolada	≥ 140	< 90

Quando as pressões sistólica e diastólica situam-se em categorias diferentes, a maior deve ser utilizada para classificação da pressão arterial.

* Pressão normal-alta ou pré-hipertensão são termos que se equivalem na literatura.

PA durante o Exercício

Parar: >180/105 mmHg

PA medida imediatamente pós-exercício
Subestima em 30% a PA de durante

Medido por Ecocardiograma

$$\boxed{\text{PA}} = \boxed{\text{DC}^{\text{PAS}}} \times \boxed{\text{RVP}^{\text{PAD}}} \rightarrow \text{Cálculo sabendo DC e PA}$$

$$\boxed{\text{FC}} \times \boxed{\text{VS}}$$

VASOS

**PERIFERIA
Endotélio**

**NA. SIMPÁTICA E
PARASSIMPÁTICA**

High heart rate: a cardiovascular risk factor?

Stéphane Cook¹, Mario Togni¹, Marcus C. Schaub², Peter Wenaweser¹, and Otto M. Hess^{1*}

¹Department of Cardiology, Swiss Cardiovascular Center, University Hospital, Freiburgstrasse, 3010 Bern, Switzerland and

²Institute of Pharmacology, University of Zurich, Zurich, Switzerland

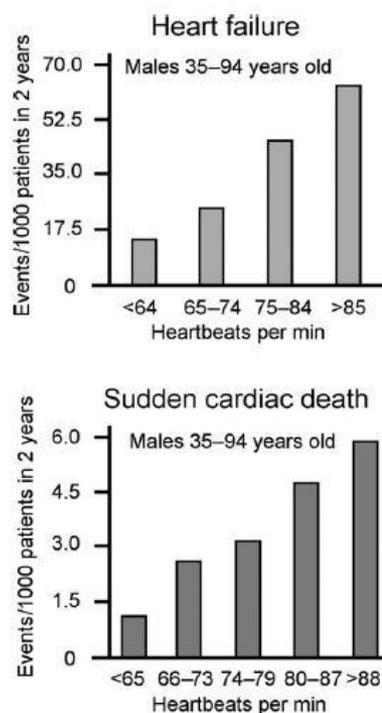


Figure 1 Dependency of heart failure events and sudden cardiac death on RHR divided in quartiles or quintiles. Included are men in a 36-year follow-up in the Framingham Heart Study.^{6,8}

High heart rate

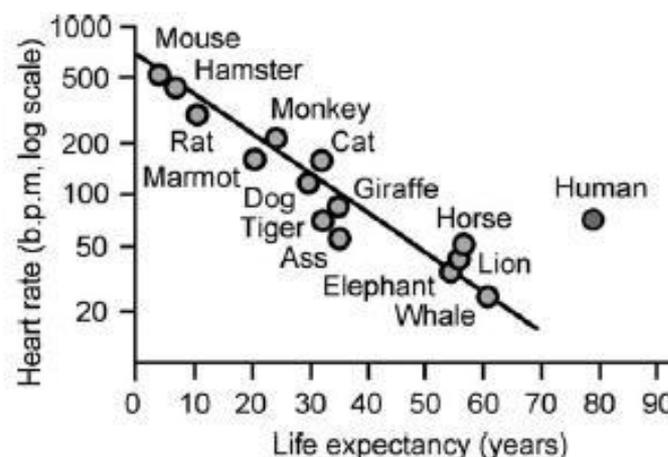
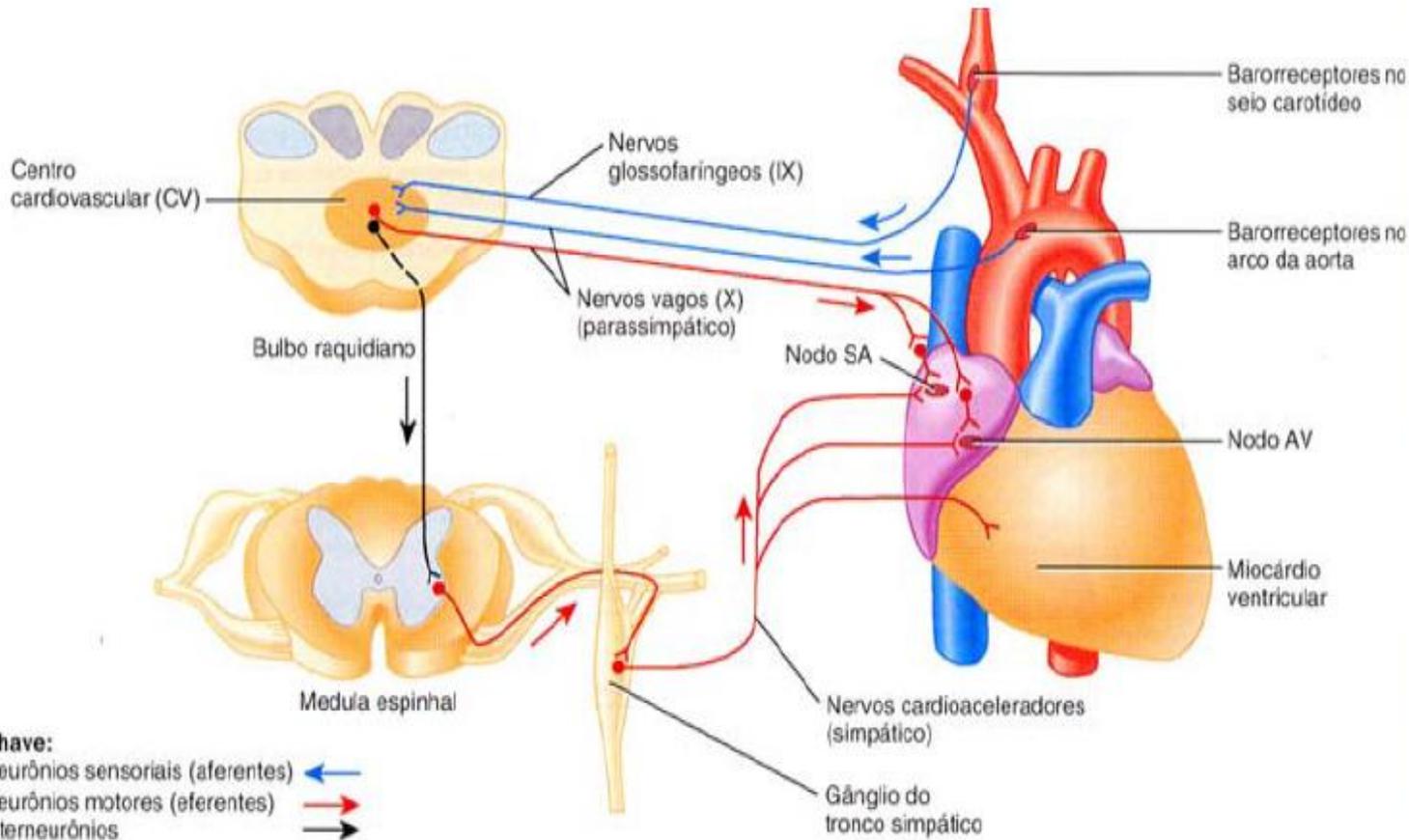


Figure 2 Inverse linear relation between RHR and life expectancy in mammals and humans. Redrawn from Levine^{2,8} with permission from American College of Cardiology Foundation.

REFLEXO BAROCEPTOR

(Lei de Marey, 1859)

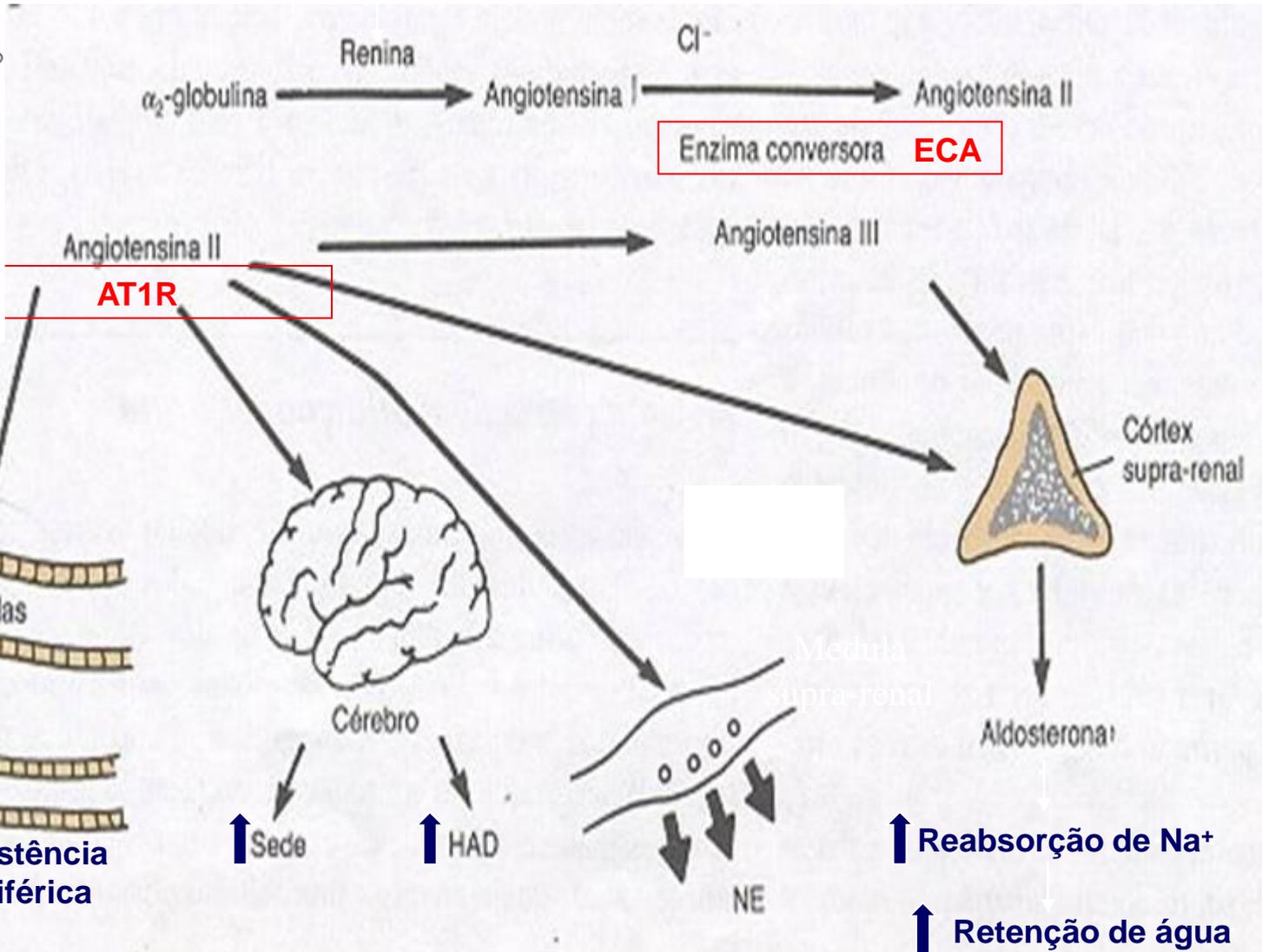
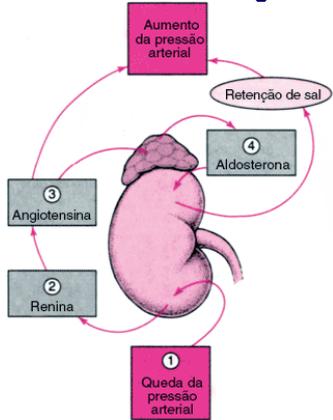
REFLEXO BARORRECEPTOR



(ação dos barorreceptores - redução de variações abruptas da PA)

Controle Lento da PA e FC

↓ PA → **Celulas justaglomerulares (pró-renina)**



Prevalência de Hipertensão no Brasil

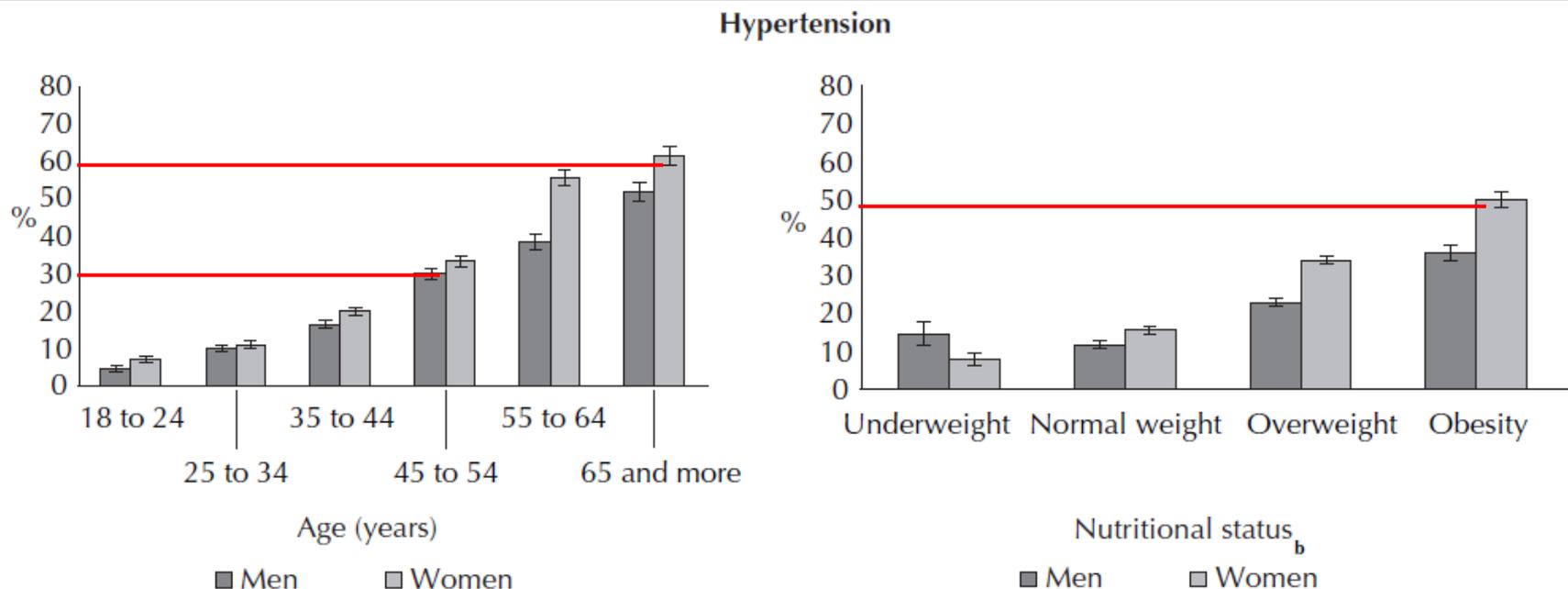


Figure. Estimated prevalence of self-reported diabetes and hypertension in adults ≥ 18 years in the group of capitals by sex and according to age (years) and nutritional status.^b Brazil, 2006. (N=54,369)

^a Weighted to adjust the sociodemographic distribution of the VIGITEL sample to the adult population distribution of each city in the 2000 Demographic Census and considering each city's population weight.

^b According to body mass index classification (Underweight: $< 18.5 \text{ kg/m}^2$; Normal weight: $18.5 - 24.99 \text{ kg/m}^2$; Overweight: $25 - 29.99 \text{ kg/m}^2$; Obesity: $\geq 30 \text{ kg/m}^2$)

Prevalência de Hipertensão em Natal

Table 2. Prevalence^a of self-reported hypertension, according to sex. Brazil, 2006. (N=54,369)

Capitals/FD	Hypertension					
	Men		Women		Total	
	%	(95% CI)	%	(95% CI)	%	(95% CI)
Aracaju	18.8	(16.0;21.6)	23.5	(21.2;25.8)	21.4	(19.6;23.2)
Belém	16.1	(13.6;18.7)	21.2	(18.9;23.5)	18.9	(17.2;20.6)
Belo Horizonte	22.7	(19.8;25.6)	24.5	(22.1;26.9)	23.7	(21.8;25.5)
Boa Vista	16	(13.5;18.5)	21.8	(19.5;24.1)	18.9	(17.2;20.6)
Campo Grande	21.2	(18.3;24.1)	23.3	(21.0;25.7)	22.3	(20.5;24.1)
Cuiabá	19.8	(17.1;22.5)	21.6	(19.3;24.0)	20.7	(19.0;22.5)
Curitiba	18.6	(15.9;21.4)	23.3	(20.9;25.7)	21.1	(19.3;22.9)
Florianópolis	14.9	(12.5;17.3)	20.2	(17.9;22.4)	17.7	(16.0;19.3)
Fortaleza	15.7	(13.1;18.2)	20.8	(18.5;23.0)	18.5	(16.8;20.2)
Goiânia	17	(14.4;19.7)	20.6	(18.3;22.8)	18.9	(17.2;20.6)
João Pessoa	22.4	(19.5;25.4)	25.2	(22.7;27.6)	23.9	(22.1;25.8)
Macapá	15.6	(13.1;18.0)	22.1	(19.7;24.4)	18.9	(17.2;20.6)
Maceió	18.4	(15.6;21.1)	23.5	(21.1;25.9)	21.2	(19.4;23.0)
Manaus	18	(15.4;20.6)	19.2	(17.0;21.5)	18.6	(16.9;20.3)
Natal	19.1	(16.3;21.9)	25.4	(23.0;27.8)	22.6	(20.7;24.4)

(Schmidt MI et al., 2009; Revista de Saúde Pública)

Rio Grande do Norte – 2012 (3402 óbitos) (993 por doenças cardiorrespiratórias)

IBGE

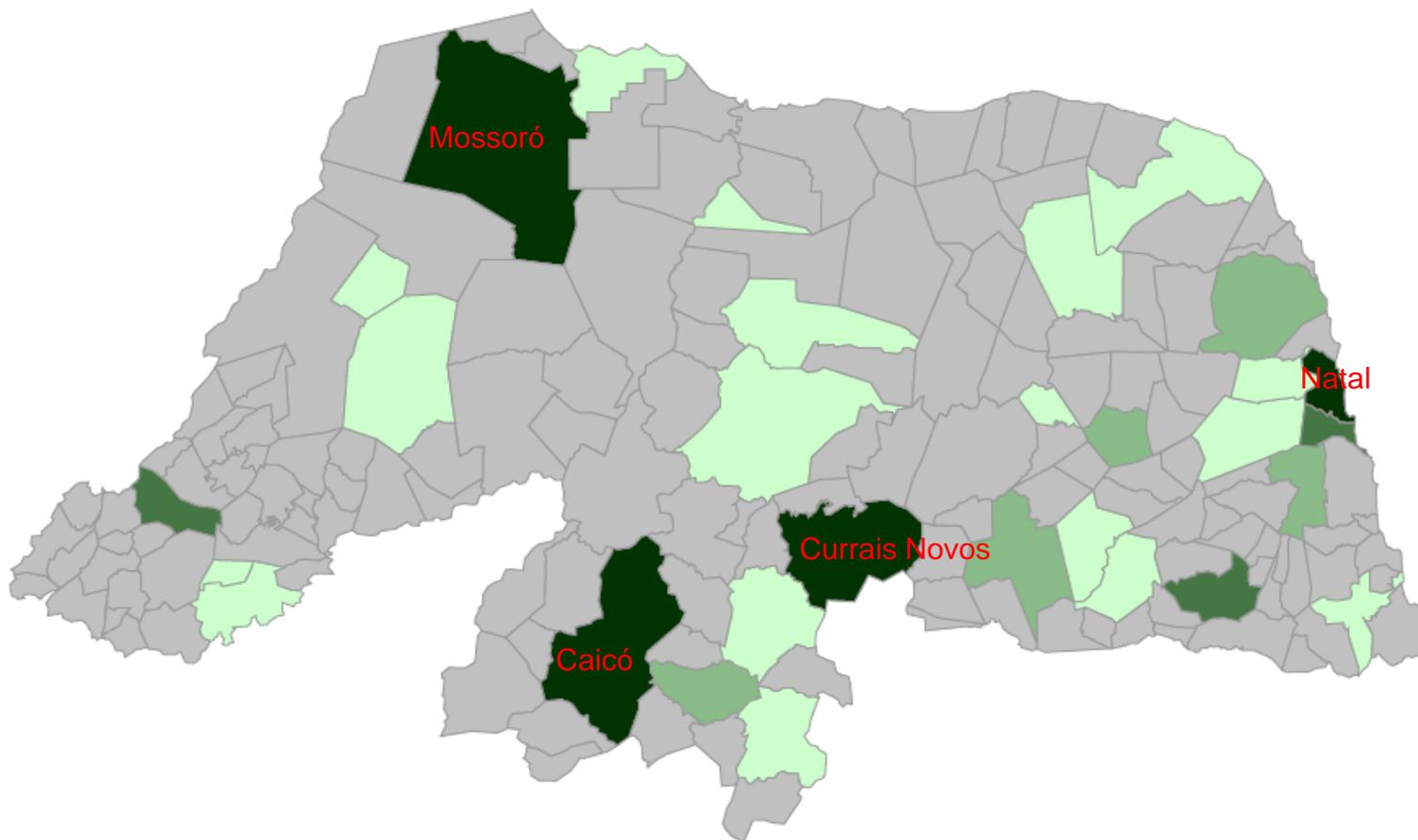
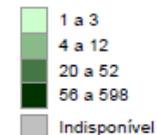
Rio Grande do Norte - Morbidades Hospitalares

Óbitos - doenças - aparelho circulatório - total

(óbitos)

<http://cidades.ibge.gov.br>

30% das mortes por doenças
cardiorrespiratórias



TRATAMENTO HIPERTENSÃO

1. Medicamentoso

2. Não-medicamentoso

- Peso
- Sal
- Álcool
- Fumo
- Atividade Física

Implicações funcionais

Enrijecimento das
artérias



↑ RVP



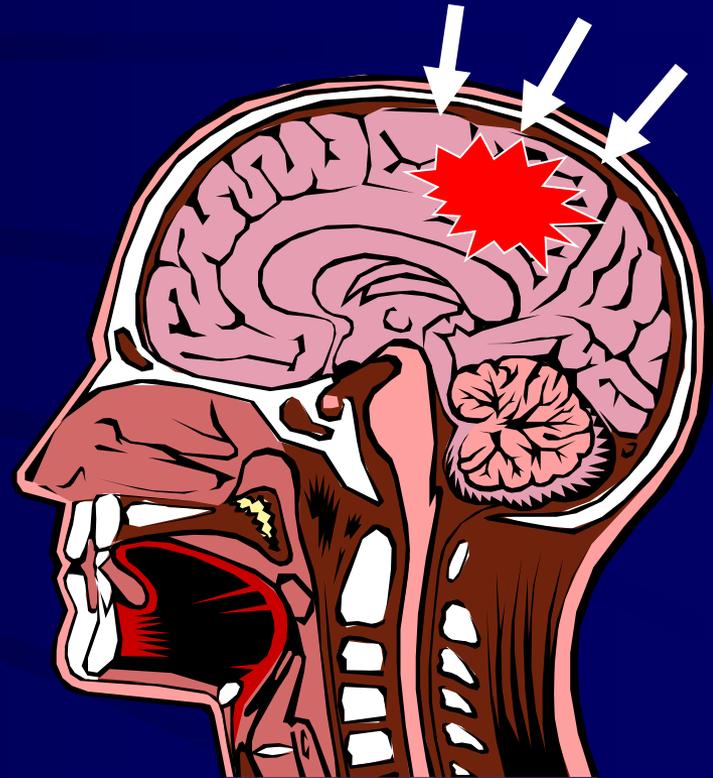
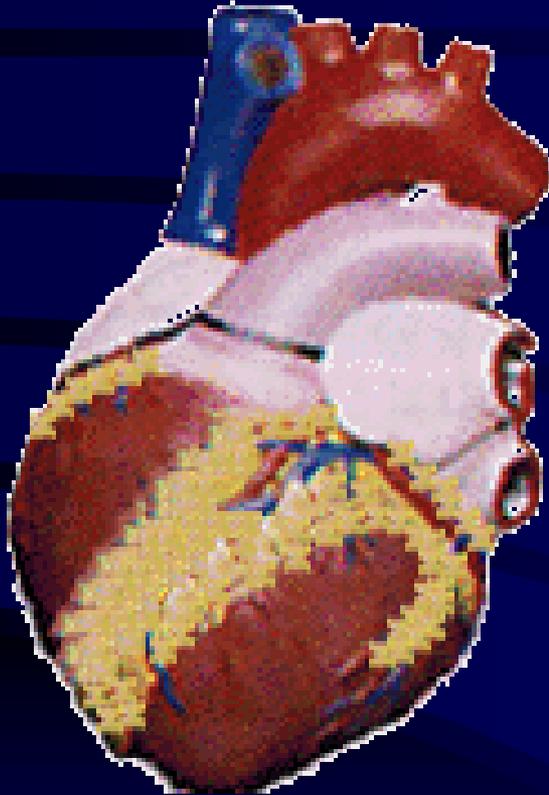
Hipertrofia do
Ventrículo esquerdo



↑ Pressão
Arterial

Essas alterações associadas a um estilo de vida sedentário representam alto risco para doenças cardiovasculares

PRESSÃO ARTERIAL MANTIDA ALTA



CORAÇÃO GRANDE = **ICC** DERRAME CEREBRAL = **AVE**

Muscle sympathetic nerve activity and hemodynamic alterations in middle-aged obese women

M.M. Ribeiro¹,
I.C. Trombetta¹, L.T. Batalha²,
M.U.P.B. Rondon¹,
C.L.M. Forjaz³, A.C.P. Barretto¹,
S.M.F. Villares²
and C.E. Negrão^{1,3}

¹Instituto do Coração, ²Departamento de Endocrinologia, Faculdade de Medicina, and ³Escola de Educação Física e Esportes, Universidade de São Paulo, São Paulo, SP, Brasil

n=15 obesas
n=11 magras

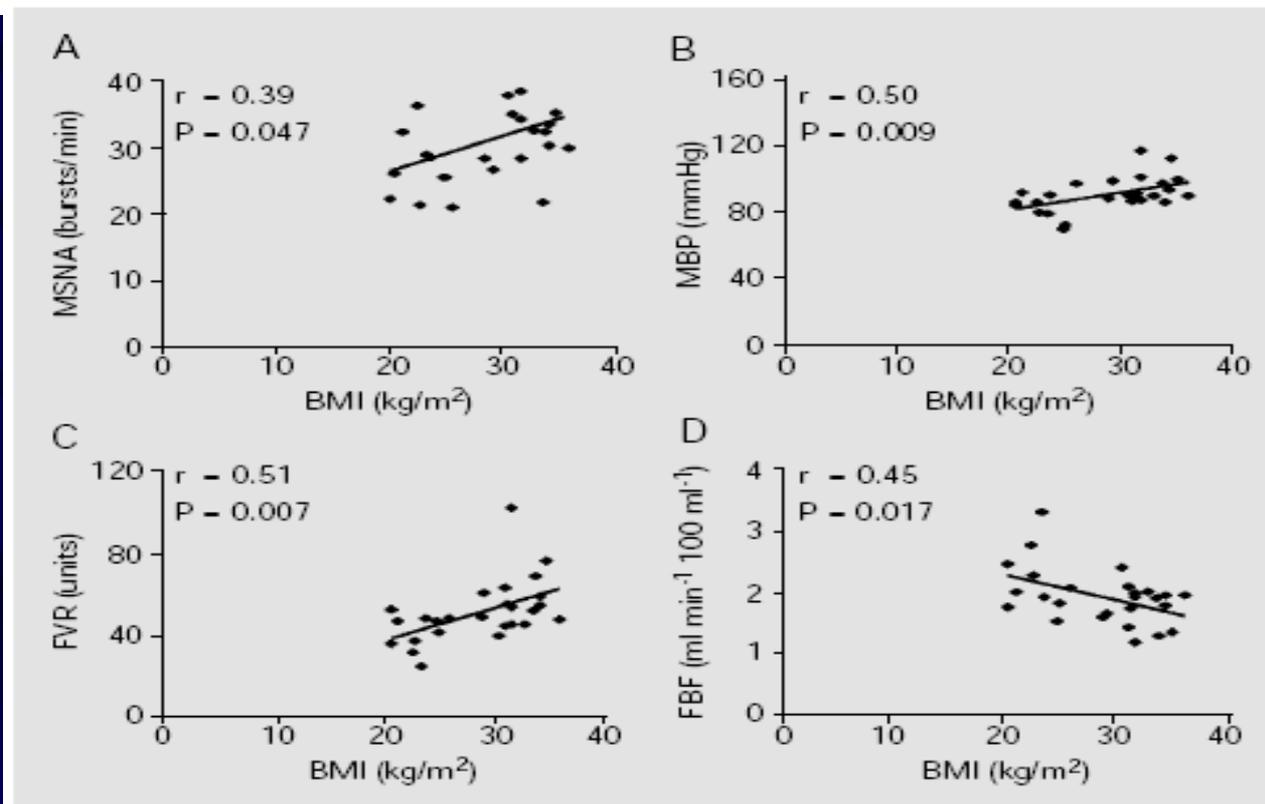


Figure 1 - Correlation between body mass index (BMI) and muscle sympathetic nerve activity (MSNA, panel A), mean blood pressure (MBP, panel B), forearm vascular resistance (FVR, panel C), and forearm blood flow (FBF, panel D) in middle-aged obese women. The Pearson correlation coefficient was used to evaluate the correlation between variables.

Abnormal Neurovascular Control during Sympathoexcitation in Obesity

Fátima H.S. Kuniyoshi,*† Ivani C. Trombetta,* Luciana T. Batalha,‡ Maria U.P.B. Rondon,* Mateus C. Laterza,* Márcia M.G. Gowdak,* Antonio C.P. Barretto,* Alfredo Halpern,‡ Sandra M.F. Villares,‡ Eliudem G. Lima,† and Carlos E. Negrão*§

OBESITY RESEARCH Vol. 11 No. 11 November 2003

n=29 obesas
n=12 magras

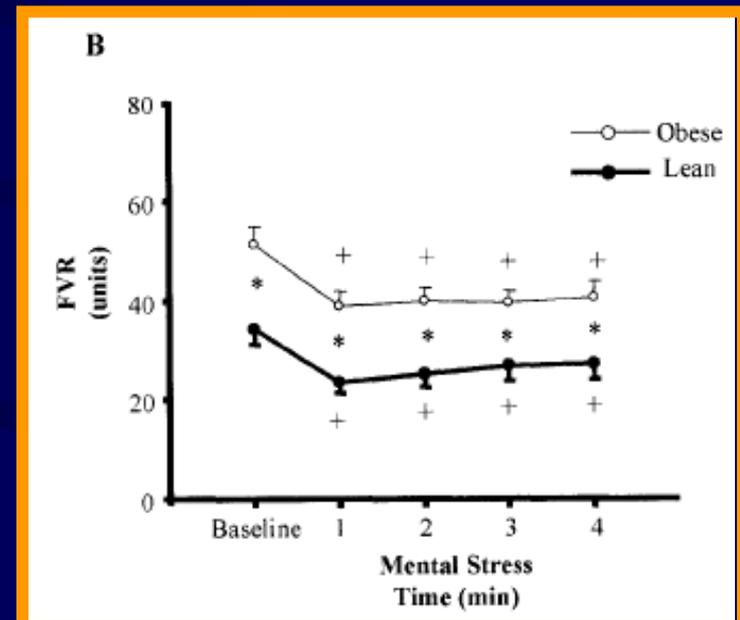
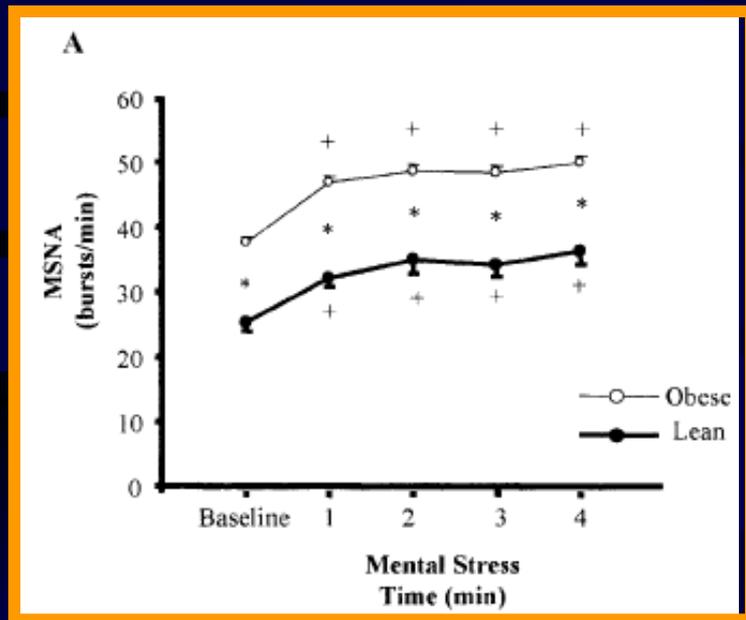
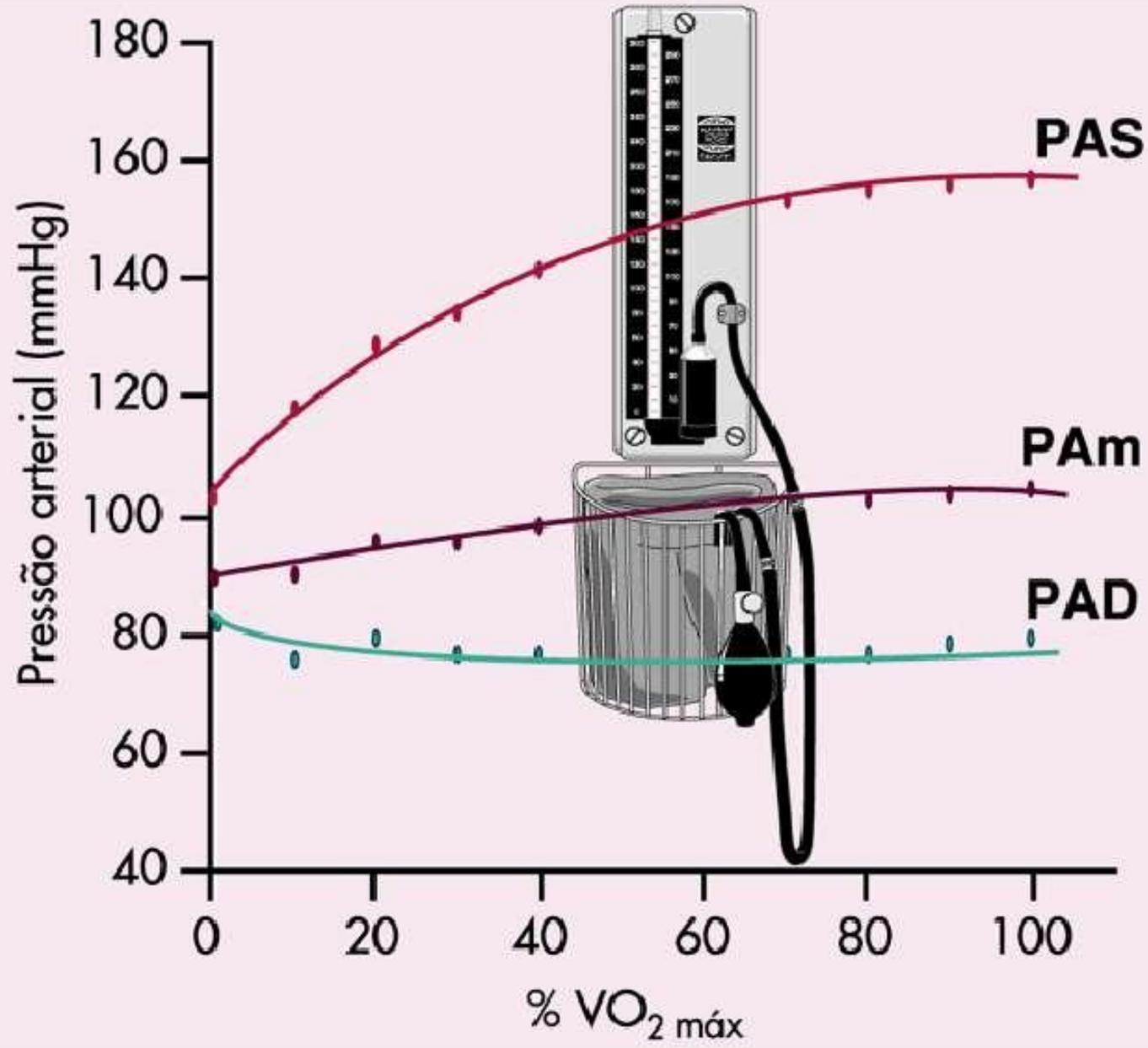


Figure 1: MSNA during mental stress in healthy obese individuals and in healthy lean individuals. (A) Muscle sympathetic nerve burst frequency. (B) Pulse synchronous sympathetic activity. Note that both muscle sympathetic nerve burst frequency and pulse synchronous sympathetic activity levels were greater in obese individuals compared with lean individuals, despite the similar magnitude of responses between groups.

Figure 2: FBF and FVR during mental stress in healthy obese individuals and in healthy lean individuals. (A) FBF. (B) FVR. Note that FBF was lower in obese individuals compared with lean individuals, whereas FVR was greater. In addition, the magnitude of change in FVR was not different between groups ($p = 0.55$), demonstrating that the vasodilatory response was similar between the two groups studied.

**Como a pressão
arterial responde
ao exercício físico?**

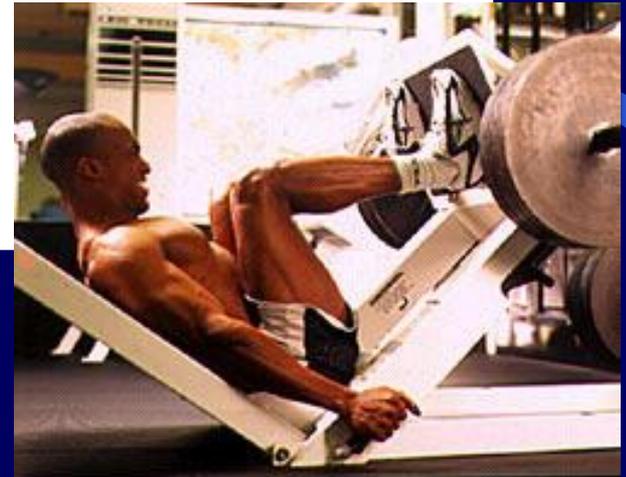


Arterial Blood Pressure Response to Heavy Resistance Exercise

MacDOUGALL et al.

Journal of Applied Physiology

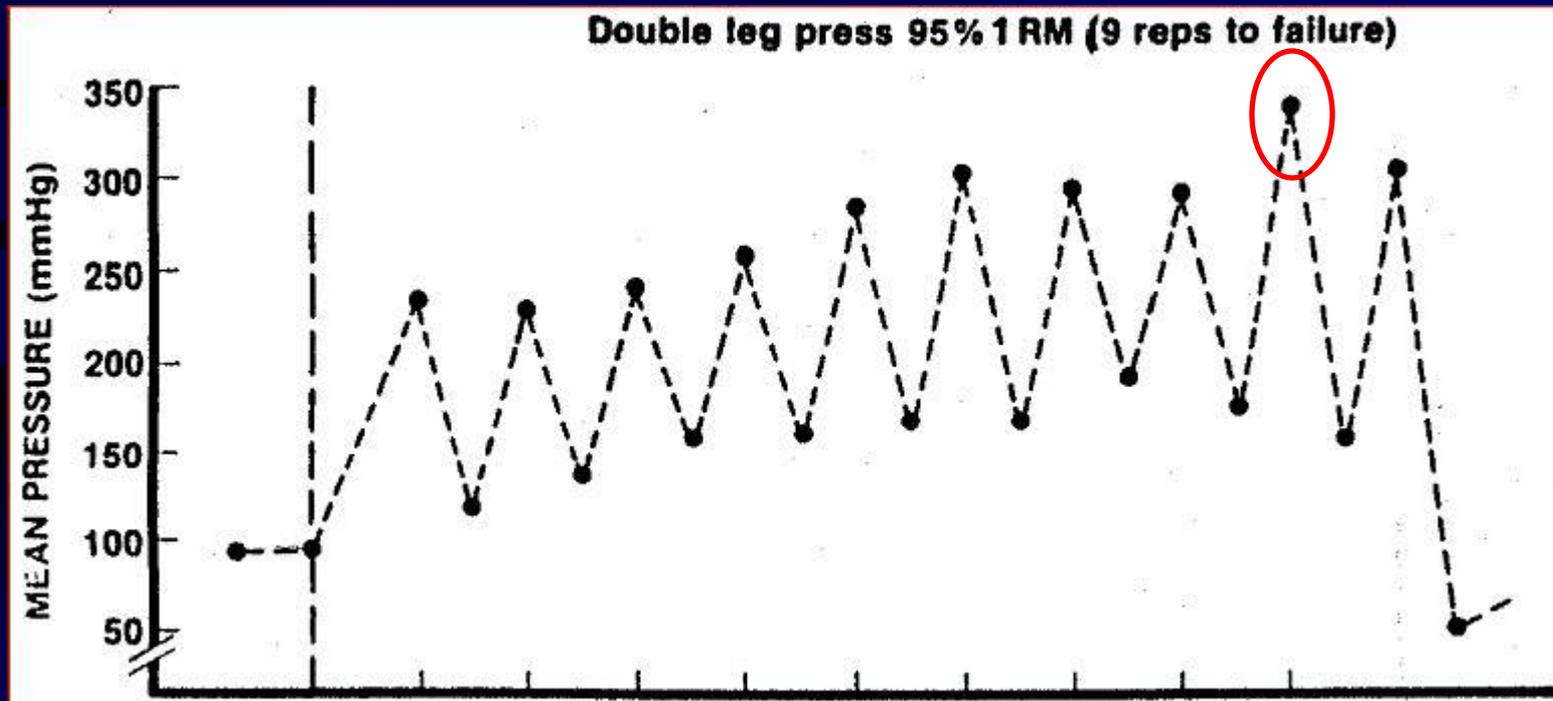
1985



PRESSÃO ARTERIAL

RESPOSTAS AGUDAS AO EXERCÍCIO

↑ PAS e PAD



MaCDougall *et al.* (1985)



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Journal of Science and Medicine in Sport 14 (2011) 254–258

**Journal of
Science and
Medicine in
Sport**

www.elsevier.com/locate/jsams

Original research

The blood pressure response of older men to maximum and sub-maximum strength testing

Dale I. Lovell^{a,*}, Ross Cuneo^b, Greg C. Gass^c

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^b *Department of Diabetes and Endocrinology, Princess Alexandra Hospital, Queensland, Australia*

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Journal of Applied Physiology

Abstract

Strength testing is commonly used to determine the muscular strength of older individuals participating in a resistance training program. The purpose of this study was to non-invasively examine and compare the blood pressure (BP) and heart rate (HR) response of maximum and sub-maximum strength tests in older men. Twenty-four healthy men aged 70–80 yr were recruited for the study. Participants completed a 1 repetition maximum (RM) strength test and four days later a sub-maximum strength test on an incline squat. Systolic blood pressure

Respostas de PA em idosos durante 1RM e RM's

Table 1

Blood pressure and heart rate response before, during and after 1RM and sub-maximum strength tests.

	1 repetition maximum (1RM)				Sub-maximum (50% of 1RM)			
	Resting	During	Post (20 s)	Post (60 s)	Resting	During	Post (20 s)	Post (210 s)
Average SBP (mm Hg)	141 ± 21	215 ± 34 ^{*,#}	160 ± 27 ^{*,#}	125 ± 26 ^{*,#}	143 ± 22	234 ± 35 [*]	120 ± 30 [*]	155 ± 26
Maximum SBP	144 ± 17	231 ± 31^{*,#}	178 ± 30 ^{*,#}	132 ± 24 [#]	146 ± 19	268 ± 37[*]	134 ± 33	168 ± 27 [*]
Minimum SBP	129 ± 21	190 ± 33 [*]	148 ± 29 ^{*,#}	118 ± 26 [#]	134 ± 24	212 ± 32 [*]	111 ± 31 [*]	141 ± 30
Average DBP (mm Hg)	70 ± 12	118 ± 17 ^{*,#}	68 ± 12 [#]	71 ± 11	73 ± 14	135 ± 22 [*]	52 ± 13 [*]	64 ± 12
Maximum DBP	83 ± 14	128 ± 21^{*,#}	79 ± 13 [#]	84 ± 12	84 ± 15	151 ± 23[*]	64 ± 11 [*]	77 ± 10
Minimum DBP	61 ± 10	109 ± 22 ^{*,#}	67 ± 11 [#]	62 ± 12	62 ± 12	128 ± 19 [*]	43 ± 11 [*]	56 ± 12
Average HR (beats min ⁻¹)	68 ± 10	112 ± 12 ^{*,#}	91 ± 10 ^{*,#}	79 ± 9 [#]	67 ± 9	145 ± 12 [*]	120 ± 13 [*]	90 ± 9 [*]
Maximum HR	76 ± 11	121 ± 15^{*,#}	105 ± 13 ^{*,#}	88 ± 13 [#]	74 ± 10	153 ± 16[*]	128 ± 15 [*]	108 ± 12 [*]
Minimum HR	59 ± 10	94 ± 14 ^{*,#}	86 ± 11 ^{*,#}	69 ± 13 [#]	58 ± 10	138 ± 14 [*]	110 ± 12 [*]	85 ± 11 [*]

Values are mean ± SD. SBP, systolic blood pressure; DBP, diastolic blood pressure; HR, heart rate.

* Significantly ($P < 0.05$) different from resting values.

Significantly ($P < 0.05$) different from sub-maximum test.

DP 1RM = 27951 mmHg*bpm vs. DP RM's = 41004 mmHg*bpm, significancia 47% aumento!

Respostas de PA em idosos durante RM's

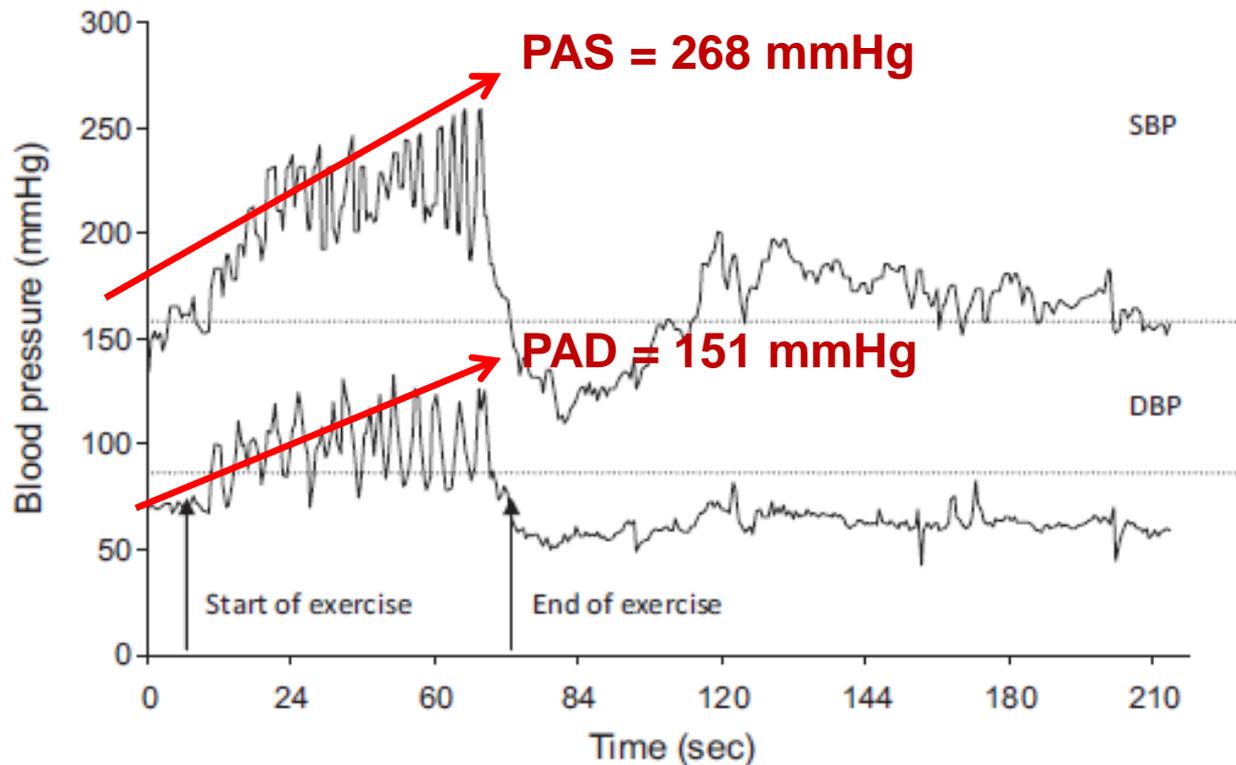
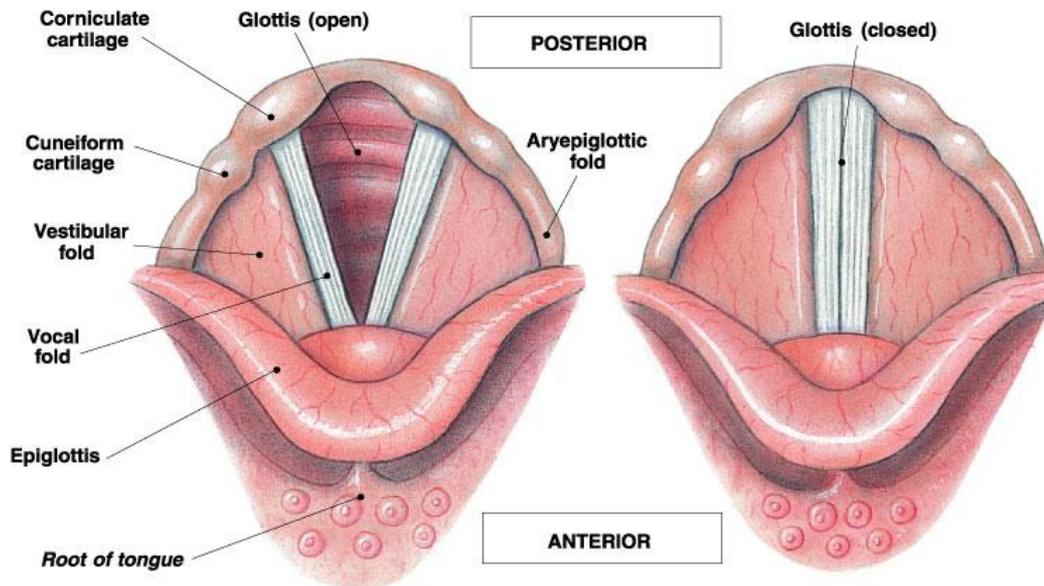
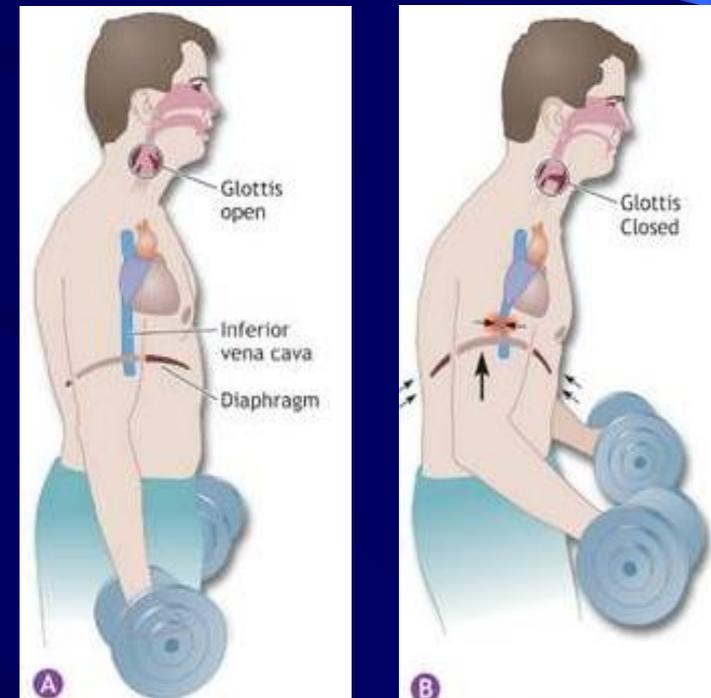


Fig. 1. An example of time-course analysis of systolic and diastolic blood pressures during a sub-maximum strength test on the incline squat machine. Dotted lines indicate resting values for systolic (SBP) and diastolic (DBP) blood pressures.

Manobra de Valsalva



Após uma inspiração, a contração dos músculos da caixa torácica e o fechamento da glote impedem a saída de ar, resultando no aumento da pressão intratorácica.

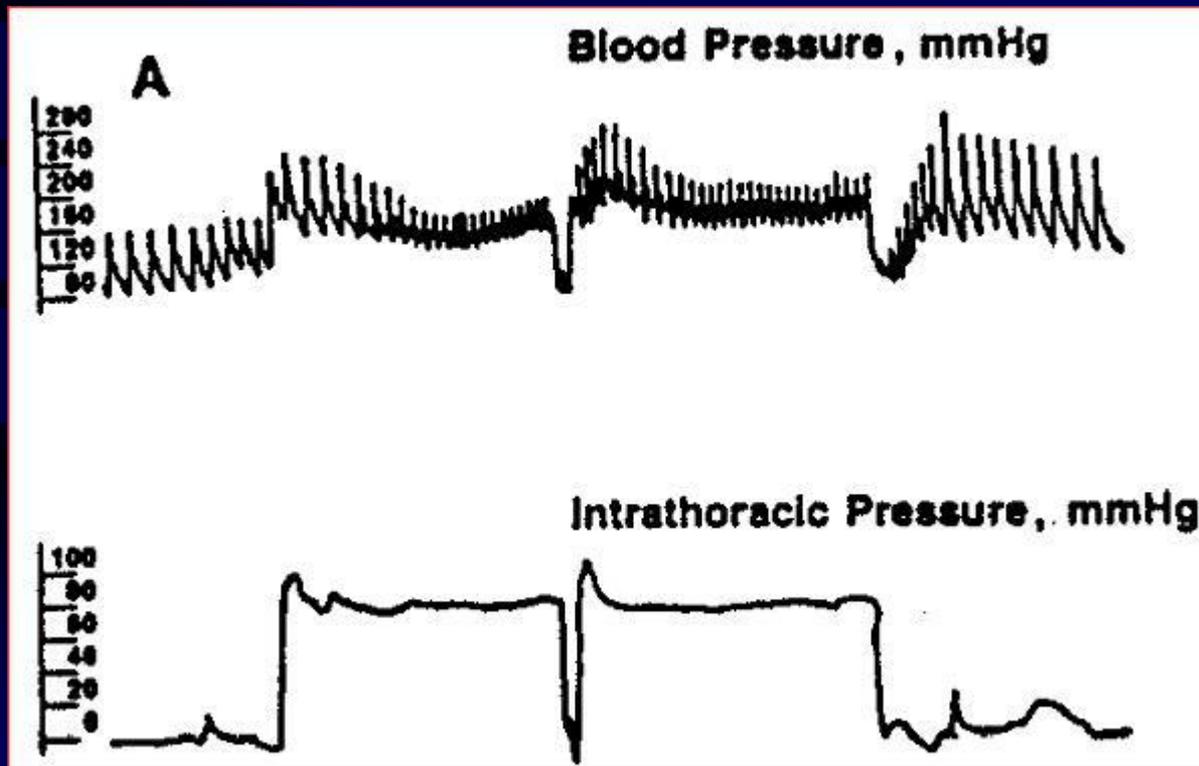


Este aumento de pressão pode causar o deslocamento de artérias durante o levantamento de pesos.

PRESSÃO ARTERIAL

RESPOSTAS AGUDAS AO EXERCÍCIO

➤ Manobra de Valsalva

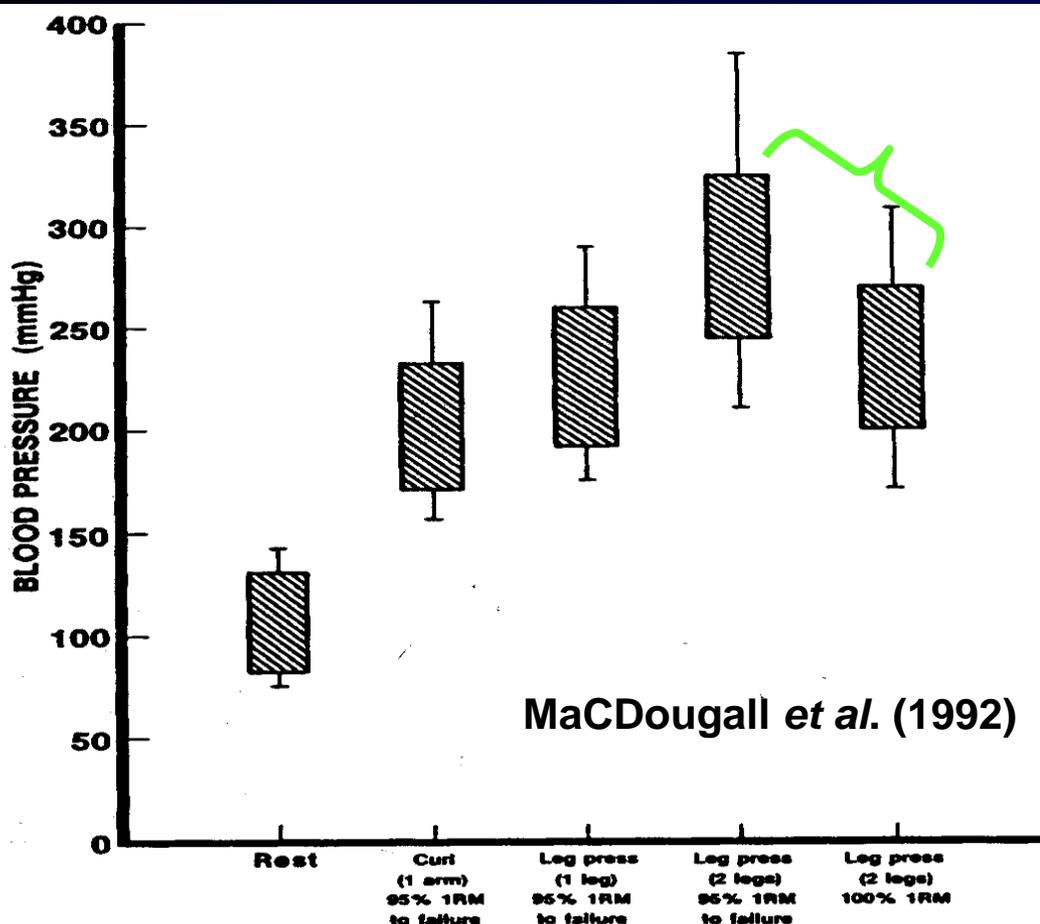


MaCDougall *et al.* (1992)

PRESSÃO ARTERIAL

RESPOSTAS AGUDAS AO EXERCÍCIO

➤ Tamanho da massa muscular envolvida



MaCDougall et al. (1992)

Peak systolic and diastolic blood pressures reached during various exercises. \bar{X} and SD, N=5

FIG. 4. Means \pm SD peak blood pressures for all subjects during various exercises at 95 and 100% of their single maximum lift (1 RM).

< massa =
< PA,
embora
alta.



Como
minimizar?

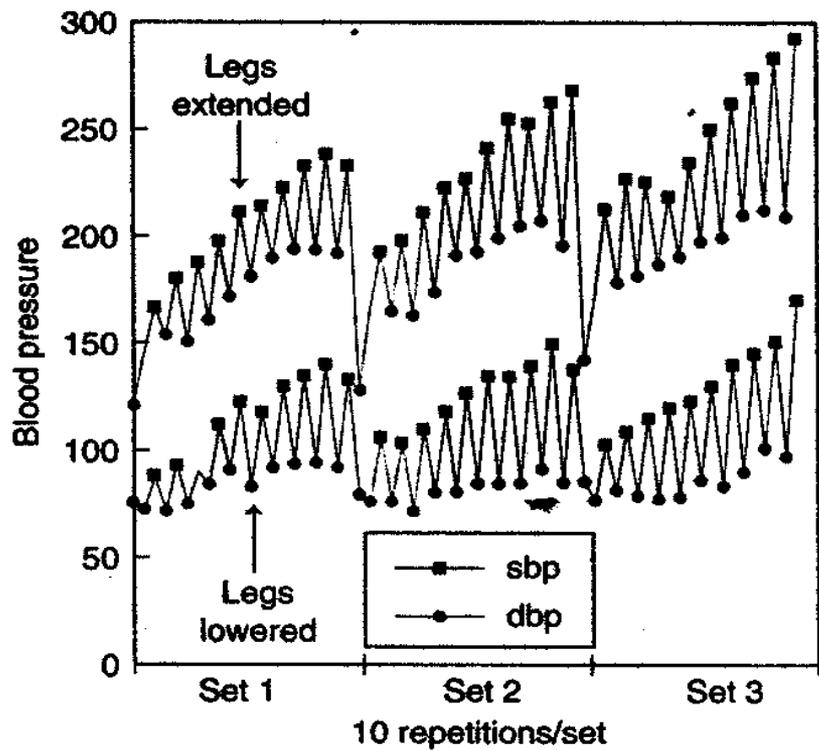


Figure 3.25 Blood pressure response increases during a two-legged leg press set to volitional fatigue as well as during three successive sets of 10 repetitions at a 10RM resistance.

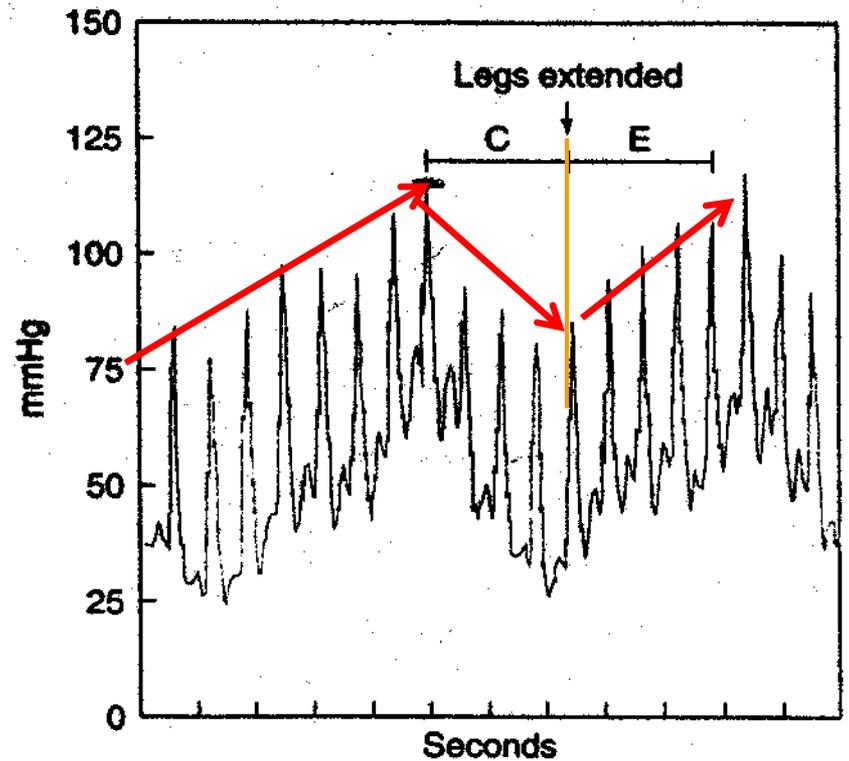


Figure 3.26 Blood pressure response during one complete repetition of a two-legged leg press exercise.

➤ Método não invasivo

➤ Exemplo p/ minimizar resposta pressórica

Qual o problema?

- Ocorrência de manobra de valsalva, redução de débito cardíaco com conseqüente menor perfusão nas coronárias;
- Promove picos na pressão arterial.

Qual o problema dos picos na PA?

- Possibilidades de aneurisma (dilatação do vaso) com conseqüente rompimento deste (ruptura arterial e AVC se for no cérebro).

P.S. Grande parte dos aneurismas são assintomáticos. Entretanto, os sintomas mais frequentes são: cefaleia, vômitos, convulsões, perdas de consciência, visão dupla ou outras alterações na vista, dentre outros.

Qual o papel do exercício no controle hemodinâmico?

EVIDÊNCIAS CIENTÍFICAS

Review

Evidence for prescribing exercise as therapy in chronic disease

B. K. Pedersen^{1,2}, B. Saltin²

Positive effect of training on:	Strong evidence A	Moderate evidence B	Limited evidence C	No evidence D
Pathogenesis				
Symptoms specific to the diagnosis				
Physical fitness or strength				
Quality of life				

Fig. 4. Hypertension.

EFEITO AGÚDO!

Ambulatory Blood Pressure After Acute Exercise in Older Men With Essential Hypertension

Nadine S. Taylor-Tolbert, Donald R. Dengel, Michael D. Brown, Steve D. McCole, Richard E. Pratley, Robert E. Ferrell, and James M. Hagberg

- **11 hipertensos (sedentários, obesos e idosos)**
- **45 minutos de esteira (3 séries de 15 minutos)**
- **4 minutos de recuperação**
- **Intensidade: 70 %VO₂max**
- **Resposta de Pressão Arterial 24 horas MAPA**

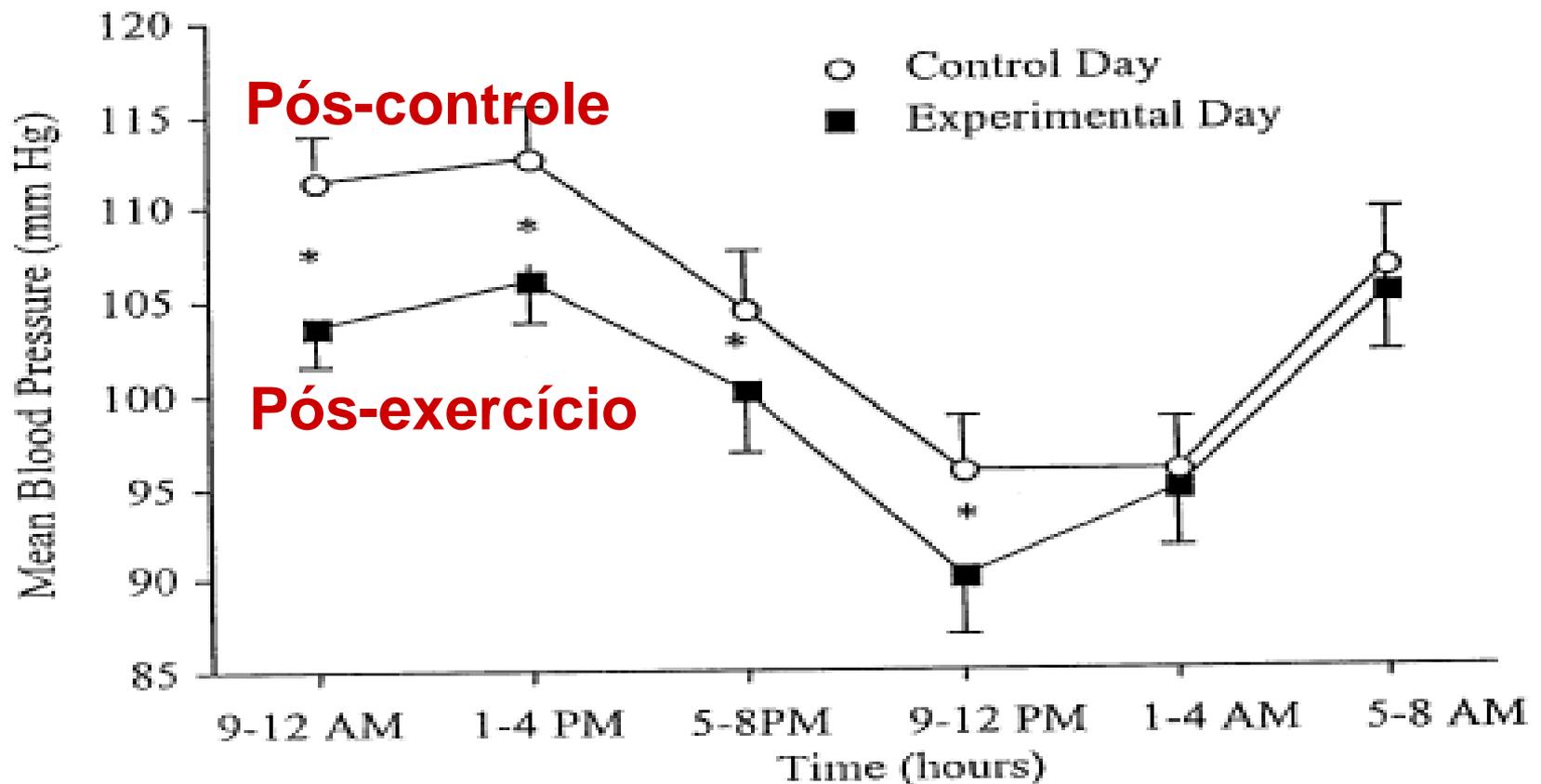


FIGURE 3. Mean arterial BP for the 24-h ambulatory BP recording preceded by and not preceded by 45 min of acute aerobic exercise at 70% VO_{2max} . Values are expressed as mean \pm SE. *P < .05 for the difference between the two recordings.

Exercise intensity modulates nitric oxide and blood pressure responses in hypertensive older women

Hugo A. P. Santana · Sérgio R. Moreira · Ricardo Cláudio Córdova · Carmen S. G. Campbell · Foued Andrei C. Sposito · Otávio T. Nóbrega · Herbert G

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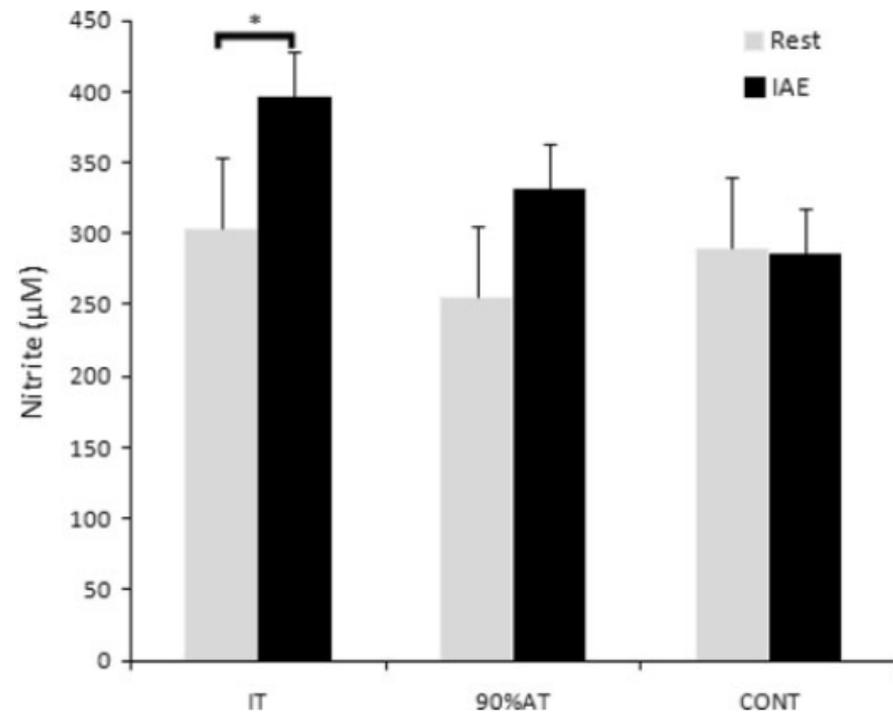


Fig. 1 Comparisons of nitrite values (mean \pm SE) between resting and immediately after sessions (IAE) of incremental test (IT), at 90 % of anaerobic threshold (90 % AT) and control (CONT). * $p < 0.05$ compared with rests ($n = 22$)

Post-resistance exercise hypotension, hemodynamic rate variability: influence of exercise intensity

C. C. Rezk · R. C. B. Marrache · T. Tinucci · D. Mion Jr ·
C. L. M. Forjaz

Hipotensão

Pós-Exercício Resistido

- 40% 1RM – 16 rep
- 80% 1RM – 08 rep
- CONT

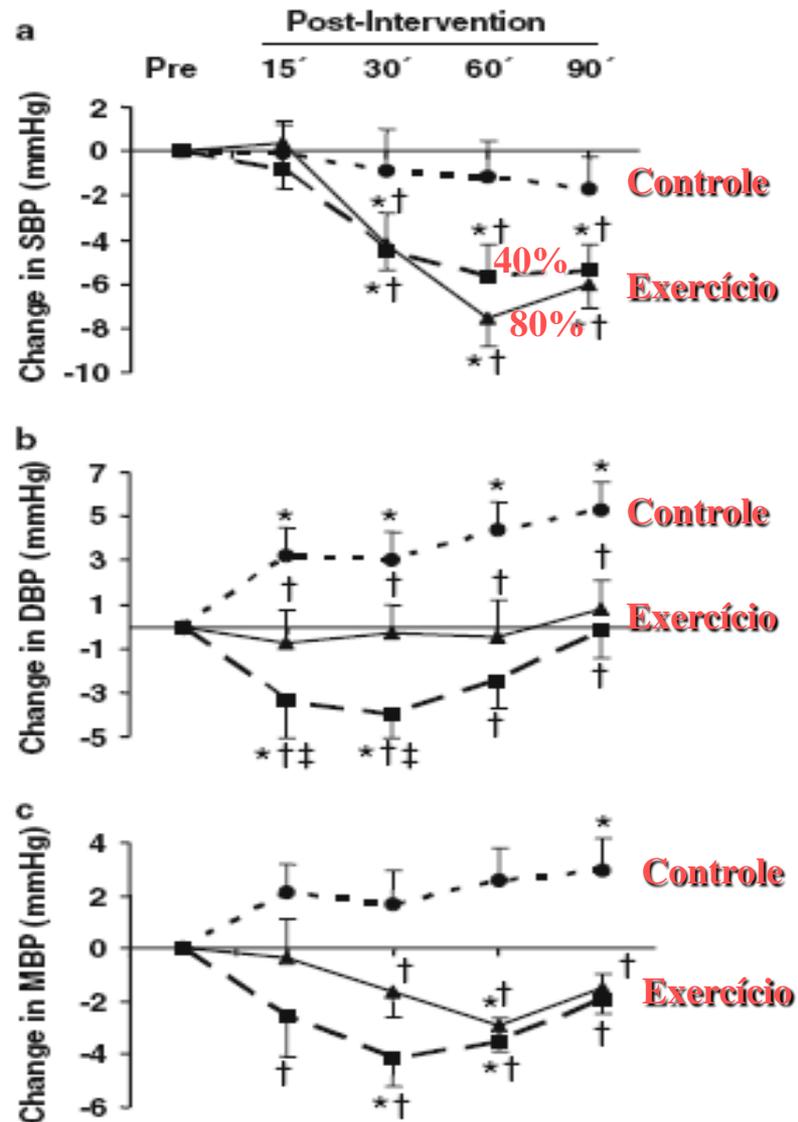


Fig. 1 Changes in systolic (*SBP panel a*), diastolic (*DBP panel b*), and mean (*MBP panel c*) blood pressures observed in 17 subjects after interventions in the control (*C circles*), resistance exercise at 40% of 1 RM (*E40% squares*), and resistance exercise at 80% of 1 RM (*E80% triangles*) sessions. *Significantly different from pre-intervention ($P < 0.05$). †Significantly different from the control session ($P < 0.05$). ‡Significantly different from the E80% session ($P < 0.05$)

- Sessões retangulares (*café da manhã padronizado – 280 Kcal*)

Controle



Sem exercício

43%RM - 16 rep. 2" cada rep. - ~45" desc. entre exercícios

**Exercício
(3 circuitos)**



23%RM - 30 rep. 2" cada rep. - ~20" desc. entre exercícios

2' para coletas



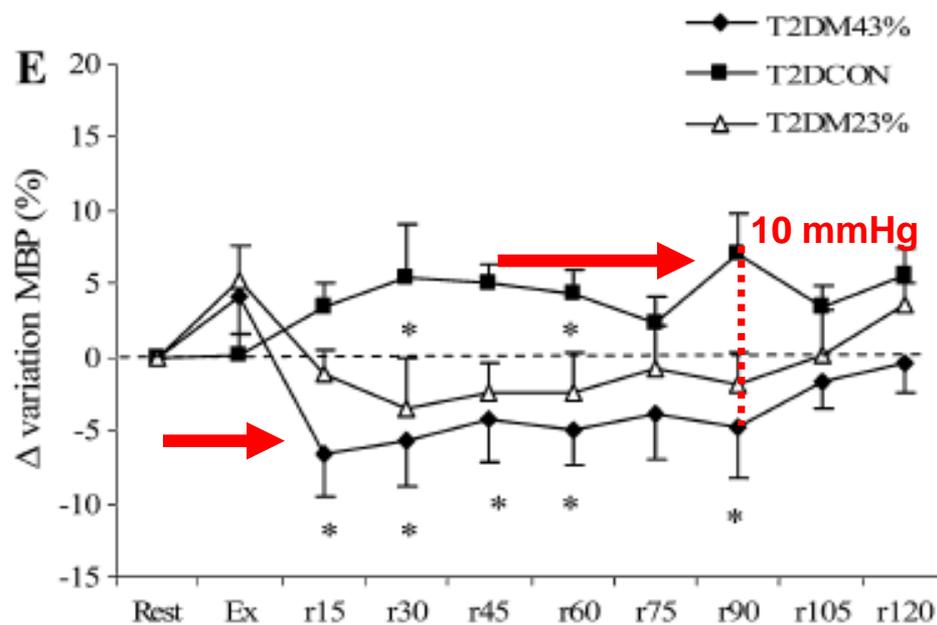
- Coletas de sangue e PA no repouso, a cada circuito e 15, 30, 45, 60, 75, 90, 105 e 120 minutos da recuperação.

POSTRESISTANCE EXERCISE BLOOD PRESSURE REDUCTION IS INFLUENCED BY EXERCISE INTENSITY IN TYPE-2 DIABETIC AND NONDIABETIC INDIVIDUALS

GRAZIELA C. SIMÕES,¹ SÉRGIO R. MOREIRA,¹ MICHAEL R. KUSHNICK,² HERBERT G. SIMÕES,¹ AND CARMEN S.G. CAMPBELL¹

¹Graduate Program on Physical Education and Health, Catholic University of Brasília, Brasília, Brazil; and

²School of Recreation and Sport Sciences, Ohio University, Athens, Ohio



Pressão Arterial Média

(Simões et al., 2010)

Isometric handgrip does not elicit cardiovascular overload or post-exercise hypotension in hypertensive older women

Rafael dos Reis Vieira Olher^{1,2,*}
 Danilo Sales Bocalini^{3,*}
 Reury Frank Bacurau⁴
 Daniel Rodriguez⁵
 Aylton Figueira Jr⁵
 Francisco Luciano Pontes Jr⁴
 Francisco Navarro⁶
 Herbert Gustavo Simões¹
 Ronaldo Carvalho Araujo⁷
 Milton Rocha Moraes⁸

Table 3 Hemodynamic parameters at control condition and 30% and 50% of r

	SBP (mmHg)			DBP (mmHg)		
	Control	30%	50%	Control	30%	50%
Rest	121 ± 13	121 ± 10	120 ± 7	76 ± 12	74 ± 9	72 ± 8
Exercise peak	121 ± 12	127 ± 14	125 ± 11	76 ± 11	76 ± 6	78 ± 7
5 min	120 ± 12	125 ± 13	120 ± 9	73 ± 8	74 ± 5	72 ± 7
10 min	118 ± 5	123 ± 12	122 ± 9	72 ± 8	72 ± 8	72 ± 8
15 min	117 ± 8	122 ± 11	121 ± 11	73 ± 7	72 ± 5	71 ± 7
30 min	118 ± 7	124 ± 11	121 ± 9	72 ± 7	72 ± 8	72 ± 8
45 min	123 ± 8	124 ± 10	121 ± 9	75 ± 6	73 ± 6	75 ± 10
60 min	122 ± 7	121 ± 10	120 ± 7	73 ± 6	75 ± 7	75 ± 7

Note: Values expressed in as the mean ± standard deviation.

Abbreviations: DBP, diastolic blood pressure; HR, heart rate; MAP, mean arterial pressure; RPP, ra

- Handgrip
- 4 sets
- 5 contrações de 10" cada set.

E o efeito da HPE
permanece mesmo
quando treinado?

ORIGINAL ARTICLE

Effect of 12 weeks of resistance exercise on post-exercise hypotension in stage 1 hypertensive individuals

MR Moraes¹,
JB Pesquero¹
¹Department of
Cruzes, Mogi das
São Paulo, SP,
and Technology

¹,
Mogi das
Paulo,
Science

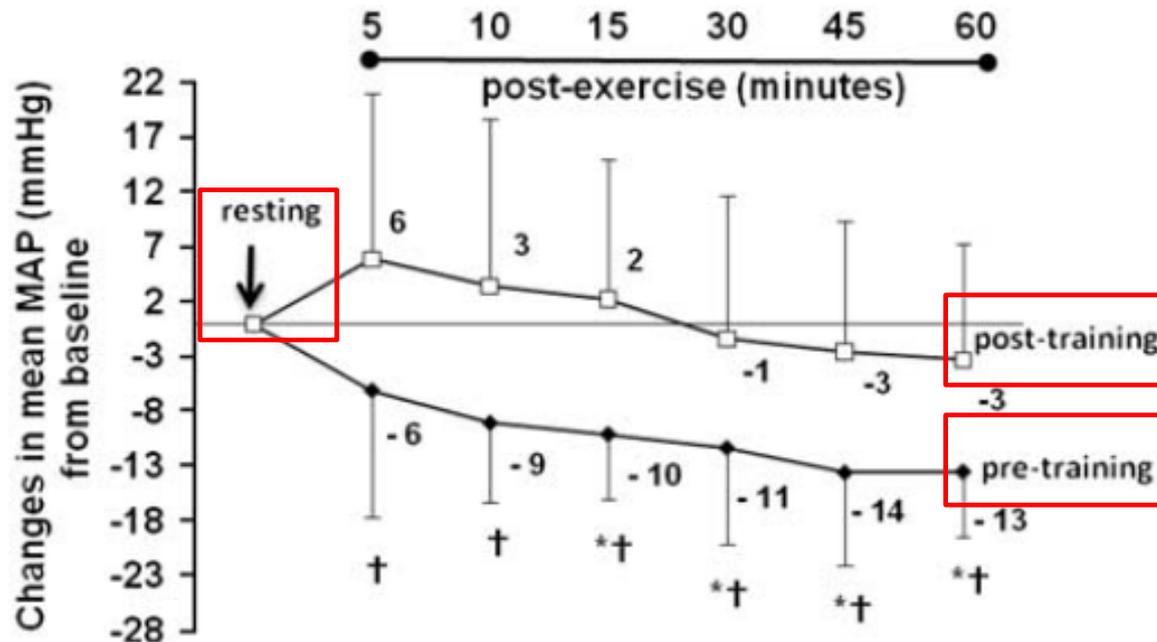


Figure 3 MAP after acute resistance exercise. Mean changes of MAP (when compared with the resting value) due to RES before (pre-training, lozenges) and after (post-training, squares) 12 weeks of RET. * $P < 0.05$ in comparison to the resting value; † $P < 0.001$ related to post-training values. Values given as mean \pm s.d.

Mecanismos

Respostas durante e
após o exercício

Central: Durante o Exercício

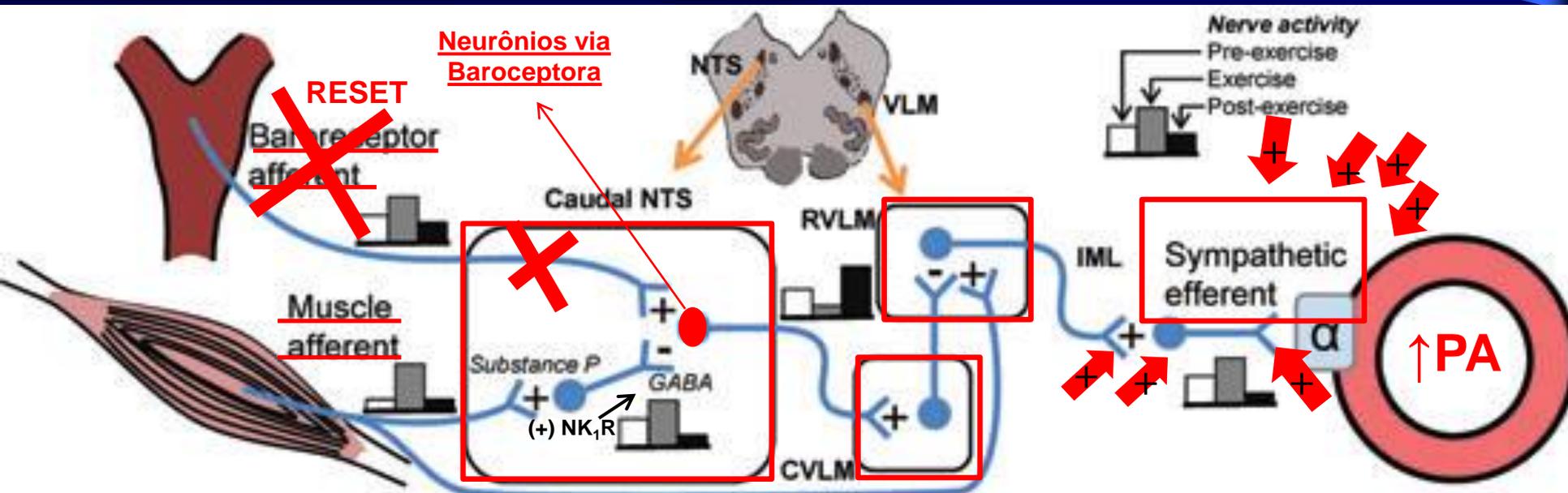
Hot Topic Review

2013

Postexercise hypotension and sustained postexercise vasodilatation: what happens after we exercise?

John R. Halliwill, Tahisha M. Buck, Alisha N. Lacewell and Steven A. Romero

Department of Human Physiology, University of Oregon, Eugene, OR 97403-1240, USA



(Chen & Bonahm, 2010; Halliwill et al. 2013)

2010

Postexercise Hypotension: Central Mechanisms

Chao-Yin Chen¹ and Ann C. Bonham^{1,2}

¹Department of Pharmacology, University of California, Davis, CA, USA

²Department of Internal Medicine, University of California, Davis, CA, USA

INPUT
(músculos
aferentes)



Núcleo **T**rato **S**olitário
(Reset da via
Barorreflexa)

**Central: Após o
Exercício**



OUTPUT simpático
(do centro de controle
cardiovascular na medula)

Central: Após o Exercício

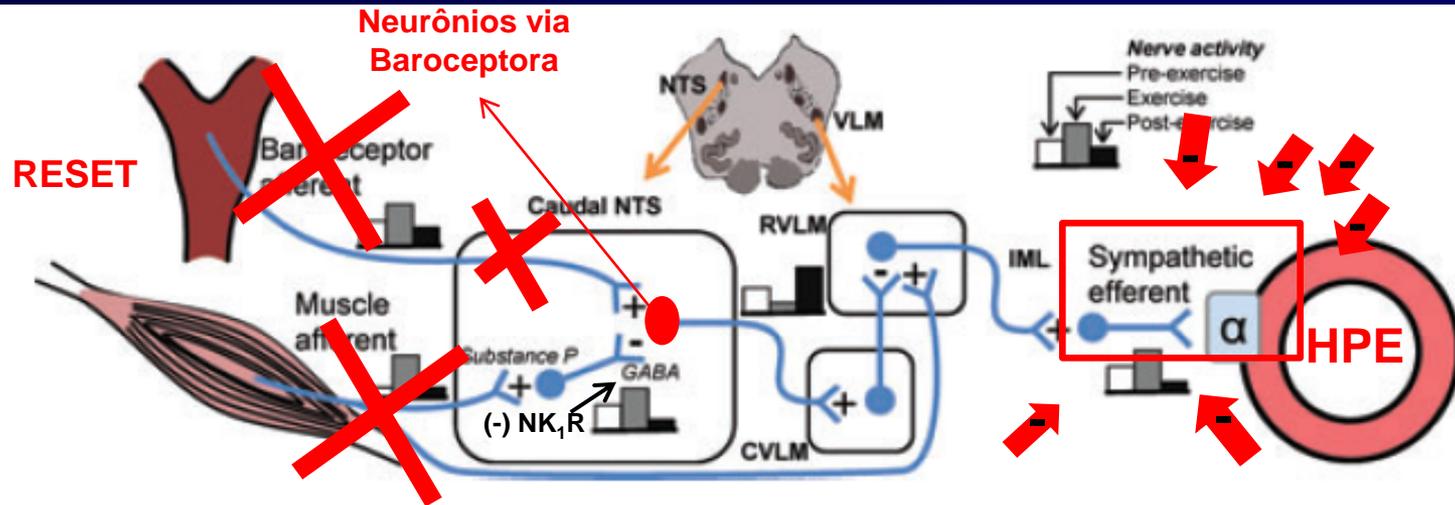
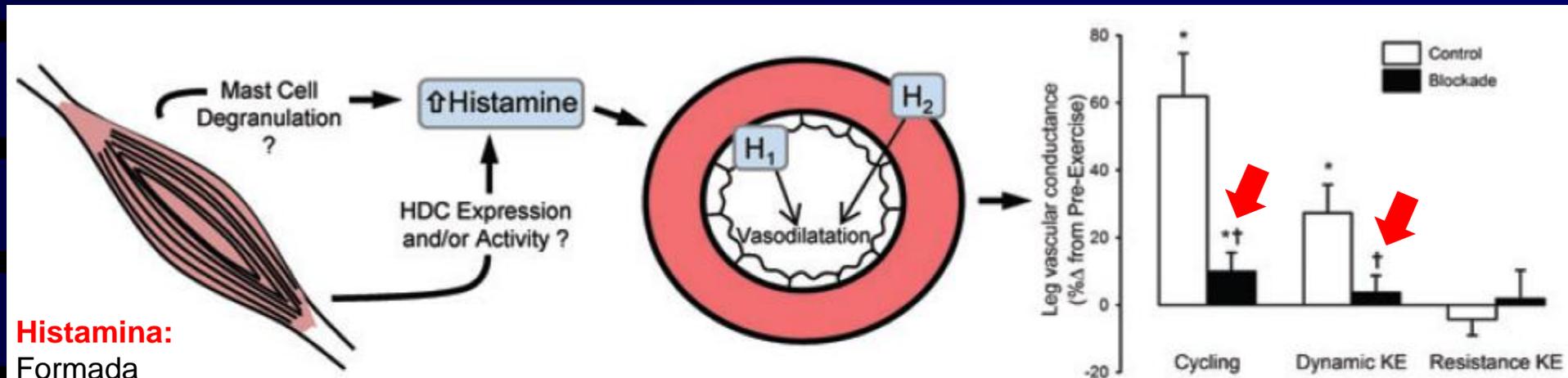


Figure 1. Pathways for baroreflex resetting during postexercise hypotension

During exercise, muscle afferents stimulate GABAergic interneurons within the caudal nucleus tractus solitarii (NTS), which reduces the firing of second order barosensitive neurons which convey information from baroreceptor afferents to the caudal ventrolateral medulla (CVLM). This results in less inhibition of sympathetic neurons in the rostral ventrolateral medulla (RVLM) and greater firing of sympathetic vasoconstrictor neurons during exercise. **During postexercise hypotension, the GABAergic interneurons exert less inhibitory influence on the second order barosensitive neurons, due to internalization of the neurokinin-1 receptor, which is a result of substance P release from muscle afferent stimulation during exercise. This results in greater inhibition of sympathetic neurons.** Note that there is also a more direct link from muscle afferents to the RVLM, but this does not appear to play a role in the postexercise responses. In the figure, the relative changes in nerve activity pre-exercise, during exercise and postexercise are illustrated by the inset bar graphs for various points in the pathway. Abbreviations: IML, intermediolateral column; and VLM, ventrolateral medulla.

Periférico: Após o Exercício

- **Imediata:** Hiperemia reativa (até 20min) / dose-dependente;
- **Persistente:** Substâncias vasoativas (2h) / dose-dependente;
- NO parece que contribui pouco em humanos (Halliwill et al., 2000).



Histamina:
Formada nos mastócitos e por estresse de cisalhamento em grandes vasos.

Figure 2. Pathways for histaminergic component of sustained postexercise vasodilatation. Histamine, perhaps from mast cell degranulation or *de novo* production by histidine decarboxylase (HDC), stimulates histamine H₁ receptors on endothelium and H₂ receptors on smooth muscle in the skeletal muscle microcirculation. This leads to a sustained postexercise vasodilatation of the previously exercised muscle. As shown in the right panel, modified from Barrett-O'Keefe et al. (2012), cycling and single-leg dynamic knee extension, but not single-leg resistance knee extension, evoke histaminergic vasodilatation that is robust at 60 min after exercise. Open bars, control; filled bars, blockade. **P* < 0.05 versus pre-exercise; †*P* < 0.05 versus control.

Periférico: Após o Exercício

Aging Clin Exp Res
DOI 10.1007/s40520-013-0017-x

2013

ORIGINAL ARTICLE

Exercise intensity modulates nitric oxide and blood pressure responses in hypertensive older women

Hugo A. P. Santana · Sérgio R. Moreira · Ricardo Y. Asano ·
Cláudio Córdova · Carmen S. G. Campbell · Foued S. Espino
Andrei C. Sposito · Otávio T. Nóbrega · Herbert G. Simões

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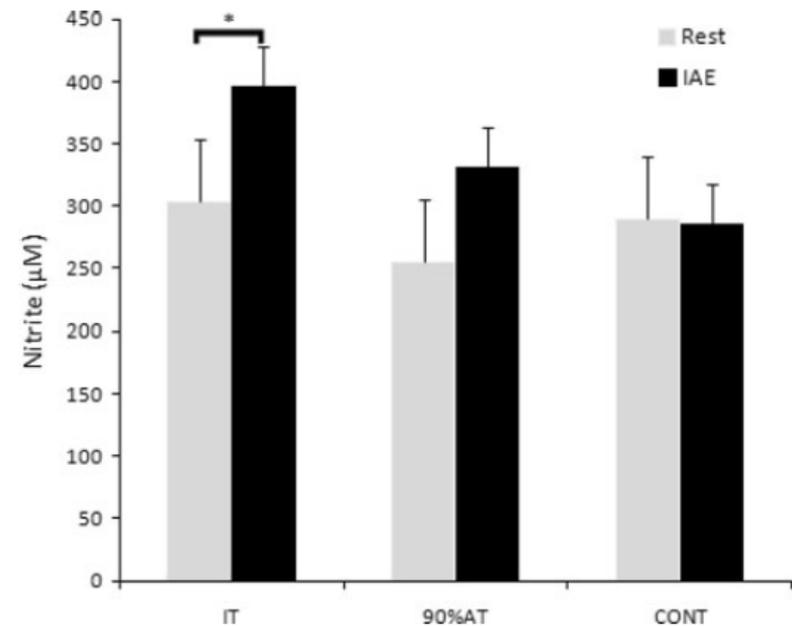


Fig. 1 Comparisons of nitrite values (mean \pm SE) between resting and immediately after sessions (IAE) of incremental test (IT), at 90 % of anaerobic threshold (90 % AT) and control (CONT). * $p < 0.05$ compared with rests ($n = 22$)

Mecanismos Integrados

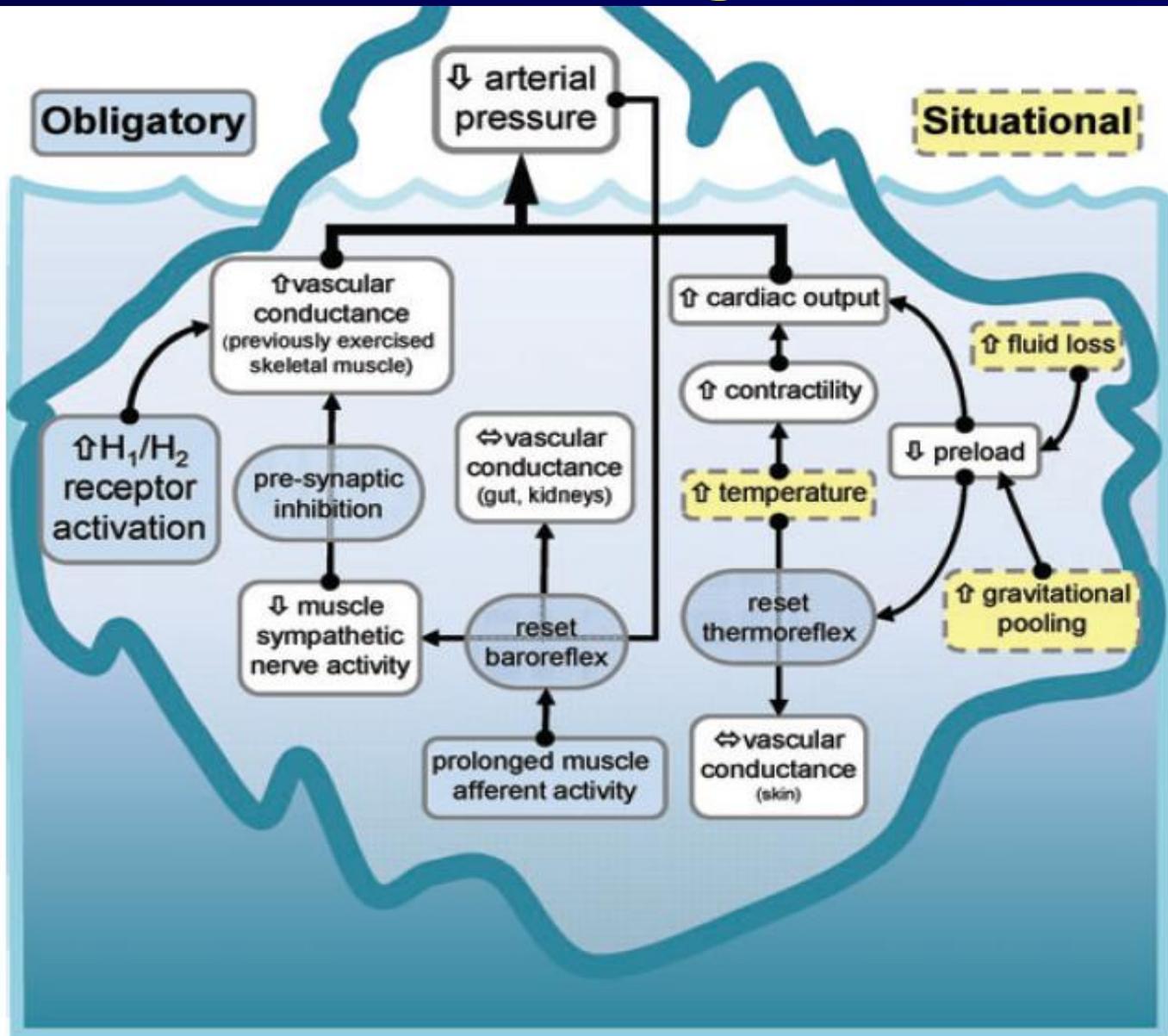


Figure 3. Integrated haemodynamic responses following exercise (Halliwill JR et al. 2013; Exp Physiol)

Mecanismos: O que sabemos hoje?

Table 2. Recent observations

Recent observations (circa 2012)

Previous understanding

Baroreflex is reset, but
mechanism is unknown

Local vasodilator mechanism
is unknown

Possible benefits include
alterations in fluid balance

New understanding

Skeletal muscle afferents
may play a primary role in
postexercise resetting of
the baroreflex

H₁ and H₂ receptors
contribute significantly

Possible benefits include
alterations in metabolism
and promotion of
angiogenesis

(Halliwill JR et al. 2013; Exp Physiol)

EFEITO CRÔNICO!

Exercise Training Increases Baroreceptor Gain Sensitivity in Normal and Hypertensive Rats

Patricia Chakur Brum, Gustavo José Justo Da Silva, Edson Dias Moreira, Fumio Ida, Carlos Eduardo Negrão, Eduardo Moacyr Krieger

Hypertension

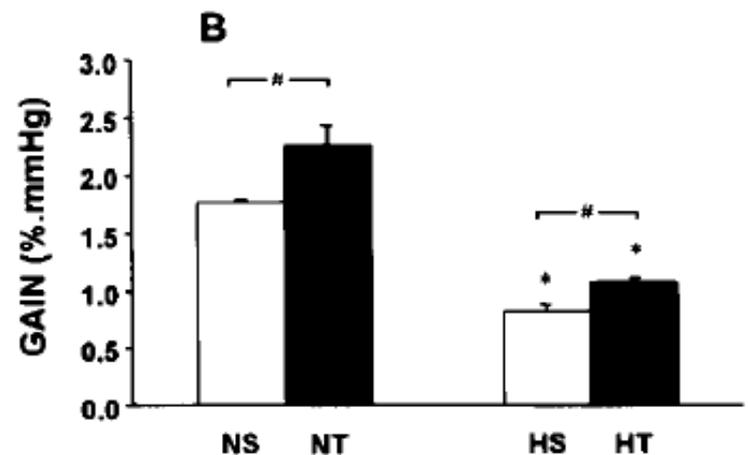
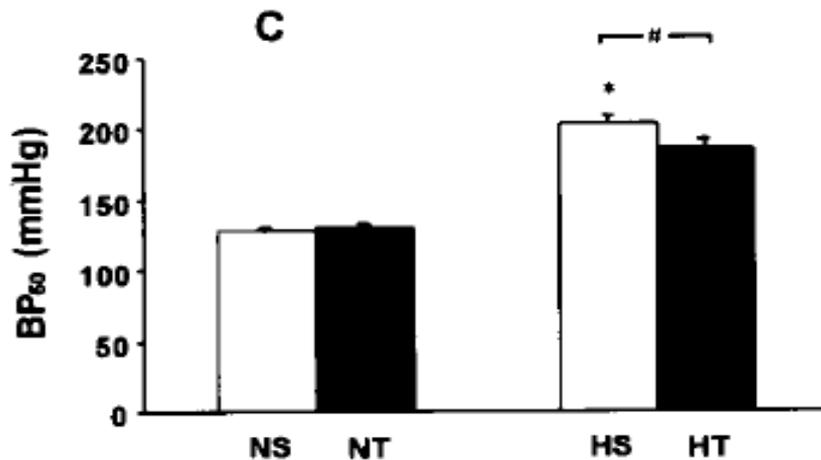
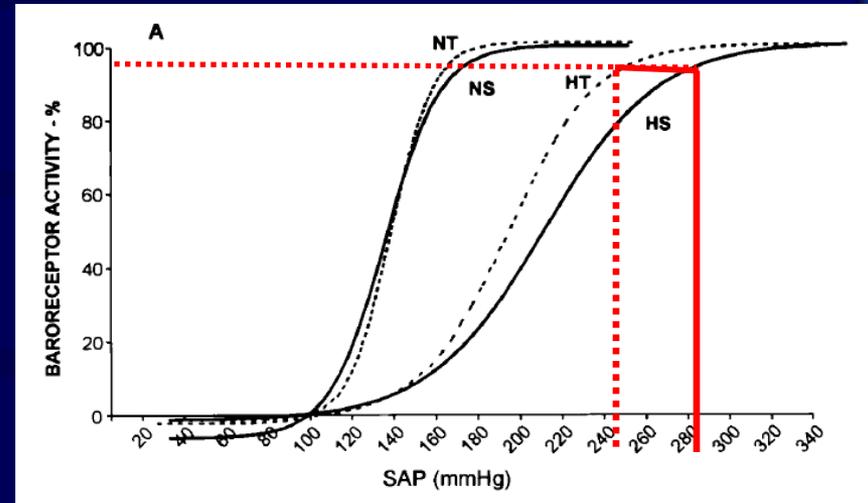
JOURNAL OF THE AMERICAN HEART ASSOCIATION

American Heart Association®



Learn and Live™

Treinamento Físico de baixa intensidade (5d/sem; 1h/dia) aumenta a sensibilidade baroreflexa em ratos.

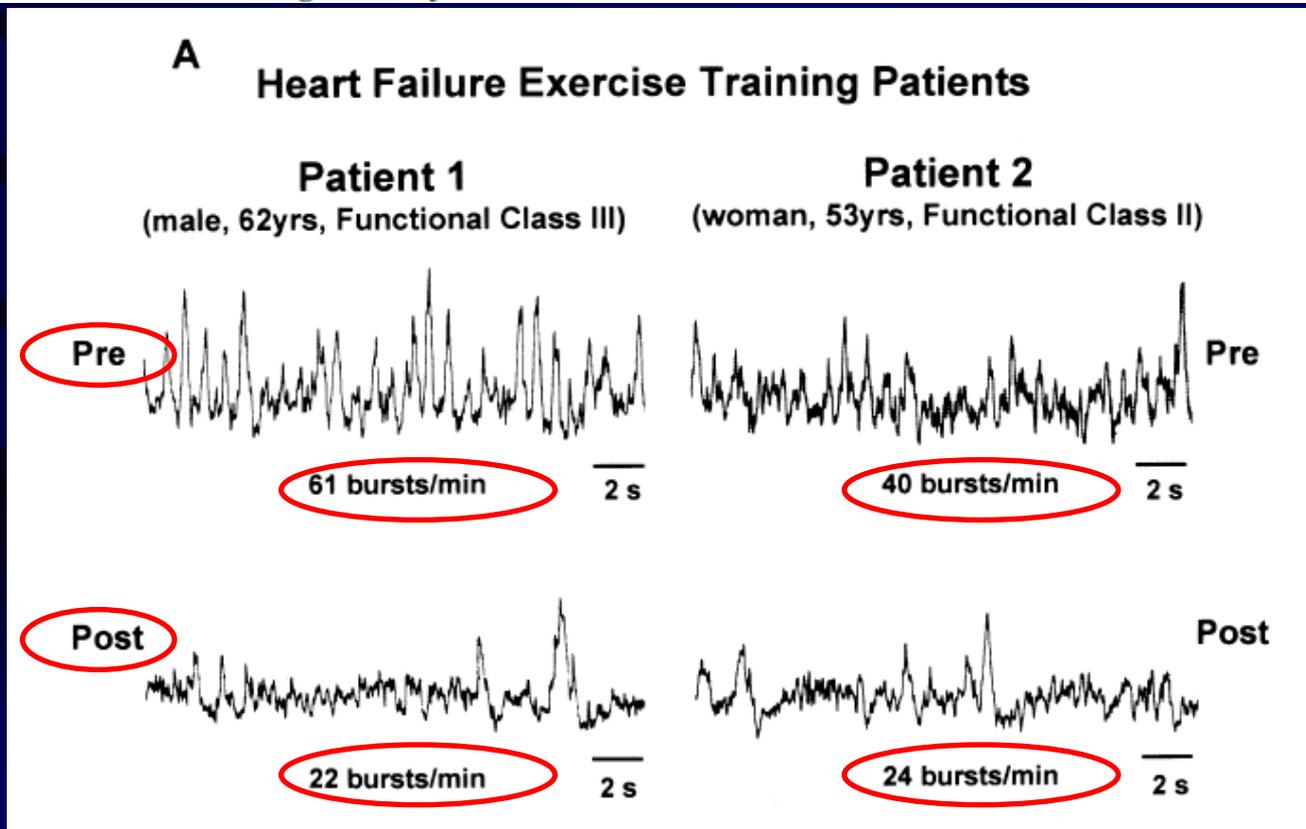


Exercise Training and Heart Failure

The Effects of Exercise Training on Sympathetic Neural Activation in Advanced Heart Failure

A Randomized Controlled Trial

Fabiana Roveda, MD, PhD,* Holly R. Middlekauff, MD,† Maria Urbana P. B. Rondon, PhD,* Soraya F. Reis, BS,* Márcio Souza, MS,‡ Luciano Nastari, MD,* Antonio Carlos P. Barretto, MD, PhD,* Eduardo M. Krieger, MD, PhD,* Carlos Eduardo Negrão, PhD*‡
São Paulo, Brazil; and Los Angeles, California



- 7 (GE)
- 9 (GC)
- 4 meses
- 3 sessões/sem
- 60min aeróbio
- 90% do PCR

Figure 1. Sympathetic neurograms. (A) Heart failure patients, exercise group. Pre-training, muscle sympathetic nerve activity (MSNA) is markedly elevated. Post-exercise training, sympathetic nerve activity levels are reduced. (B) Heart failure patients, sedentary group; MSNA levels are markedly elevated before and after the sedentary period.

Nitric Oxide Synthesis Blockade Increases Hypertrophy and Cardiac Fibrosis in Rats Submitted to Aerobic Training

Hugo Celso Dutra de Souza, Daniel Martins Dias Penteado, Marli Cardoso Martin-Pinge, Octávio Barbosa Neto, Vicente de Paula Antunes Teixeira, João Henrique Dutra Blanco, Valdo José Dias da Silva

Faculdade de Medicina de Ribeirão Preto, Universidade Estadual de Londrina, Faculdade de Medicina do Triângulo Mineiro - Ribeirão Preto, SP, Londrina, PR, Uberaba, MG - Brazil

Óxido Nítrico tem papel importante nas adaptações cardiovasculares promovidas pelo treinamento.



140 x 90

Algun tempo depois



120x80

CHRONIC CONVENTIONAL RESISTANCE EXERCISE REDUCES BLOOD PRESSURE IN STAGE 1 HYPERTENSIVE MEN

2011

MILTON R. MORAES,^{1,2} REURY F.P. BACURAU,³ DULCE E. CASARINI,⁴ ZAIRA P. JARA,⁴
FERNANDA A. RONCHI,⁴ SANDRO S. ALMEIDA,¹ ELISA M.S. HIGA,⁴ MARCOS A. PUDO,²
THIAGO S. ROSA,¹ ANDERSON S. HARO,¹ CARLOS C. BARROS,¹ JOÃO B. PESQUERO,¹
MARTIN WÜRTELE,¹ AND RONALDO C. ARAUJO¹

¹Department of Biophysics, Universidade Federal University of São Paulo, São Paulo, Brazil; ²School of Physical Education, University of Mogi das Cruzes, Mogi das Cruzes, São Paulo, Brazil; ³Department of Science, Universidade Estadual Paulista, São Paulo, Brazil; and ⁴Nephrology Division, Universidade Federal de São Paulo, São Paulo, Brazil

TABLE 1. Anthropometric parameters and blood pressure of the hypertensive volunteers pre- and posttraining.*

Variable anthropometric	Resistance exercise		p
	Pretraining	Posttraining	
Age, years	46 ± 3		
Body mass, kg	88 ± 6	87 ± 5	NS
BMI, kg·m ⁻²	29 ± 2	28 ± 1	NS
Fat-free mass, kg	61 ± 2	64 ± 3	0.005
Fat mass, kg	27 ± 2	23 ± 2	0.001
Body fat, %	30 ± 2	26 ± 2	0.001
Total body water, L	47 ± 2	48 ± 2	0.01
Σ Skinfold, mm	191 ± 14	153 ± 12	0.001
Total weightlifting, kg	140 ± 5	185 ± 11	0.001
Strength handgrip, kg·f ⁻¹	43 ± 2	48 ± 2	0.041
Sit-and-reach, cm	16 ± 2	22 ± 2	0.001
VO ₂ peak (ml·kg ⁻¹ ·min ⁻¹)	41 ± 3	44 ± 3	NS
Blood pressure, mm Hg			
Systolic	150 ± 3	134 ± 3	0.001
Diastolic	93 ± 2	81 ± 1	0.01
Mean	112 ± 2	99 ± 3	0.01

*BMI = body mass index; Σ = sum of 7 skinfold; NS = not significant.

- N= 15 hipertensos;
- Idade: 46±3 anos;
- Medicados a 6 anos;
- Interrupção/medicação;
- ER a 60% 1RM;
- 12 semanas (3x/sem);
- 1 mês destreinamento.

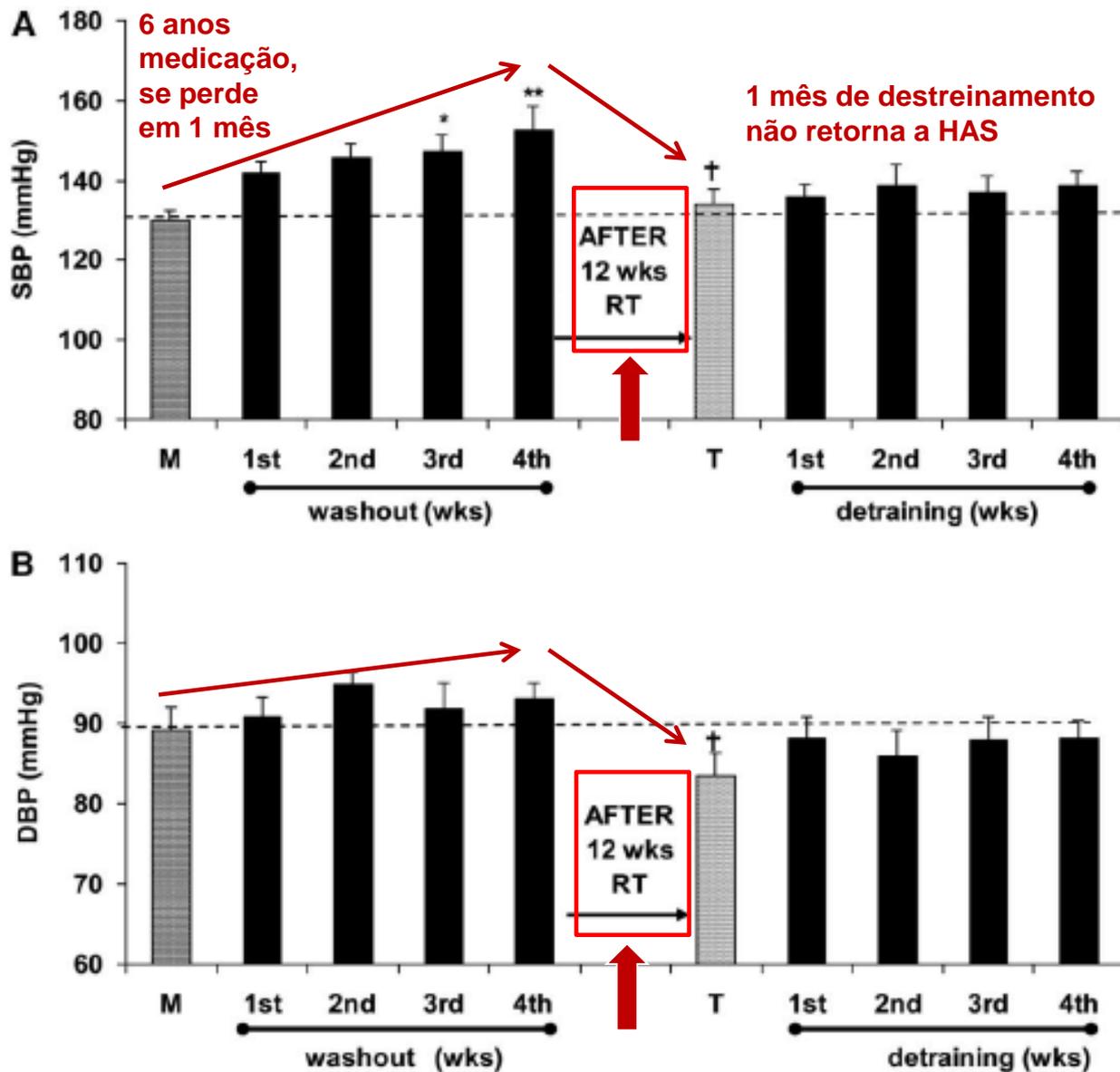


Figure 2. Blood pressure before and after 12 weeks of conventional resistance exercise. Systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP) of the volunteers ($n = 11$) before (M) the antihypertensive medication washout period, after the 12-week resistance exercise training period (T), and during the detraining period ($*p < 0.05$; $**p < 0.01$; $†p < 0.01$, related to last week of washout); wks = weeks; RT = resistance training.

(Moraes et al., 2011; JSCR)

É necessário as 12 semanas para ajustes na pressão arterial?

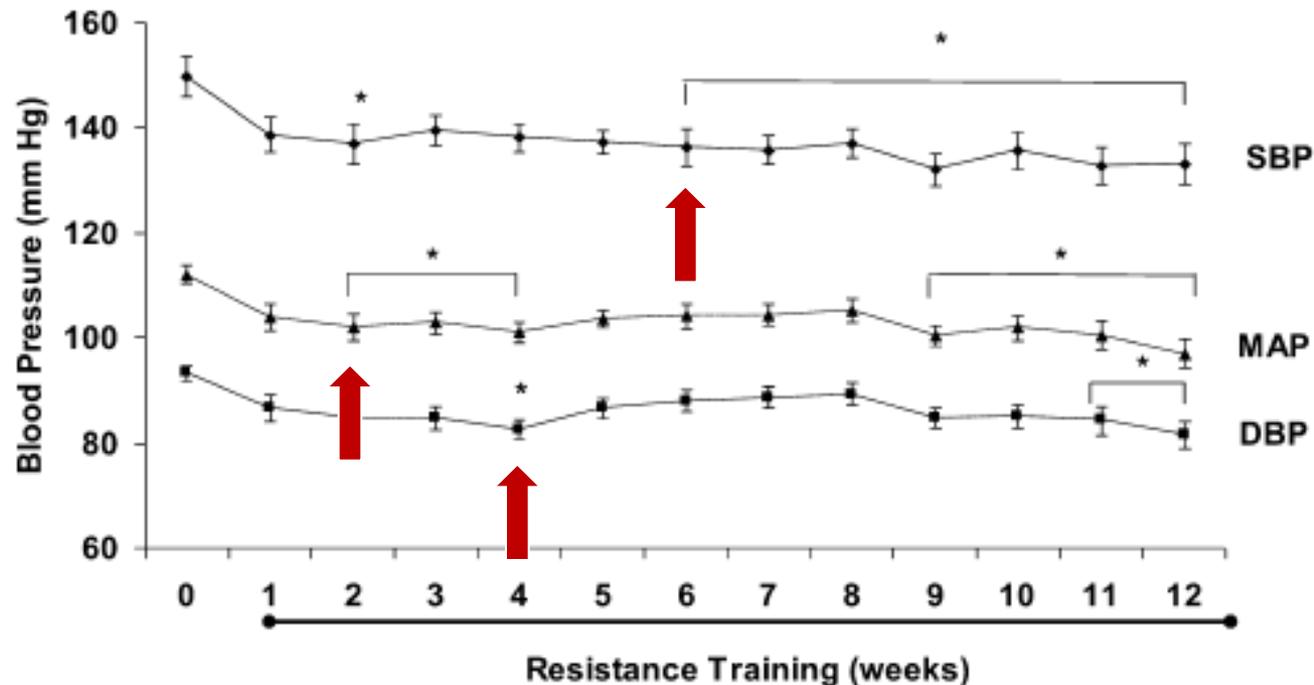


Figure 3. Blood pressure during 12 weeks of conventional resistance exercise (RE). Systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP) of the volunteers ($n = 15$) pretraining (0) and during the 12 weeks (1-12) of the RE training program ($*p < 0.05$).

**Sistematicamente,
o que a literatura
tem mostrado
sobre o
treinamento
crônico na PA?**

2013

Exercise Training for Blood Pressure: A Systematic Review and Meta-analysis

Veronique A. Cornelissen, PhD;

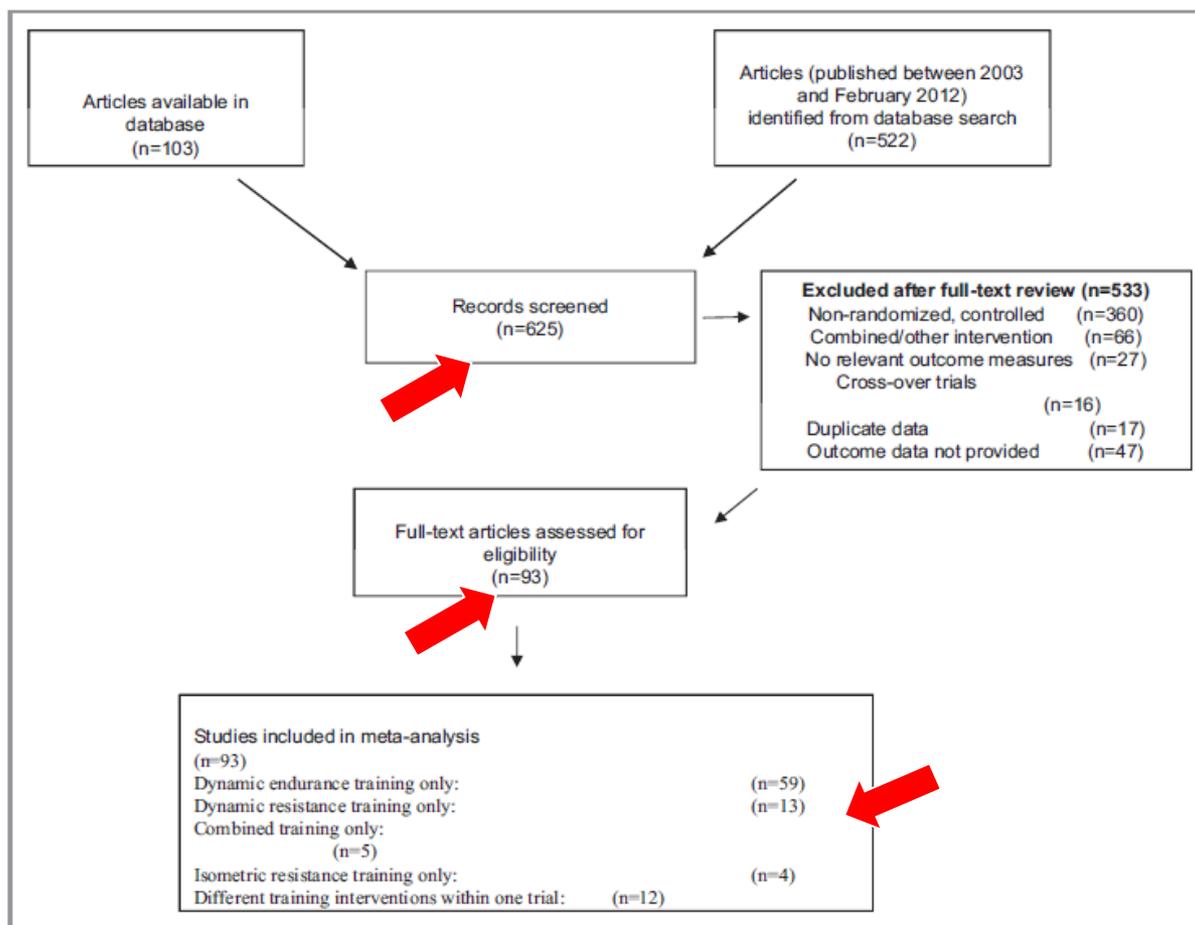


Figure 1. PRISMA flow diagram. PRISMA indicates preferred reporting items for systematic reviews and meta-analyses.

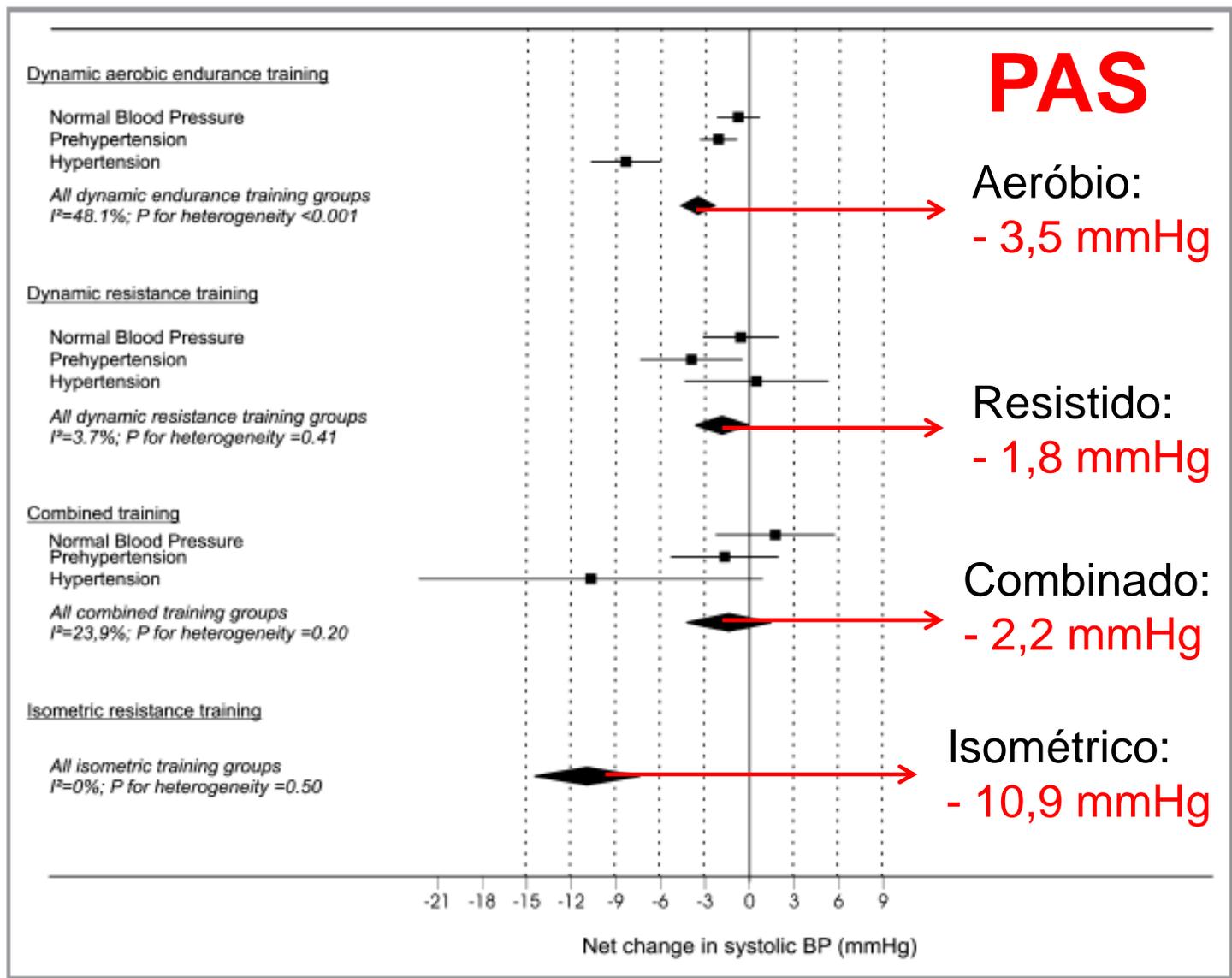


Figure 2. Net changes in systolic blood pressure (BP) after different exercise modalities using random-effects analyses. Data are net mean changes, adjusted for control data (95% confidence limits).

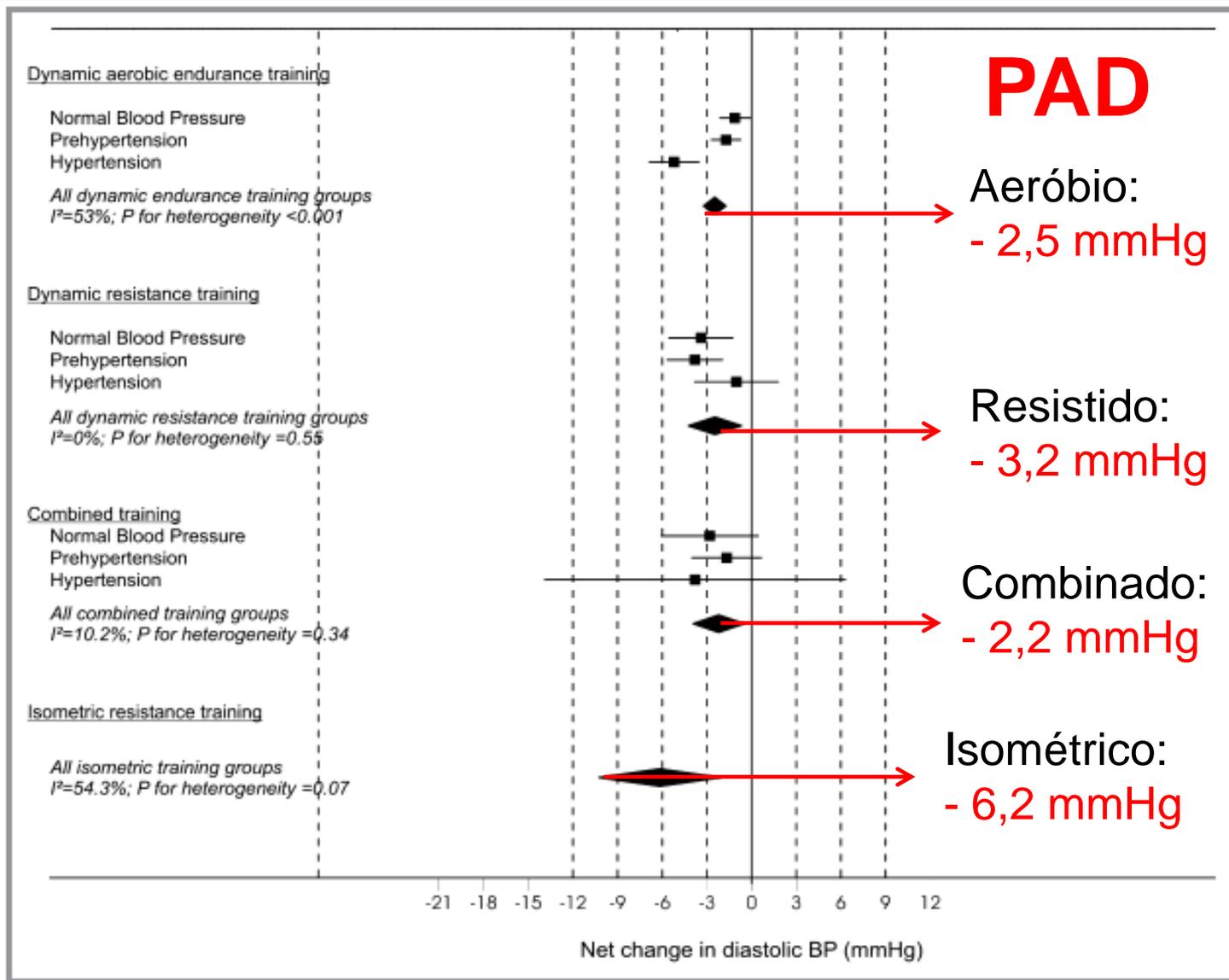
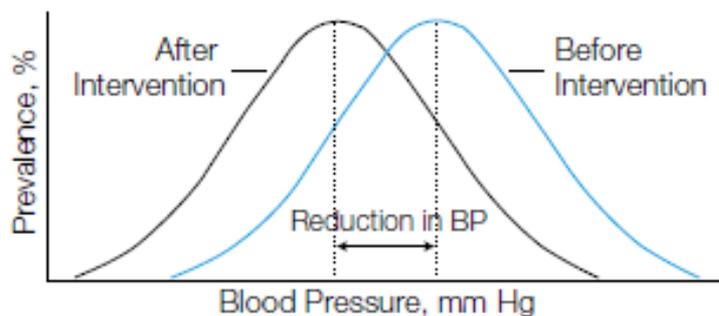


Figure 3. Net changes in diastolic blood pressure (BP) after different exercise modalities using random effects analyses. Data are net mean changes, adjusted for control data (95% confidence limits).

Figure. Systolic Blood Pressure Distributions



Reduction in BP, mm Hg	% Reduction in Mortality		
	Stroke	CHD	Total
→ 2	-6	-4	-3
→ 3	-8	-5	-4
→ 5	-14	-9	-7

BP indicates blood pressure; CHD, coronary heart disease. Adapted from *Arch Intern Med*,⁷ with additional data from Stamler.¹⁶

Reduções de 2 mmHg na PAD:

-14% no risco de AVC e isquemias;

-6% no risco de doença coronariana;

-17% na prevalência de HAS em população de 35-64 anos de idade.

Exercise Training for Blood Pressure: A Systematic Review and Meta-analysis

Veronique A. Cornelissen, PhD; Neil A. Smart, PhD

Dynamic endurance and combined training in SBP and DBP, and not similar across these 3 endurance training, were pronounced in male participants, but significant participants with normal after dynamic resistance training, reductions in SBP and DBP were largest in the study groups of prehypertensive participants. Moreover, the effects of endurance training, dynamic resistance training, and combined training on SBP and DBP in the individual with normal BP or prehypertension were similar, underlining the value of dynamic resistance training as an adjunct therapy for the prevention of high BP in these preclinical populations. Our results suggest endurance training might be superior to dynamic resistance training for hypertensive individuals, although it should be noted only 4 of

29 dynamic resistance study groups involved hypertensive patients. Therefore, until clearer evidence emerges, it may be prudent to prescribe endurance training rather than dynamic resistance training for the hypertensive individual if lower BP is desired.

Our findings further demonstrate that isometric handgrip training and isometric leg training result in larger reductions in SBP and a trend toward lower DBP compared with the 3 other exercise modalities, but the paucity of studies to date limits the strength of this conclusion. As stated earlier, there is no between-trial heterogeneity among the 5 isometric training groups,⁸ and lack of significant publication bias suggests the findings are robust, although generalizability of the results might be premature as data were available from only 4 trials (5 study groups).

(Cornelissen & Smart; American Heart Association, 2013)

Aplicação Prática

Efeito redutor crônico do AERÓBIO na PA

- 1) Independente de idade os efeitos ocorrem;
- 2) Quanto maior o estado hipertensivo melhor o efeito;
- 3) Tempo de intervenção entre <12 a 24 semanas. Acima procurar modificar importantemente o estímulo;
- 4) Intensidade de moderada a alta;
- 5) Duração da sessão entre 30 a 45 min;
- 6) Volume semanal entre <150 a 210 min.

(Cornelissen & Smart; American Heart Association, 2013)

Aplicação Prática

Efeito redutor crônico do RESISTIDO na PA

- 1) Mais velhos (≥ 50 anos) melhores são os efeitos;
- 2) Em pré-hipertensos os efeitos são melhores;
- 3) Tempo de intervenção entre <12 a 24 semanas;
- 4) Acima de 24 semanas procurar modificar os estímulos importantemente;
- 5) Sem diferenças na intensidade, com tendência de baixa a moderada parecer melhor.

The Anti-Hypertensive Effects of Exercise

Integrating Acute and Chronic Mechanisms

Mark Hamer

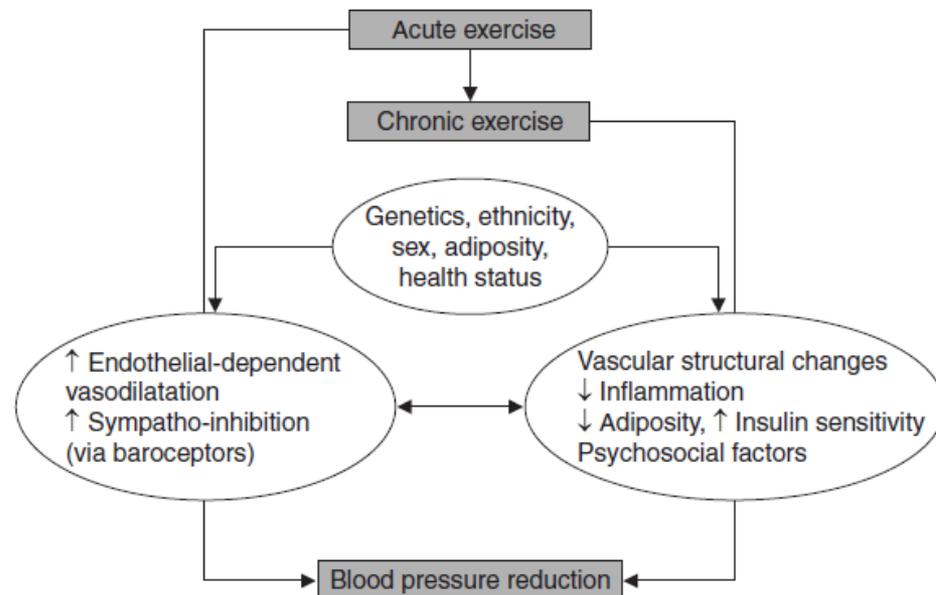


Fig. 1. The integration of acute and chronic anti-hypertensive mechanisms of exercise. ↓ indicates decrease; ↑ indicates increase.

**A hipotensão pós-
exercício tem alguma
relação com o efeito
crônico do treinamento?**

Blood Pressure Responses to Acute and Chronic Exercise Are Related in Prehypertension

2012

SAM LIU¹, JACK GOODMAN¹, ROBERT NOLAN², SHAWN LACOMBE¹, and SCOTT G. THOMAS¹

¹Graduate Department of Exercise Sciences, Faculty of Kinesiology and Physical Education, University of Toronto, Toronto, Ontario, CANADA; and ²Behavioral Cardiology Research Unit, University Health Network, Toronto, Ontario, CANADA

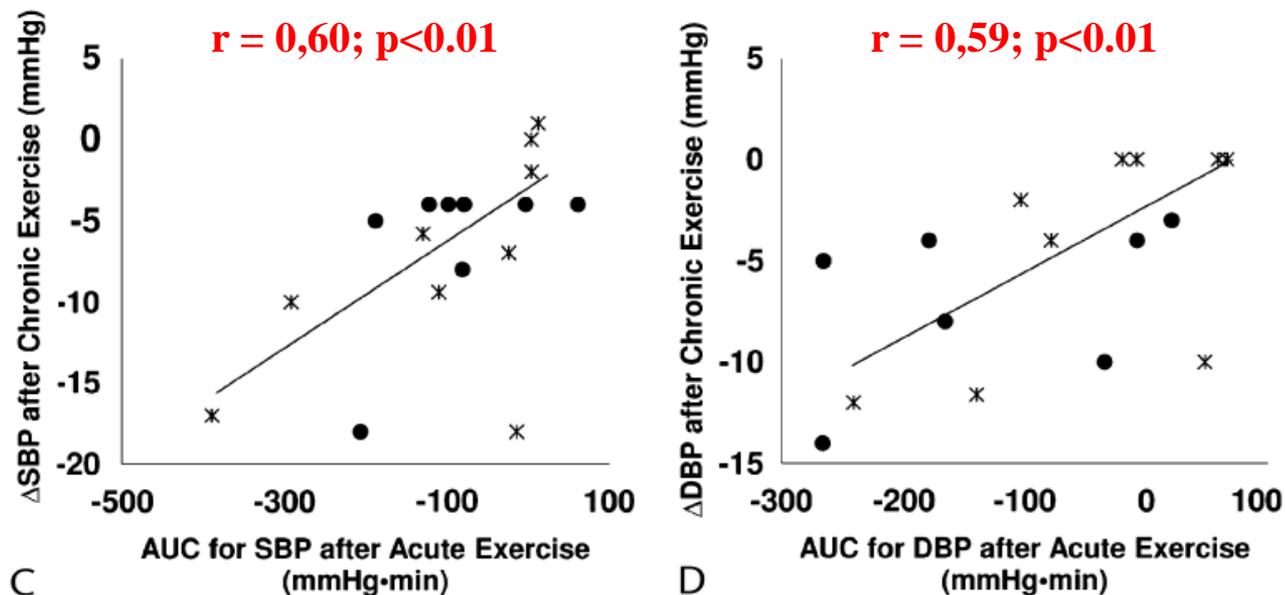


FIGURE 2—A. The magnitude of change (Δ) in SBP after acute exercise was significantly correlated with the magnitude of change (Δ) in resting SBP after chronic training ($r = 0.89, P < 0.01; 1.1 \pm 0.14 (B \pm SE), P < 0.01; \text{adjusted } r^2 = 0.78, P < 0.001$). Males: $r = 0.83, P < 0.01; 0.53 \pm 0.24 (B \pm SE), P < 0.001; \text{adjusted } r^2 = 0.82 (P < 0.01)$. Females: $r = 0.90, P < 0.01; 0.82 \pm 0.15 (B \pm SE), P < 0.001; \text{adjusted } r^2 = 0.78 (P < 0.001)$. B. Significant correlation between Δ DBP after acute exercise and resting Δ DBP after chronic training ($r = 0.75, P < 0.01; 0.722 \pm 0.19 (B \pm SE), P < 0.01; \text{adjusted } r^2 = 0.58, P < 0.001$). Males: $r = 0.77, P < 0.01; 0.75 \pm 0.29 (B \pm SE), P = 0.09$. Females: $r = 0.87, P < 0.01; 0.85 \pm 0.266 (B \pm SE), P < 0.01; \text{adjusted } r^2 = 0.79, P < 0.01$. C. The AUC for SBP after acute exercise was significantly correlated with Δ SBP after chronic training ($r = 0.60, P < 0.01; 0.60 \pm 0.10 (B \pm SE), P < 0.01; \text{adjusted } r^2 = 0.32, P < 0.01$). Males: $r = 0.57, P > 0.05$. Females: $r = 0.60, P > 0.05$. D. The AUC for DBP after acute exercise was significantly correlated with Δ DBP after chronic training ($r = 0.59, P < 0.01; 0.60 \pm 0.11 (B \pm SE), P < 0.001; \text{adjusted } r^2 = 0.31, P < 0.05$). Males: $r = 0.61, P > 0.05$. Females: $r = 0.62, P > 0.05$. The linear regressions are adjusted for baseline BMI.

Correlation between Acute and Chronic 24-Hour Blood Pressure Response to Resistance Training in Adult Women

2014

Authors

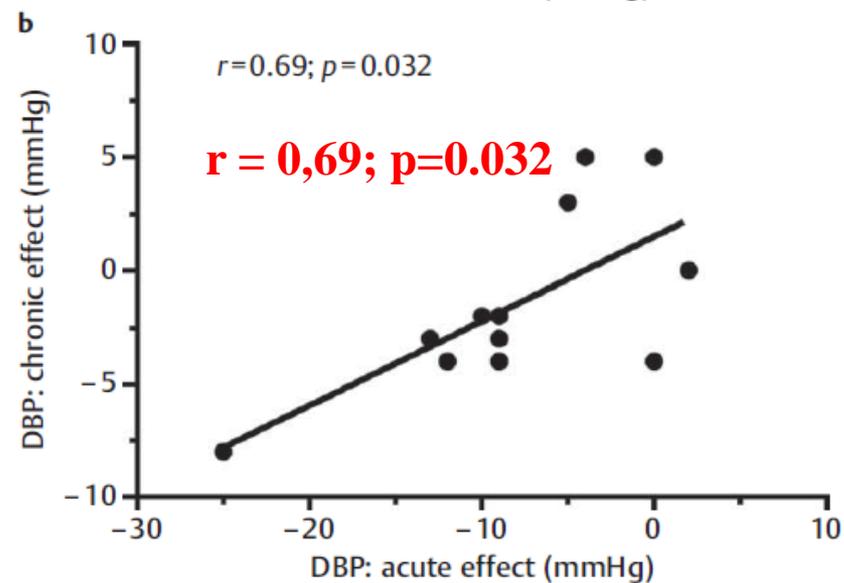
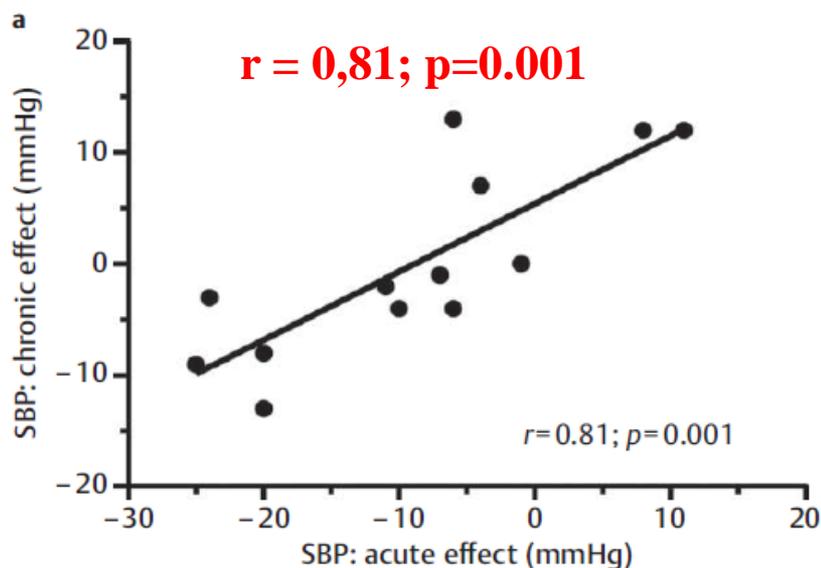
R. A. Tibana¹, N. M. F. de Sousa², D. da Cunha Nascimento¹, G. B. Pereira³, S. G. Thomas⁴, S. Balsamo⁵, H. G. Simoes⁶, J. Prestes⁷

Fig. 3 Correlation between the magnitudes of change in chronic exercise training and the lowest values after acute exercise for systolic (SBP; a) and diastolic blood pressure (DBP; b).

Journal of Strength and Conditioning Research

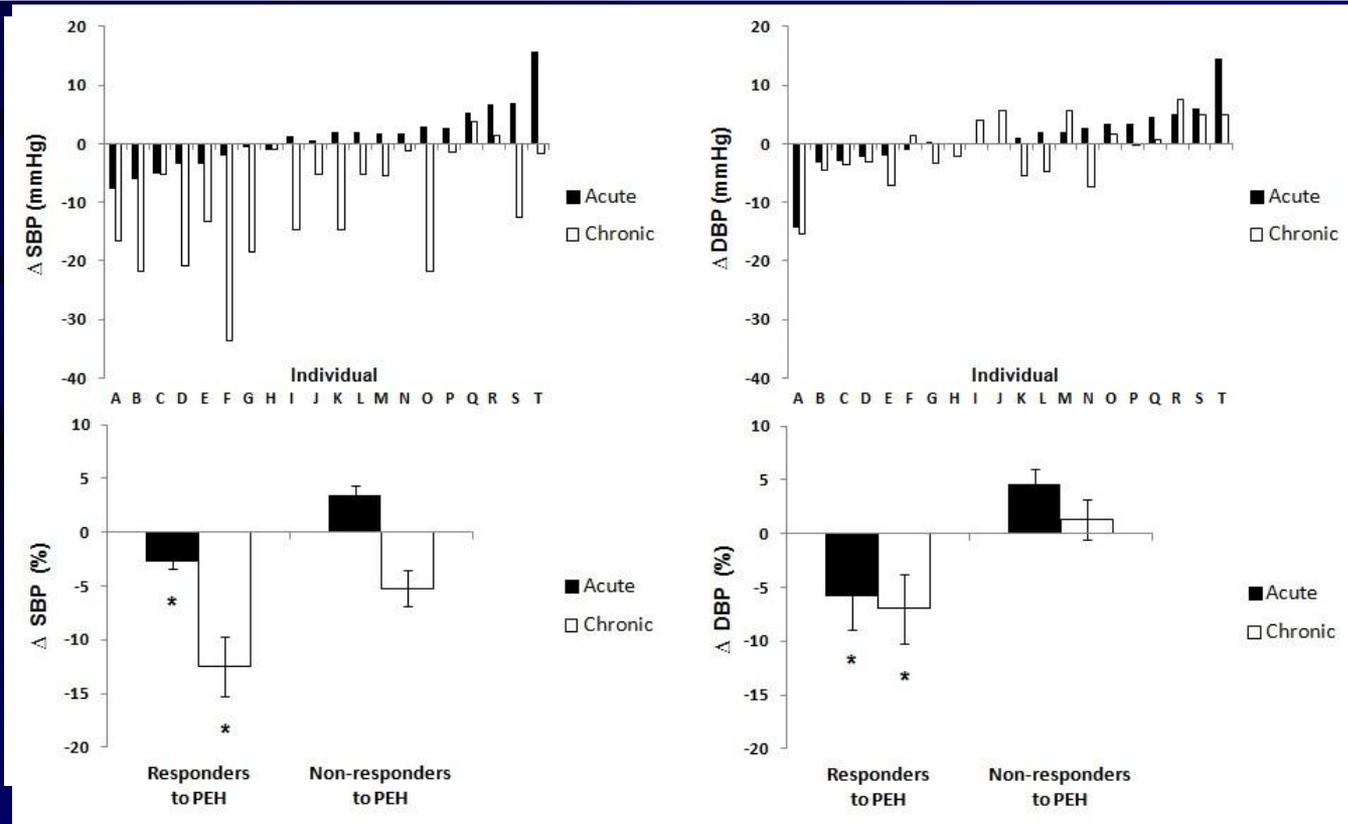
ACUTE BLOOD PRESSURE CHANGES ARE RELATED TO CHRONIC EFFECTS OF RESISTANCE EXERCISE IN HYPERTENSIVES

--Manuscript Draft--

Sérgio Rodrigues Moreira¹; Gabriel Grizzo Cucato²; Denize Faria Terra³; Scott G.

Thomas⁴; Raphael Mendes Ritti-Dias⁵.

Em revisão, 2014-2015



* $p < 0.05$ to PEH Non-responders in the same condition (Acute or Chronic)

**Qual a aplicação
clínica da
Hipotensão pós-
exercício?**

original
article

2014 BJPT Brazilian Journal of
Physical Therapy

Combined exercise circuit session acutely attenuates stress-induced blood pressure reactivity in healthy adults

Sérgio R. Moreira¹, Ricardo M. Lima², Karina E. S. Silva³,
Herbert G. Simões⁴

- N = 20 homens, aparentemente saudáveis;
- Exercício combinado 35min;
- Sessão controle;
- Aeróbio PSE =13 – 15min; Resistido 50%1RM – 20min;
- HPE e reatividade vascular de PA.

(Moreira SR et al, 2014; Braz J Fisiot)

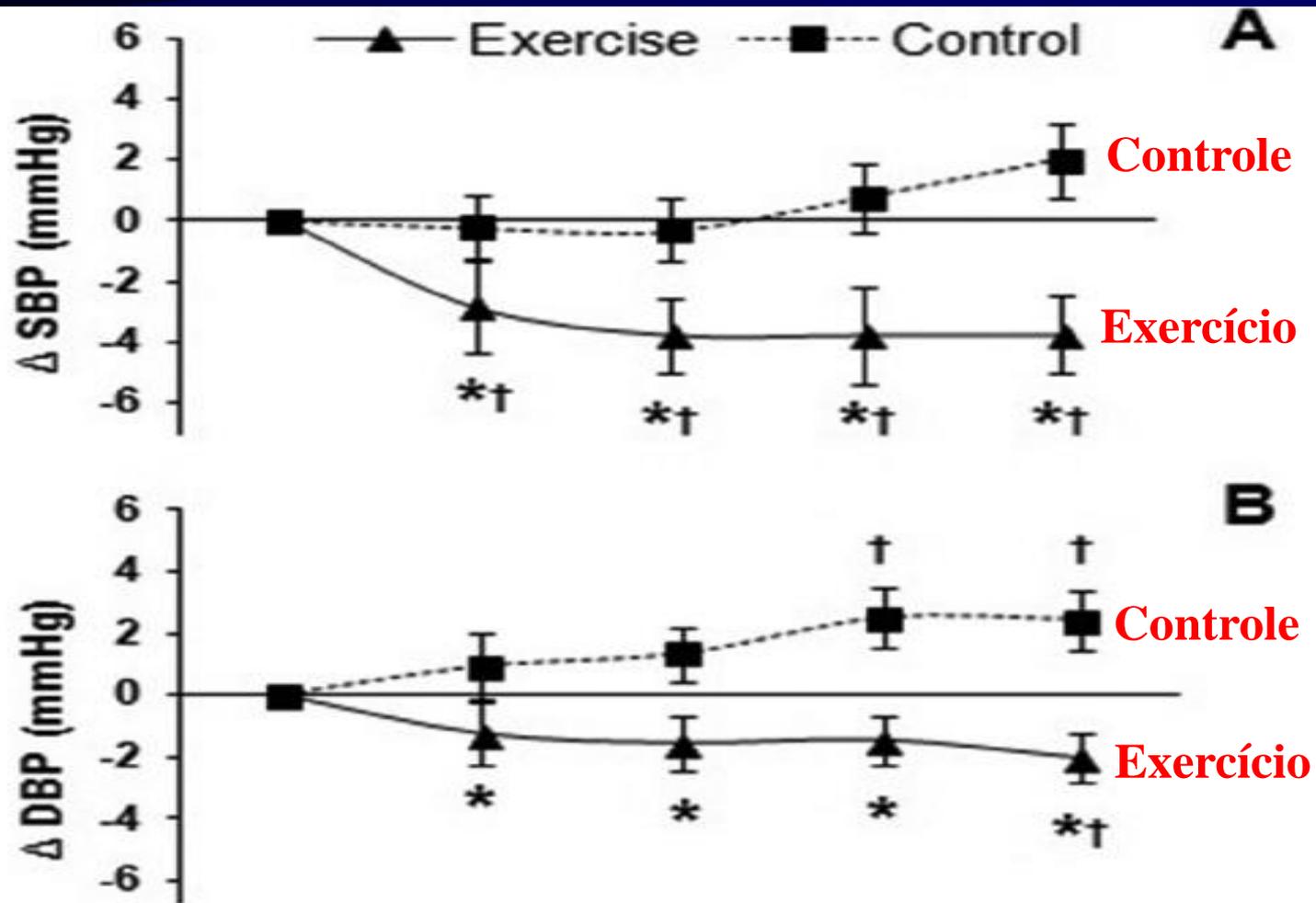


Figure 1. Range (mmHg) of systolic blood pressure (Δ SBP), diastolic blood pressure (Δ DBP), mean arterial pressure (Δ MAP), and heart rate (Δ HR) in the post-exercise session recovery moments (Rec15'-Rec60'). * $p < 0.03$ compared to Control session; † $p < 0.03$ compared to Rest.

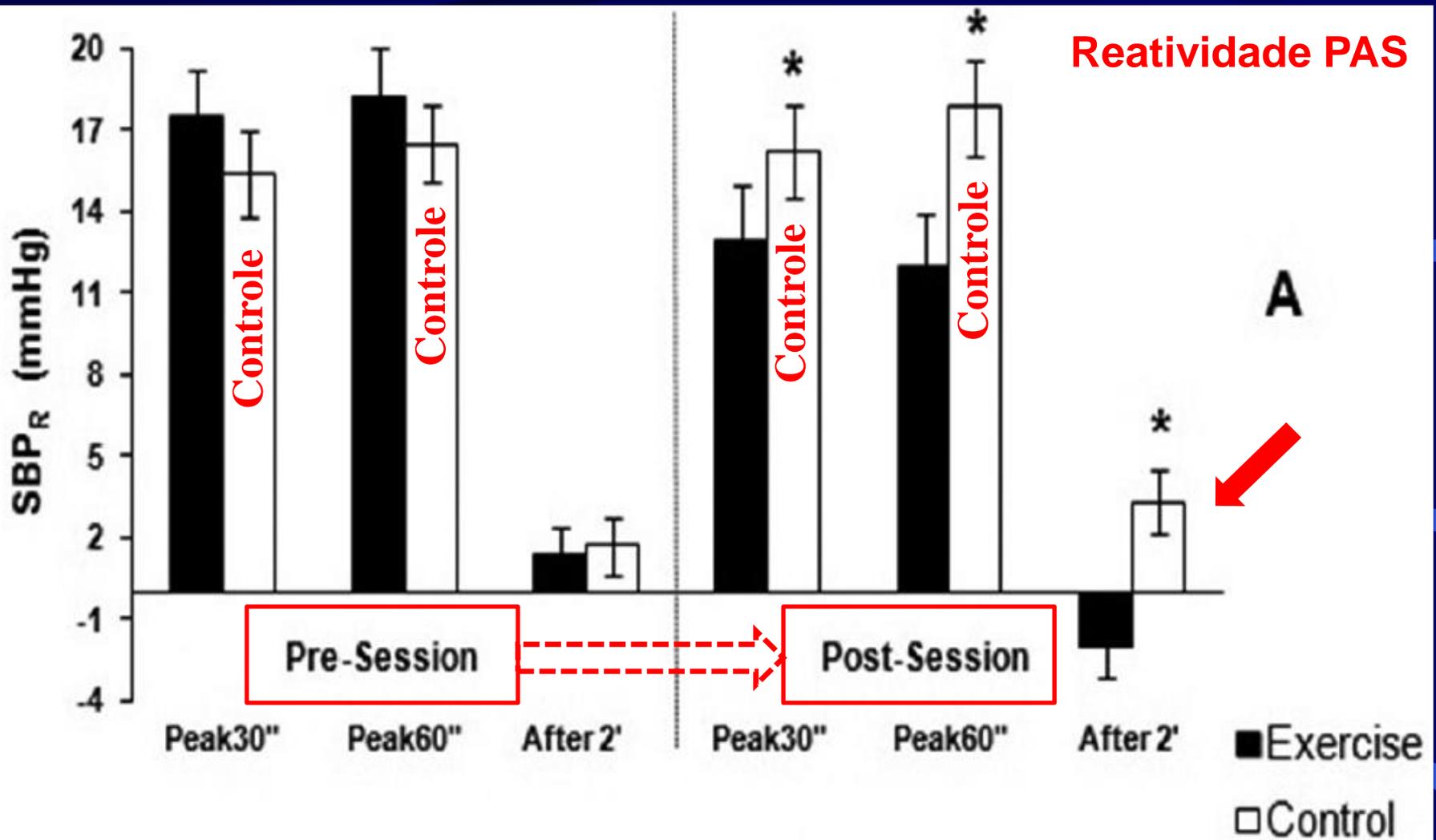


Figure 2. Range (Δ mmHg) of systolic blood pressure reactivity (SBP_R) and diastolic blood pressure reactivity (DBP_R) during (Peak30'' and Peak60'') and after (After2') the Cold Pressor Test in the pre-exercise session (Pre-Session) and post-exercise session (Post-Session) moments. *p<0.01 compared to exercise session.

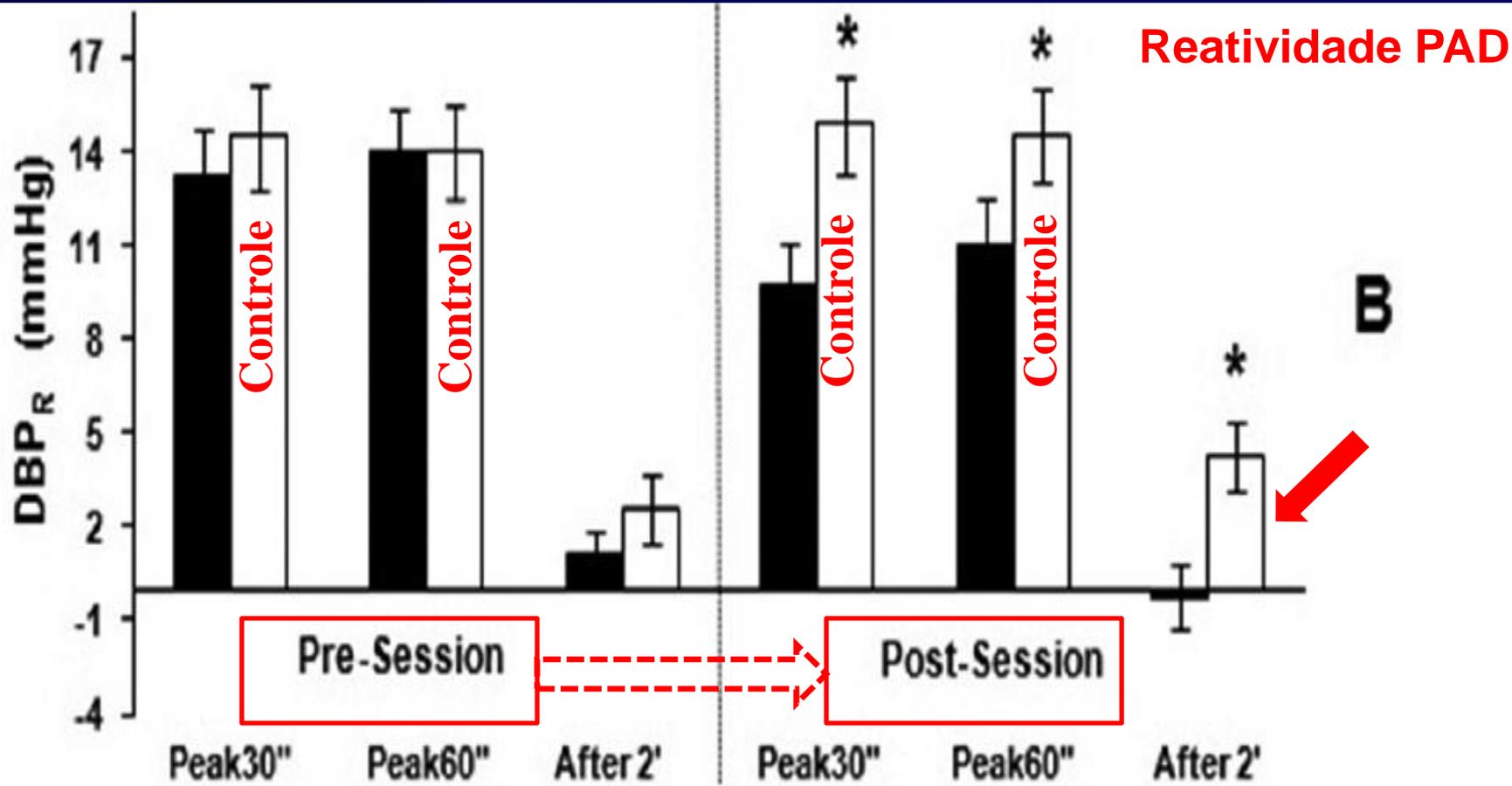
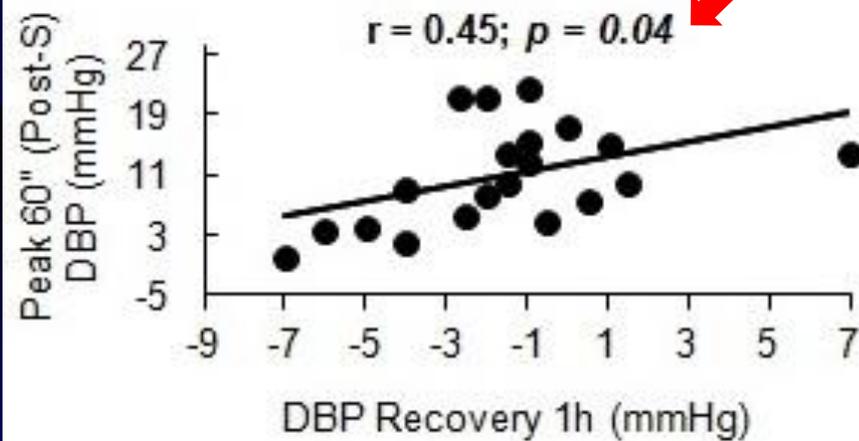
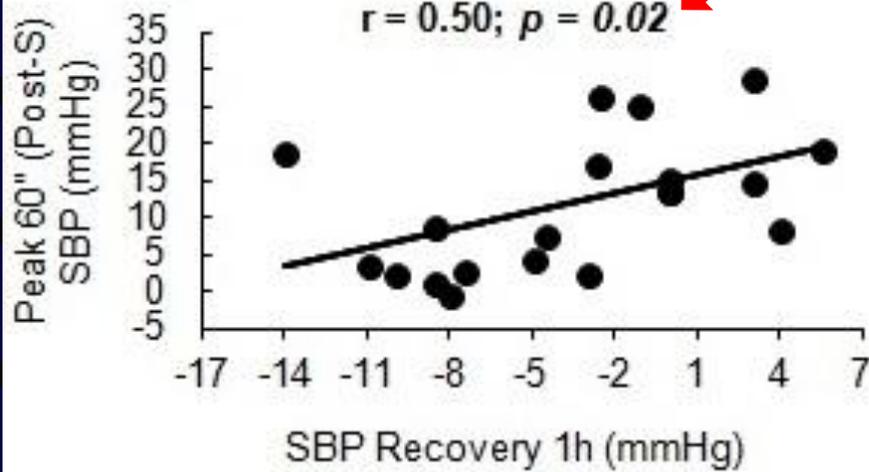
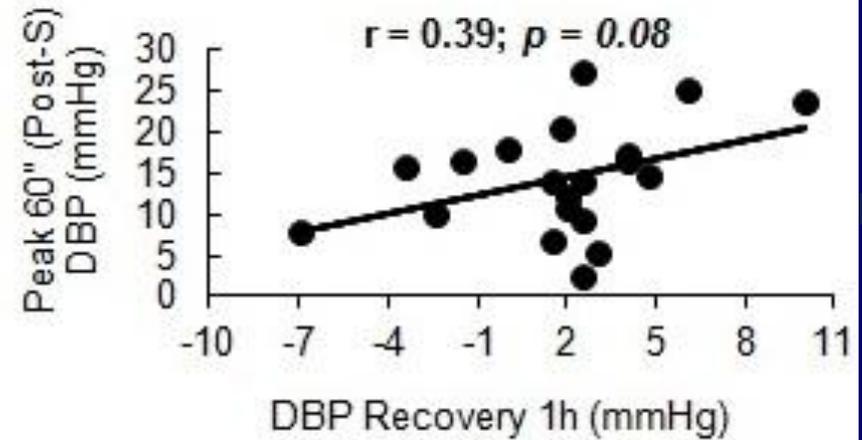
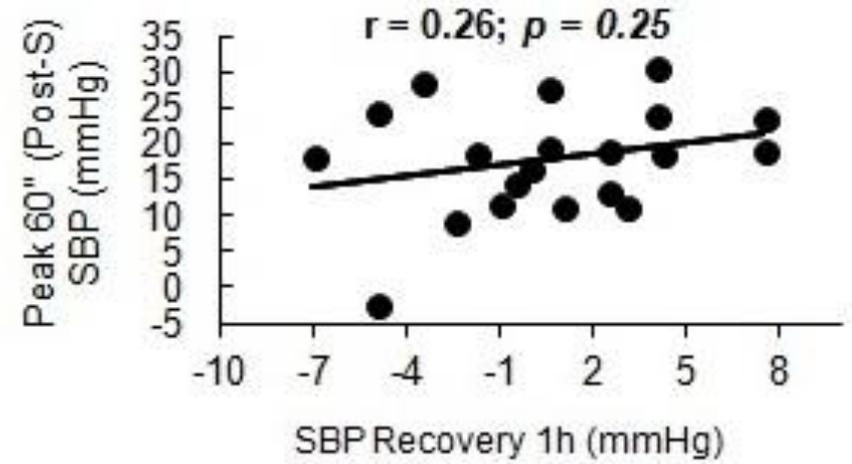


Figure 2. Range (Δ mmHg) of systolic blood pressure reactivity (SBP_R) and diastolic blood pressure reactivity (DBP_R) during (Peak30'' and Peak60'') and after (After2') the Cold Pressor Test in the pre-exercise session (Pre-Session) and post-exercise session (Post-Session) moments. * $p < 0.01$ compared to exercise session.

Exercise



Control



Exercise lowers blood pressure in university professors during subsequent teaching and sleeping hours

This article was published in the following Dove Press journal:
International Journal of General Medicine
18 October 2011
[Number of times this article has been viewed](#)

- Exercício Aeróbio
- 80-85% FC reserva
- 30 minutos
- Sessão Controle

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Carmen S Grubert
Campbell¹
Gisele Mendes¹
Gisela Arsa^{1,3}
Sérgio R Moreira²
Francisco M da Silva¹
Jonato Prestes¹
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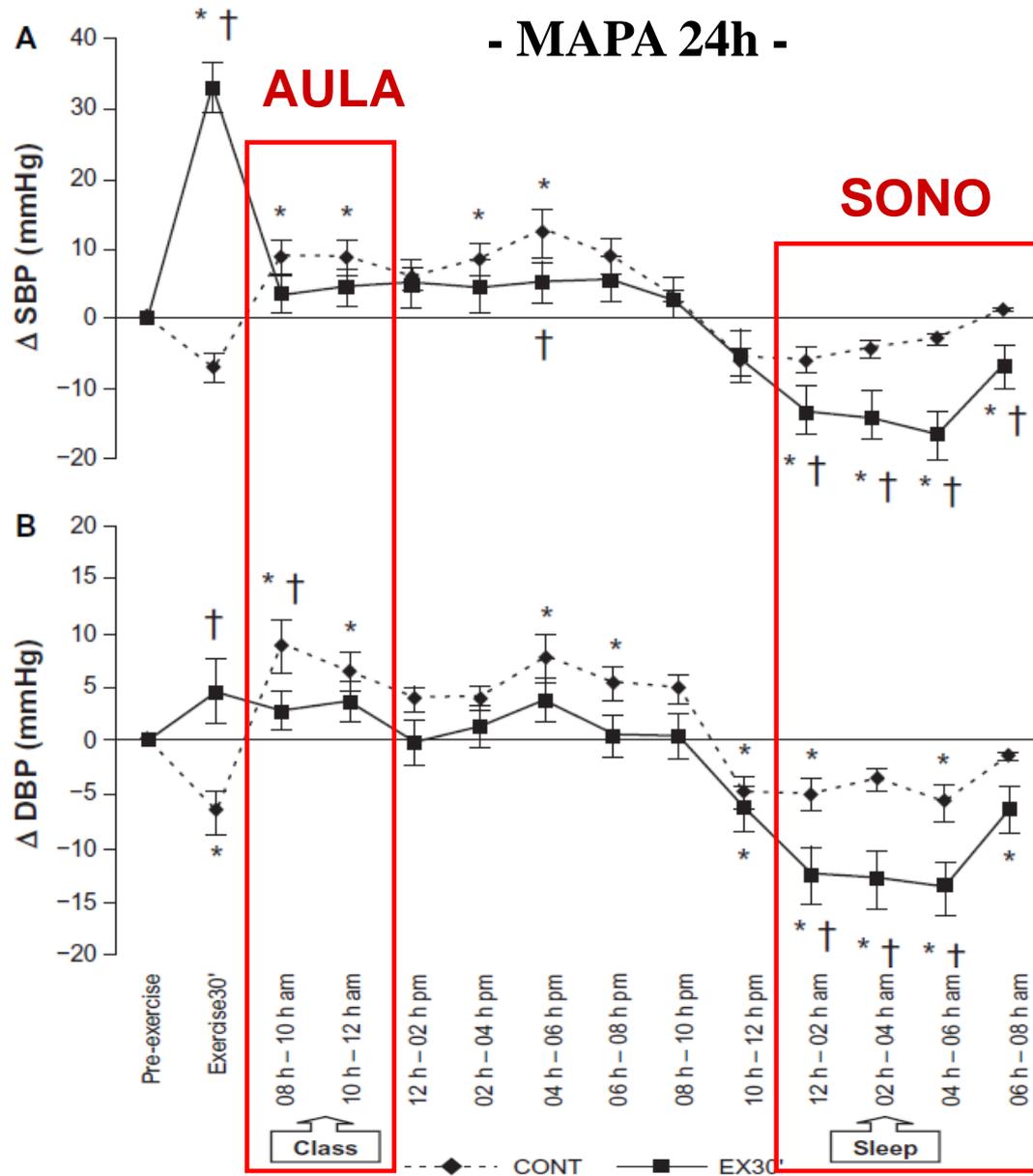


Figure 1 Change (Δ) in systolic blood pressure (A), diastolic blood pressure (B) and mean arterial pressure (C) during the 24 hours following exercise (EX30) and control (CONT) sessions.

Note: * $P < 0.05$ compared with rest (pre-exercise); † $P < 0.05$ compared with CONT session.

Abbreviations: SBP, systolic blood pressure; DBP, diastolic blood pressure; MAP, mean arterial pressure.

Dissertação a ser defendida em 06/08/2014!

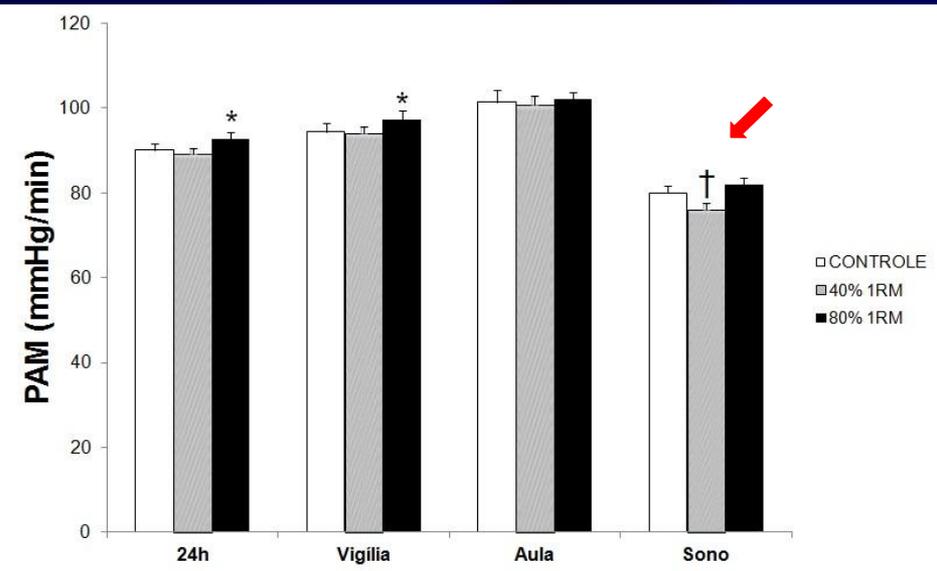


**UNIVERSIDADE FEDERAL DO VALE DO SÃO FRANCISCO
PROGRAMA DE PÓS-GRADUAÇÃO CIÊNCIAS DA SAÚDE E
BIOLÓGICAS**

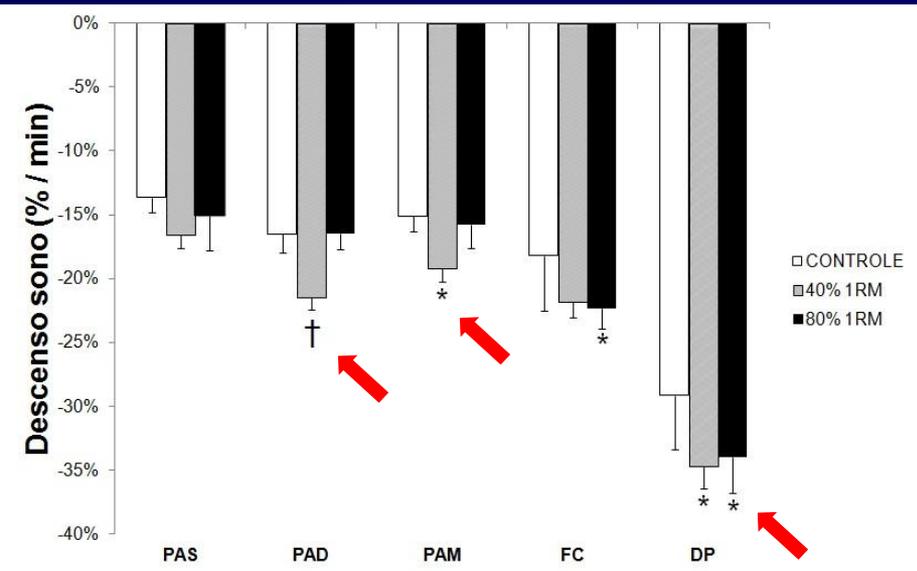
Alfredo Anderson Teixeira de Araujo



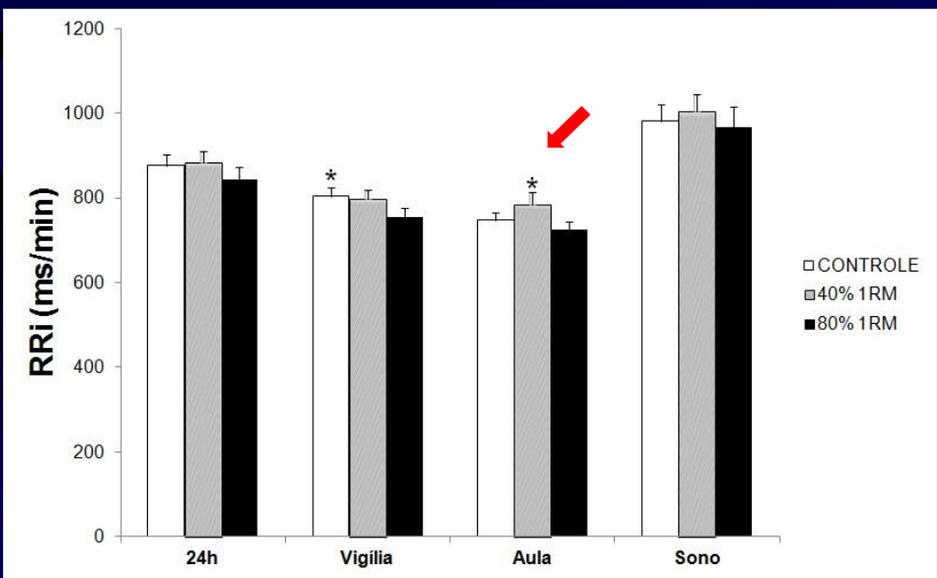
**PRESSÃO ARTERIAL E DINÂMICA SIMPATO-VAGAL DE
PROFESSORES UNIVERSITÁRIOS 24H PÓS-EXERCÍCIO
RESISTIDO EM DIFERENTES INTENSIDADES**



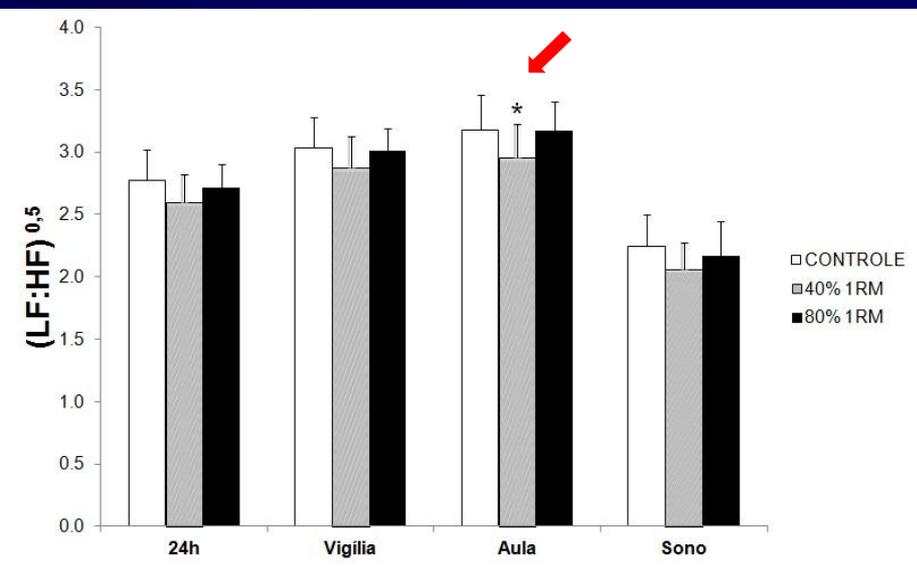
* $p \leq 0,05$ em relação às sessões Controle e 40%1RM;
 $\dagger p \leq 0,05$ em relação às sessões Controle e 80%1RM.



* $p \leq 0,05$ em relação à sessão Controle; $\dagger p \leq 0,05$ em relação às sessões Controle e 80%1RM



* $p \leq 0,05$ em relação à sessão 80%1RM.



* $p \leq 0,05$ em relação à sessão Controle.

**A genética tem
alguma influência
nas respostas
cardiovasculares?**

- *Nem todos apresentam efeitos redutores na PA* (Hagberg et al., 1999-2000; Pescatello et al., 2007; Wang et al., 2009);

- Polimorfismo Inserção/Deleção (I/D) do gene da Enzima Conversora da Angiotensina (ECA) (Rigat et al., 1990; Cambien et al., 1992; Tanriverdi et al., 2005; Moraes et al., 2008; Kim, 2009).

Genótipos da ECA:

I/I	I/D	D/D
-/-	-/+	+/+
[ECA]	[ECA]	[ECA]

(Rigat et al., 1990; Alvarez et al., 2000; Jaliu et al., 2002; Tanriverdi et al., 2005).

Sistemas de regulação do tônus vascular

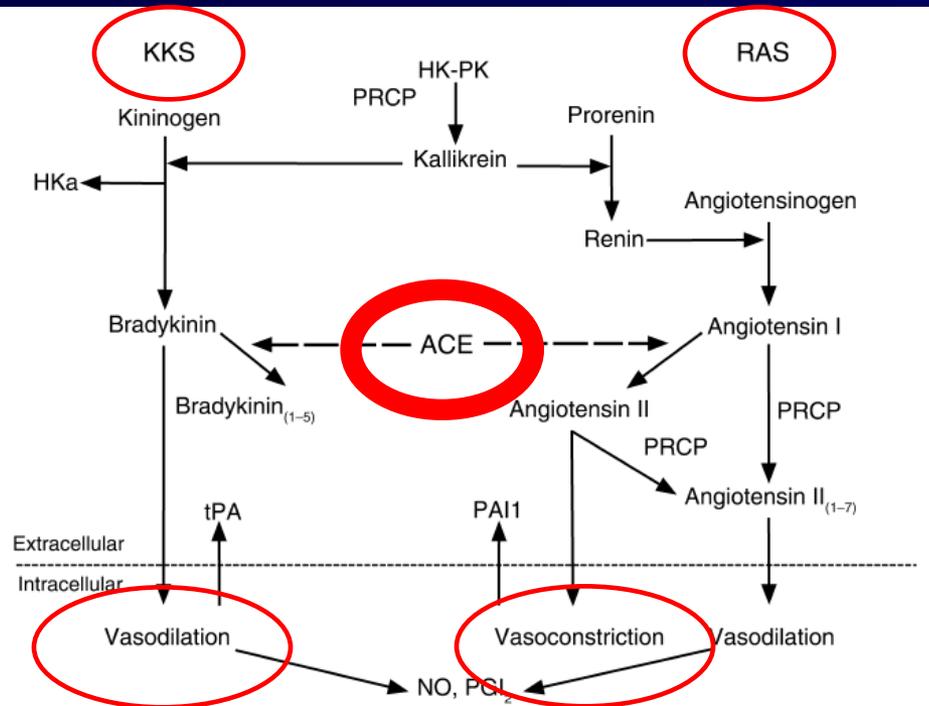


Figure 2

The interaction between the plasma KKS and RAS. Plasma kallikrein converts prorenin to renin, and renin has the ability to convert angiotensinogen to angiotensin I. Angiotensin-converting enzyme (ACE) converts inactive angiotensin I to the vasoconstrictor angiotensin II. Angiotensin II stimulates plasminogen activator inhibitor 1 (PAI1) release from endothelial cells. At the same time ACE degrades bradykinin into bradykinin₍₁₋₇₎ (not shown) or bradykinin₍₁₋₅₎, a peptide with thrombin inhibitory activity. PRCP is the enzyme that degrades angiotensin II or angiotensin I to the vasodilating peptide, angiotensin II₍₁₋₇₎. Angiotensin II₍₁₋₇₎ stimulates NO and PGI₂ formation, which potentiates the effects of bradykinin. PRCP also has the ability to convert PK to kallikrein. Formed kallikrein digests kininogens to liberate bradykinin, leaving a kinin-free kininogen (HKa) that has anti-proliferative and anti-angiogenic properties. Thus, PRCP, the same enzyme that degrades the vasoconstrictor angiotensin II, leads to the increased formation of the vasodilators bradykinin and angiotensin II₍₁₋₇₎. Finally, the resulting bradykinin stimulates tPA, NO, and PGI₂ formation, thus counterbalancing the prothrombotic effect of angiotensin II.

(Schmaiser et al.,
2002- J Clin Inves)

2011

RESEARCH ARTICLE

Open Access

The higher exercise intensity and the presence of allele I of ACE gene elicit a higher post-exercise blood pressure reduction and nitric oxide release in elderly women: an experimental study

Hugo AP
Ricardo Y

liveira⁶,
ões^{1†}

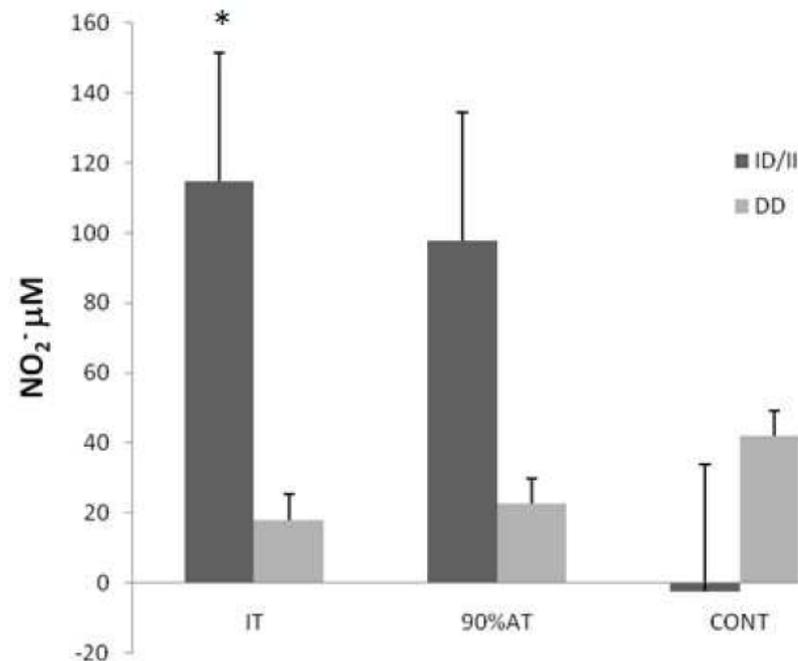
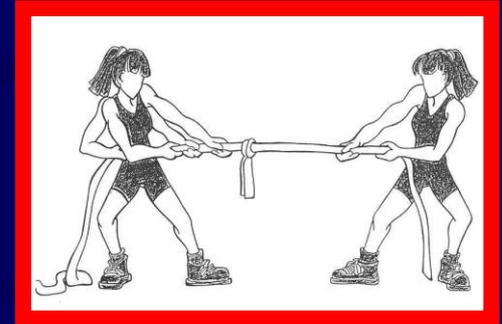


Figure 1 Mean (\pm SEM) delta variation of NO_2^- (nitrite) for IT (Incremental test), 90% AT (90% of anaerobic threshold) and CONT (control) sessions performed by ID/II ($n = 18$) and DD ($n = 10$) genotypes of ACE gene. * $p < 0.05$ in relation to D/D group on IT session.

'Hot topic'

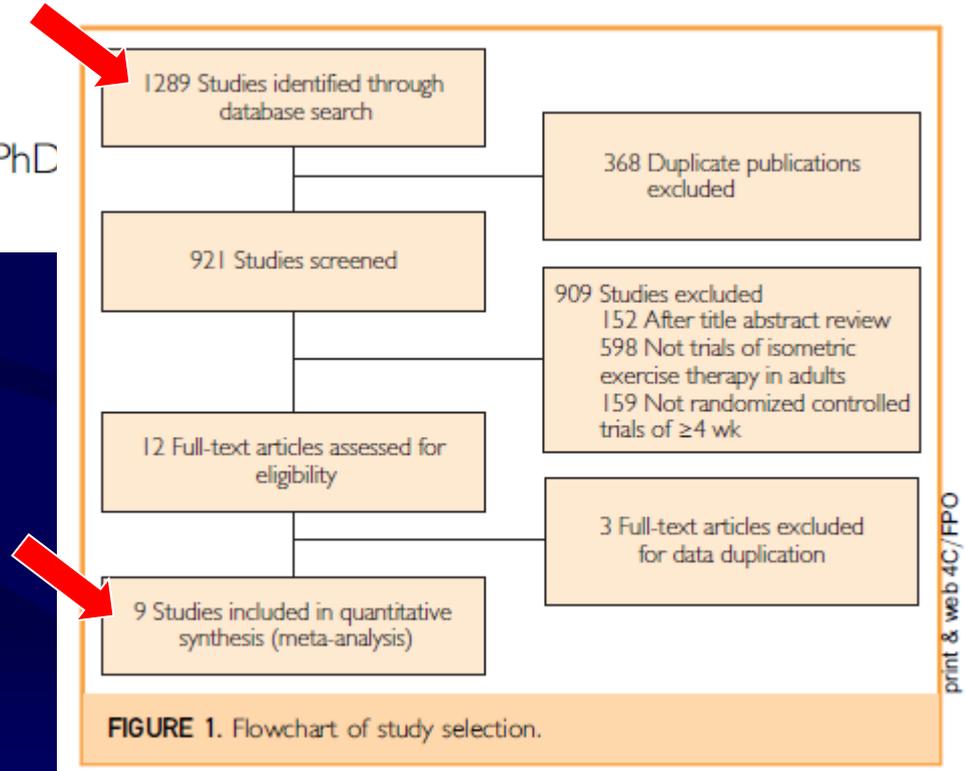


Foi visto que agudamente o ISOMÉTRICO não promove HPE (Olher et al. 2013) e cronicamente são escassas as evidências de efeito redutor na PA (Cornelissen & Smart, 2013).

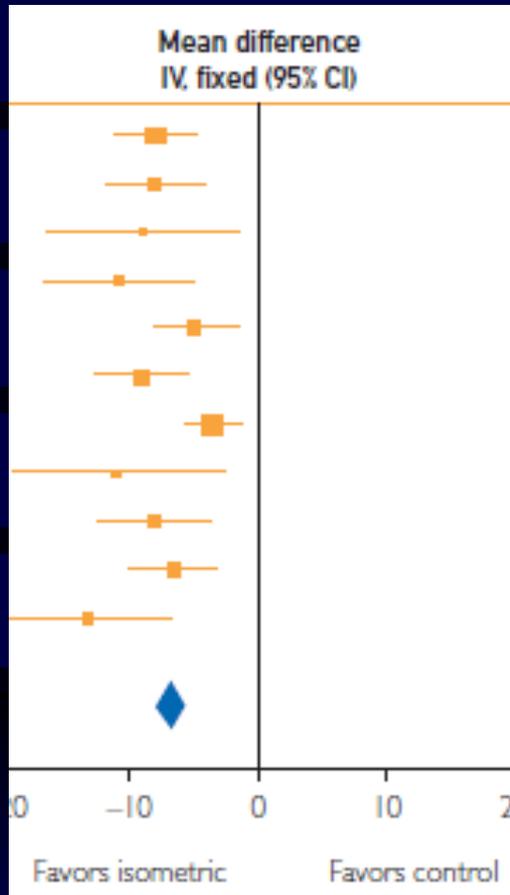
O que você acha, tem efeito ou não?

Isometric Exercise Training for Blood Pressure Management: A Systematic Review and Meta-analysis

Debra J. Carlson, BHIthSc; Gudrun Dieberg, PhD
Philip J. Millar, PhD; and Neil A. Smart, PhD

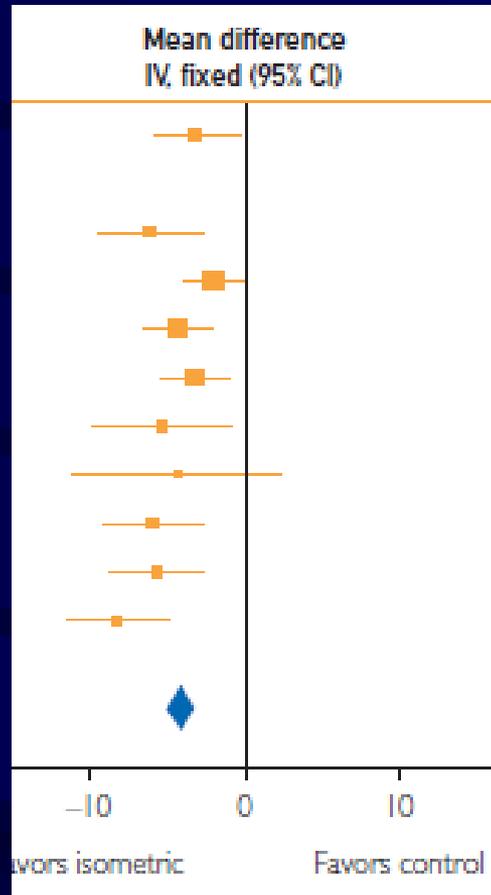


PAS



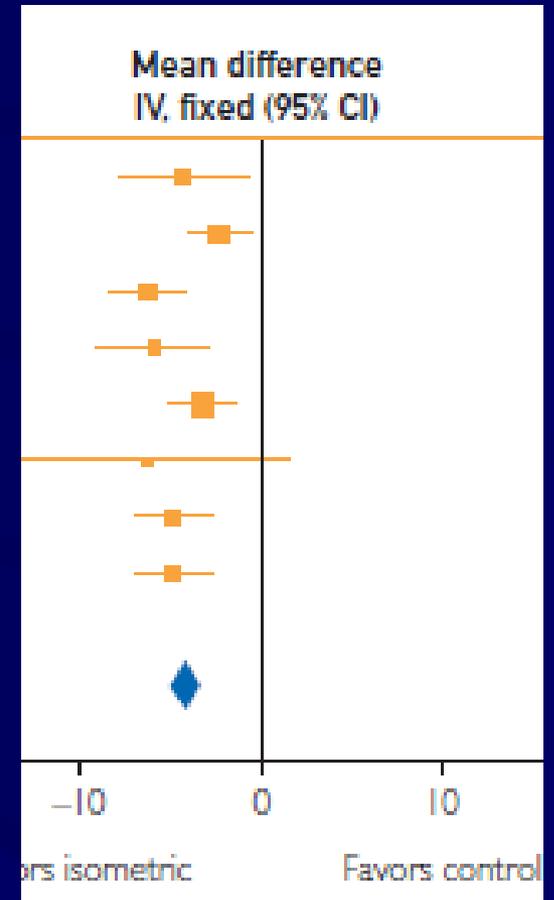
- 6,8 mmHg

PAD



- 3,9 mmHg

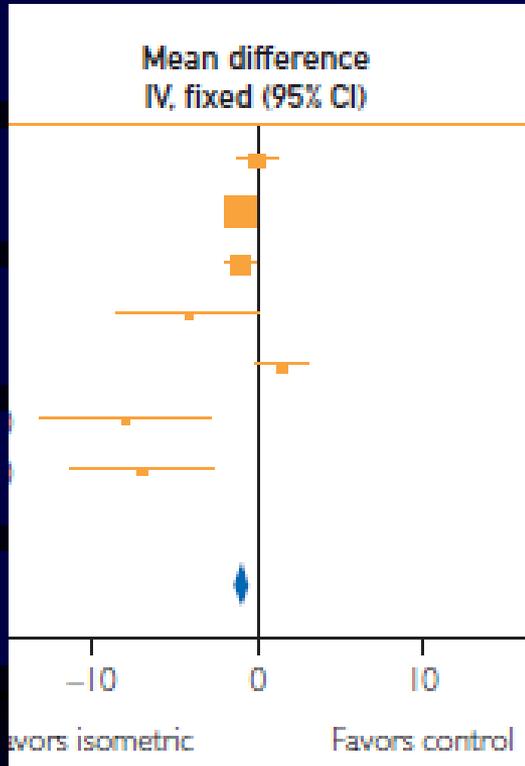
PAM



- 3,9 mmHg

(Carlson DJ et al, 2014; Mayo Clinic)

FC



- 0,79 bpm

A FC muda quase nada, o que sugere descartar a via central como mecanismo para ajustes cardiovasculares do exercício ISOMÉTRICO.

McGowan (2008) destaca que o treinamento isométrico pode aumentar a vasodilatação endotélio-dependente (mediada pelo NO) em resposta a hiperemia reativa na musculatura treinada.

(*Carlson DJ et al, 2014; Mayo Clinic*)

Melhor ou Pior?

VANTAGENS:

- Rapidez na realização da sessão;
- Maior aderência ao programa;
- Manutenção da respiração espontânea.

Fisiologicamente: Exercício isométrico submáximo está associado a igual ou menor aumento da FC e PAS, em comparação ao aeróbio, com aumentos da PAD (aumento da pressão de perfusão nas coronárias), o que sugere reduzida demanda de oxigênio ao miocárdio. Em conjunto ao DP menor, em comparação ao aeróbio, o isométrico diminui a chance de isquemia induzida pelo exercício.

(Millar PJ et al, 2013; Carlson DJ et al, 2014)

Evidence for the Role of Isometric Exercise Training in Reducing Blood Pressure: Potential Mechanisms and Future Directions

Philip J. Millar • Cheri L. McGowan •
Véronique A. Cornelissen • Claudio G. Araujo •
Ian L. Swaine

Generalidades

- As adaptações ao treinamento isométrico se perdem com maior rapidez;
- O isométrico parece que muda em maior grau a função e não a estrutura cardiovascular.

Adaptações Cardíacas

- VS e DC não se alteraram

Adaptações Vasculares

- Aumento do pico de fluxo sanguíneo e hiperemia reativa
- Vasos e arteríolas ajustam sua resistência/complacência o que pode aumentar a dilatação fluxo-mediada

Adaptações Autonômicas

- HF (n.u) aumentou em hipertensos após 10sem de treinamento isométrico
- LF (n.u) diminuiu em hipertensos com PA e atividade simpática altos, já em jovens não

Dúvida: Aumento do vasodilatador local ou diminuição do fluxo simpático?

(Millar PJ et al, 2013; Sports Medicine)

Aplicação Prática

Efeito redutor crônico do ISOMÉTRICO na PA

- 4 séries de *handgrip* ou *leg*;
- 2min cada série;
- Intensidade de 30-50% CVM;
- Intervalo de 1-4 minutos entre séries;
- Duração de 11-20min /sessão;
- Frequência de 3-5 vezes/semana;
- Programa: 4-10 semanas.

(Millar PJ et al, 2013; Carlson DJ et al, 2014)

Perspectivas Práticas Futuras

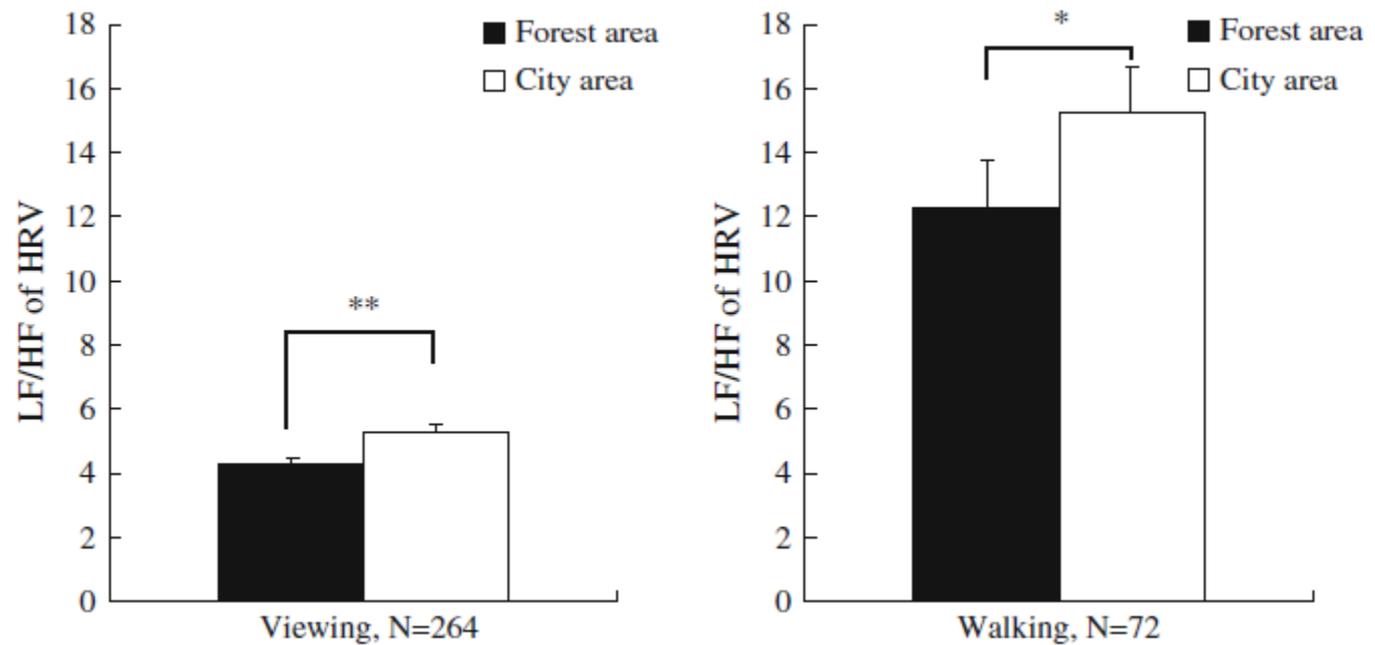
The physiological effects of *Shinrin-yoku* (taking in the forest atmosphere or forest bathing): evidence from field experiments in 24 forests across Japan

Bum Jin Park · Yuko Tsunetsugu · Tamami Kasetani ·
Takahide Kagawa · Yoshifumi Miyazaki

Fig. 1 Forest viewing and walking



Fig. 7 Change in LF/HF of HRV upon forest viewing and walking. Mean \pm SE; ** $p < 0.01$; * $p < 0.05$; p value by t test





**EXERCÍCIO AERÓBIO E ÓLEO ESSENCIAL DE EUCALIPTO:
Respostas cardiovasculares e afetivas na recuperação e
durante o estresse induzido**

Coordenador: Sérgio R. Moreira



2013/2014



Aerobic Exercise and Eucalyptus Globulus: Cardio-affective effects on recovery and stress

Amostra:

- $n = 12$ indivíduos de ambos os sexos (8M; 4F);
- Aparentemente saudáveis;

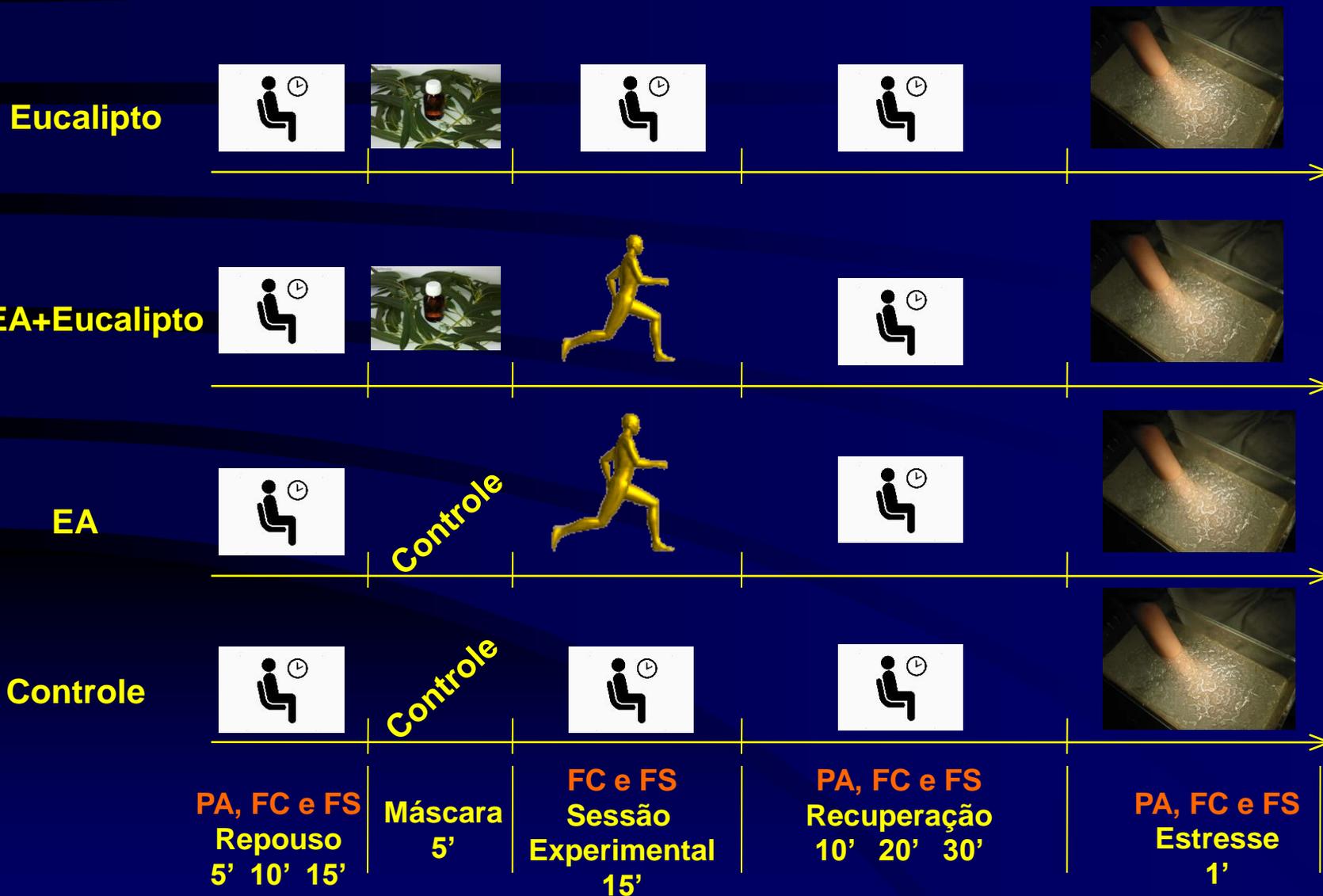
- **Idade:** $26,9 \pm 7,5$ anos;
- **Peso:** $69,1 \pm 16,7$ kg;
- **Estatura:** $166,0 \pm 7,0$;
- **Índice de massa corporal:** $24,9 \pm 4,4$;
- **Pressão arterial sistólica:** 116 ± 12 ;
- **Pressão arterial diastólica:** 74 ± 7 .

Cálculo Amostral:

- Power 90%;
- $\alpha = 5\%$ (probabilidade de erro);
- 5 fatores/repetições * 4 grupos/sessões;
- Número sugerido = 12 (*Gpower*® versão 3.0)

Procedimentos Gerais

4 sessões separadas por 4-7 dias



Medida de PA e FC no Repouso e na Recuperação



Equipamento Automático
Microlife® mod. BP 3AC1-1.

(Stergiou et al., 2008)

Máscara facial

Dia óleo de Eucalipto: 3 gotas

Dia controle: Ar puro

Momento da inalação no Óleo de Eucalipto ou Ar puro



Momento Exercício Aeróbico ou Controle



Tipo de Exercício: corrida ou caminhada;

Intensidade: 80-85% FC máxima prevista para idade ($220 - \text{idade}$);

Duração: 15 minutos.



Estresse Cardiovascular Induzido

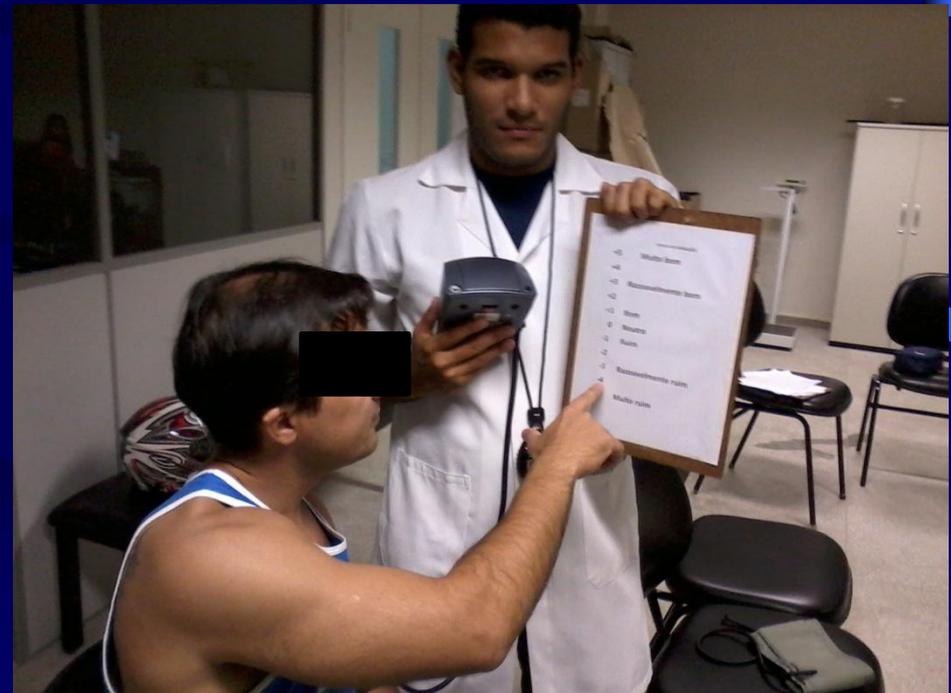
Teste de Estresse Cardiovascular:

“Cold Pressor Test” – Imersão da mão em água com temperatura entre 3-4° Celsius.

(Hines & Brow, 1936 e Wood et al., 1984)



Sensação de
Prazer:
“Feeling Scale”.



Resultados e Discussão

(controle do estudo)

Frequência Cardíaca de Trabalho

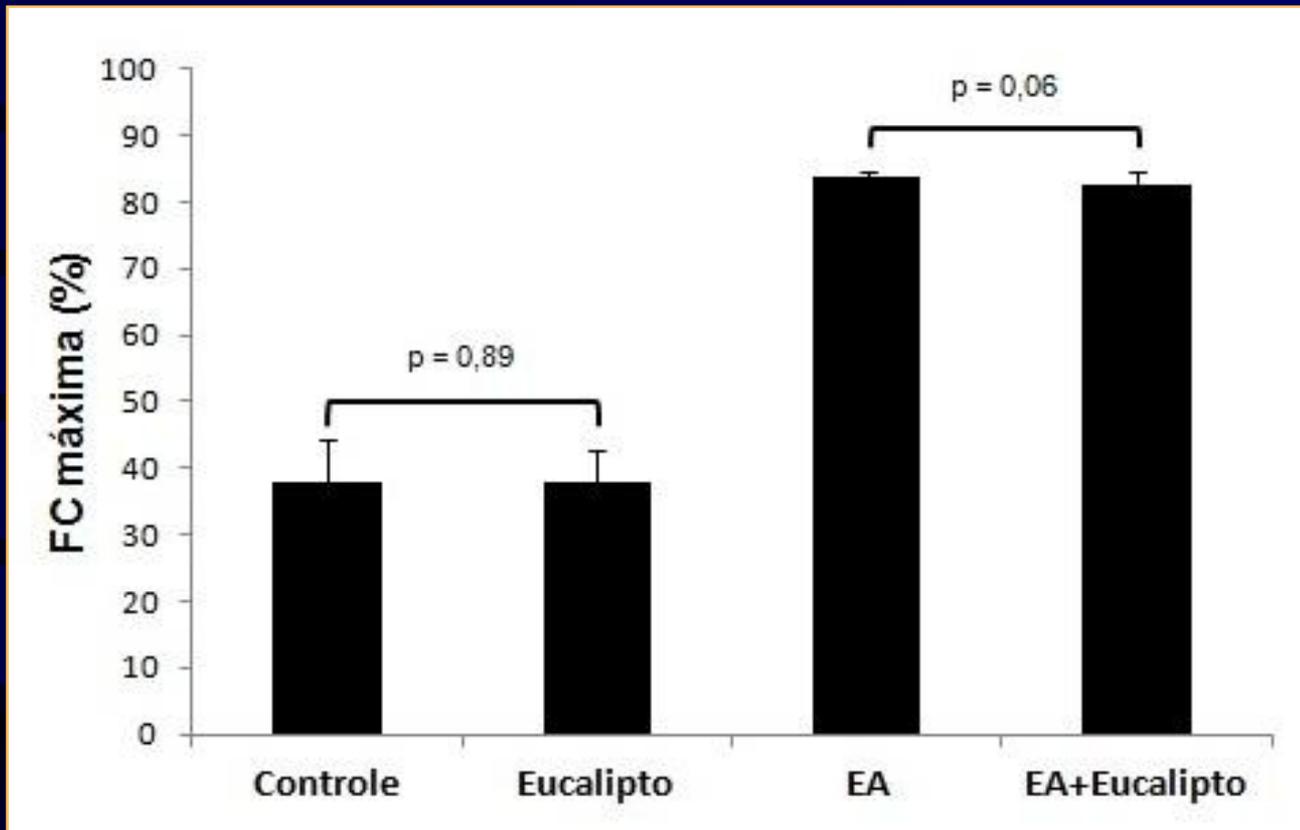


FIGURA 1. Média (\pm DP) do percentual da frequência cardíaca (FC) máxima obtido nas sessões Controle, Eucalipto, Exercício Aeróbio (EA) e EA+Eucalipto (n=12).

Percepção Subjetiva de Esforço

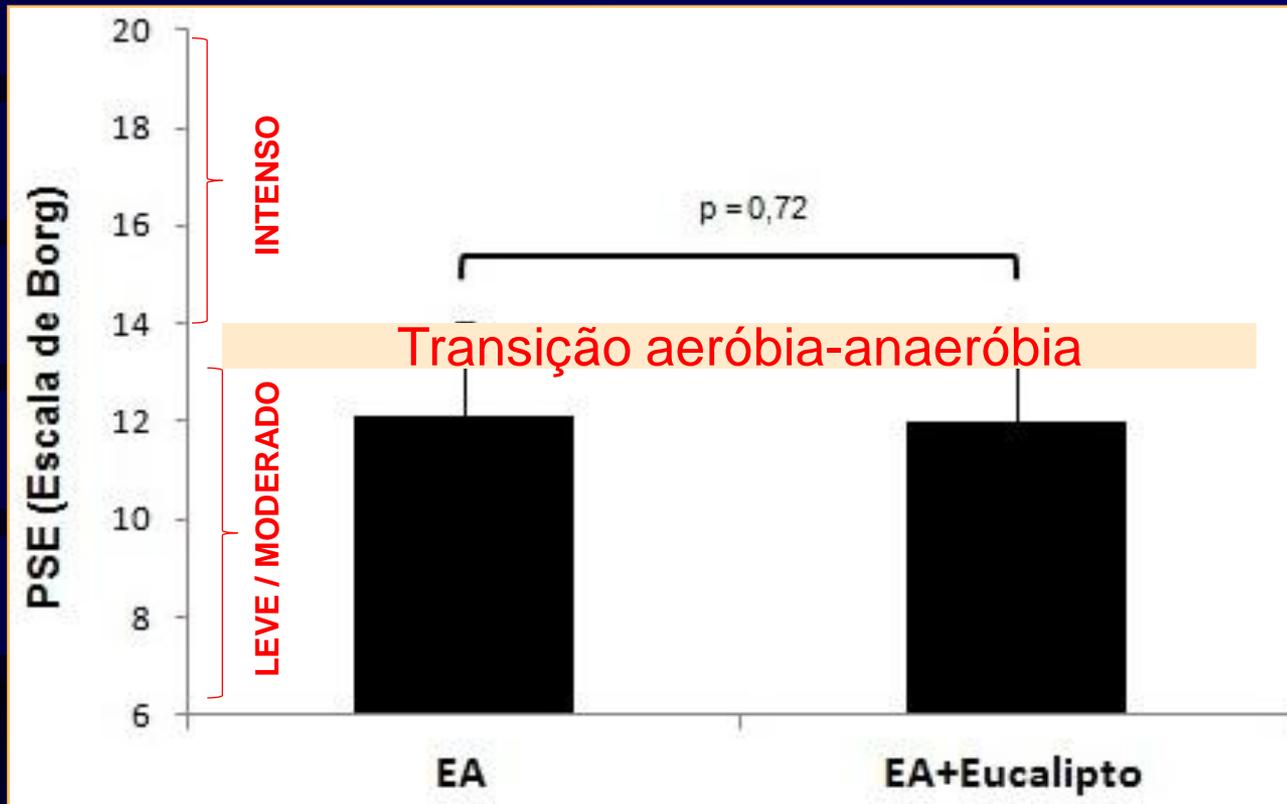


FIGURA 2. Média (\pm DP) da percepção subjetiva de esforço (PSE) nas sessões Exercício Aeróbio (EA) e EA+Eucalipto (n=12).

Resultados e Discussão

(principais)

PA Sistólica

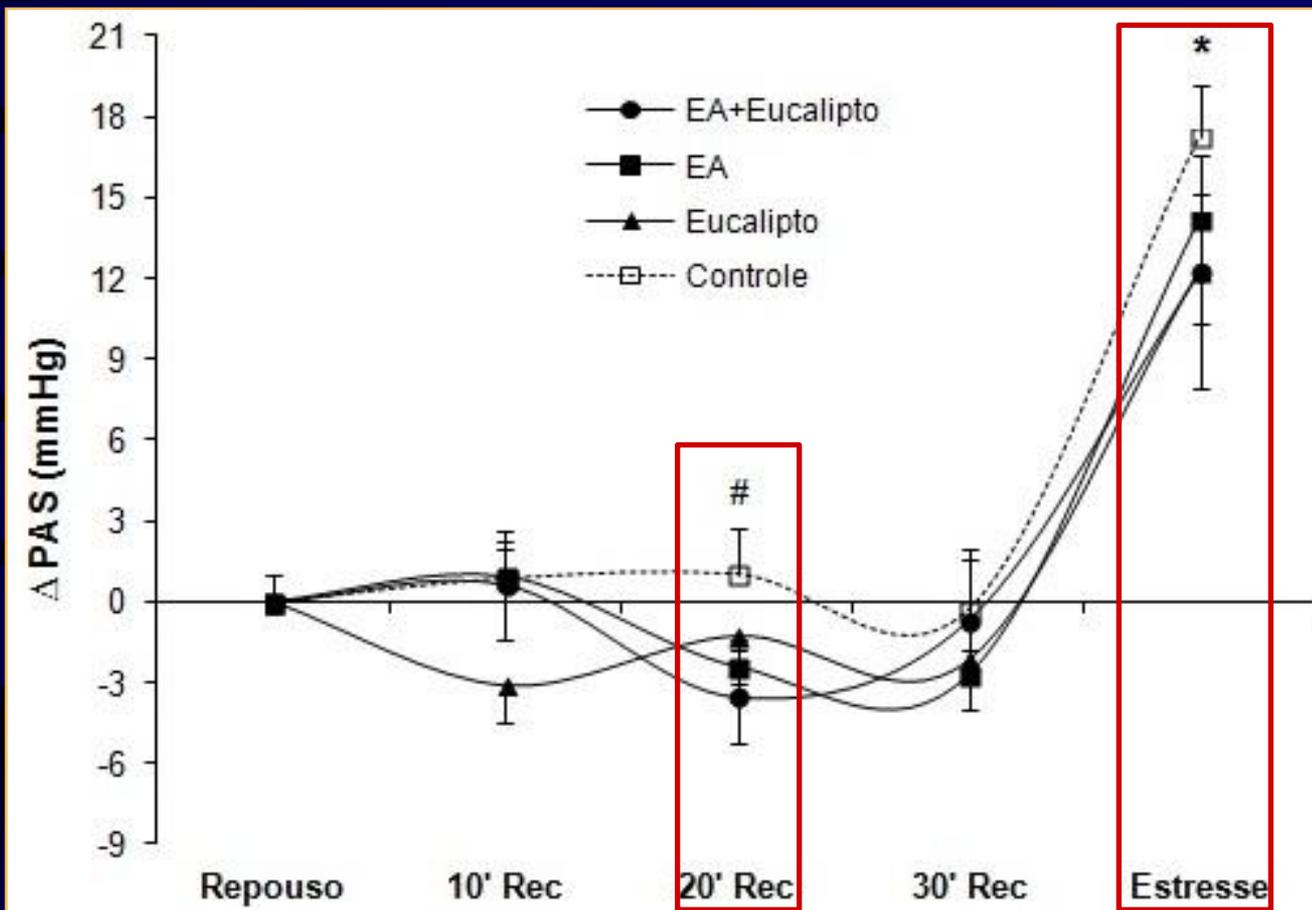


FIGURA 3. Média (\pm EPM) da variação (Δ) da pressão arterial sistólica (PAS) nos diferentes momentos (10-30min da recuperação – Rec e estresse cardiovascular induzido) das sessões Controle, Eucalipto, Exercício Aeróbico (EA) e EA+Eucalipto (n=12). * $p < 0,05$ em relação a sessão EA+Eucalipto e Eucalipto; # $p = 0,06$ em relação a sessão EA+Eucalipto.

PA Diastólica

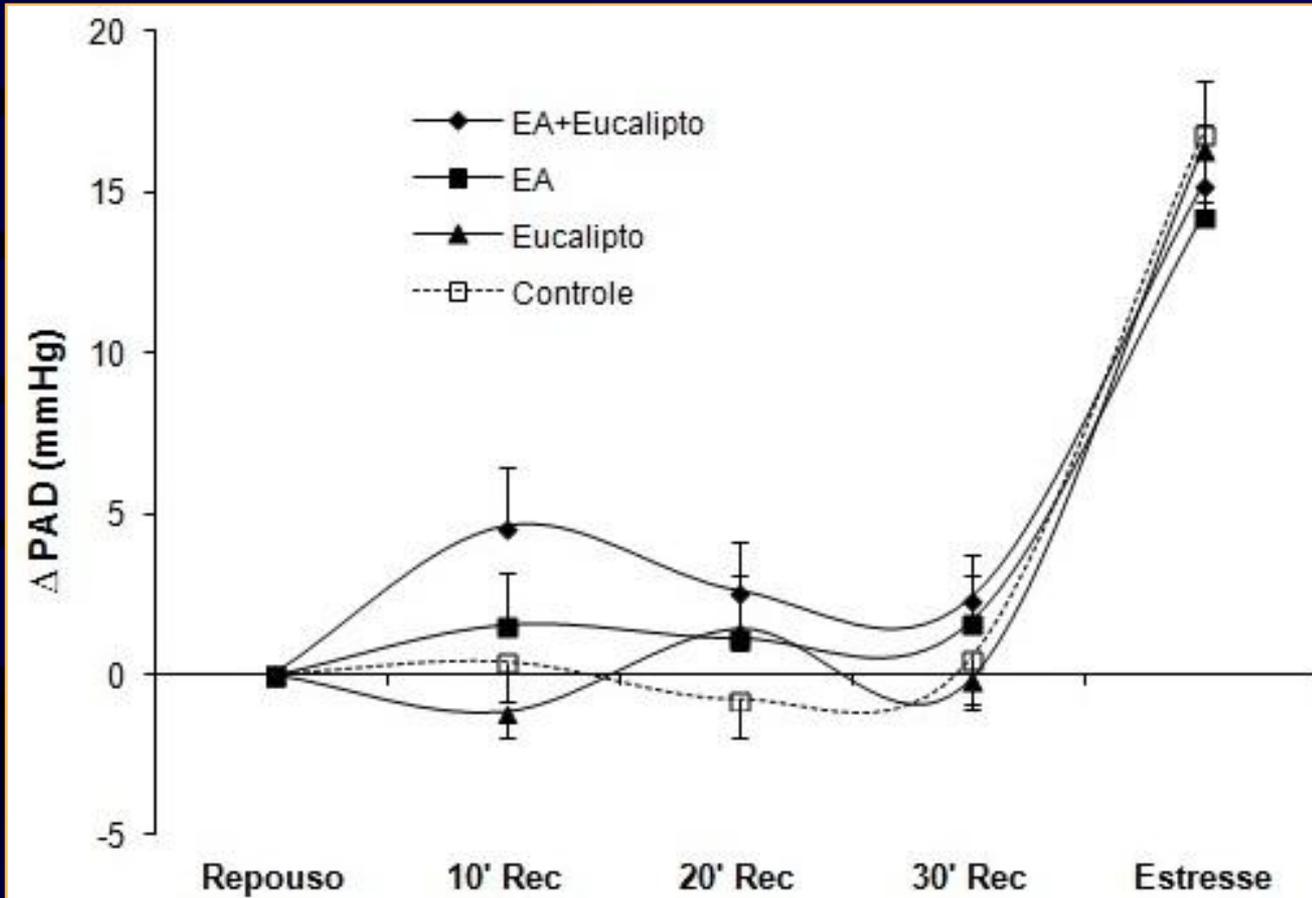


FIGURA 4. Média (\pm EPM) da variação (Δ) da pressão arterial diastólica (PAD) nos diferentes momentos (10-30min da recuperação – Rec e estresse cardiovascular induzido) das sessões Controle, Eucalipto, Exercício Aeróbico (EA) e EA+Eucalipto (n=12).

Frequência Cardíaca

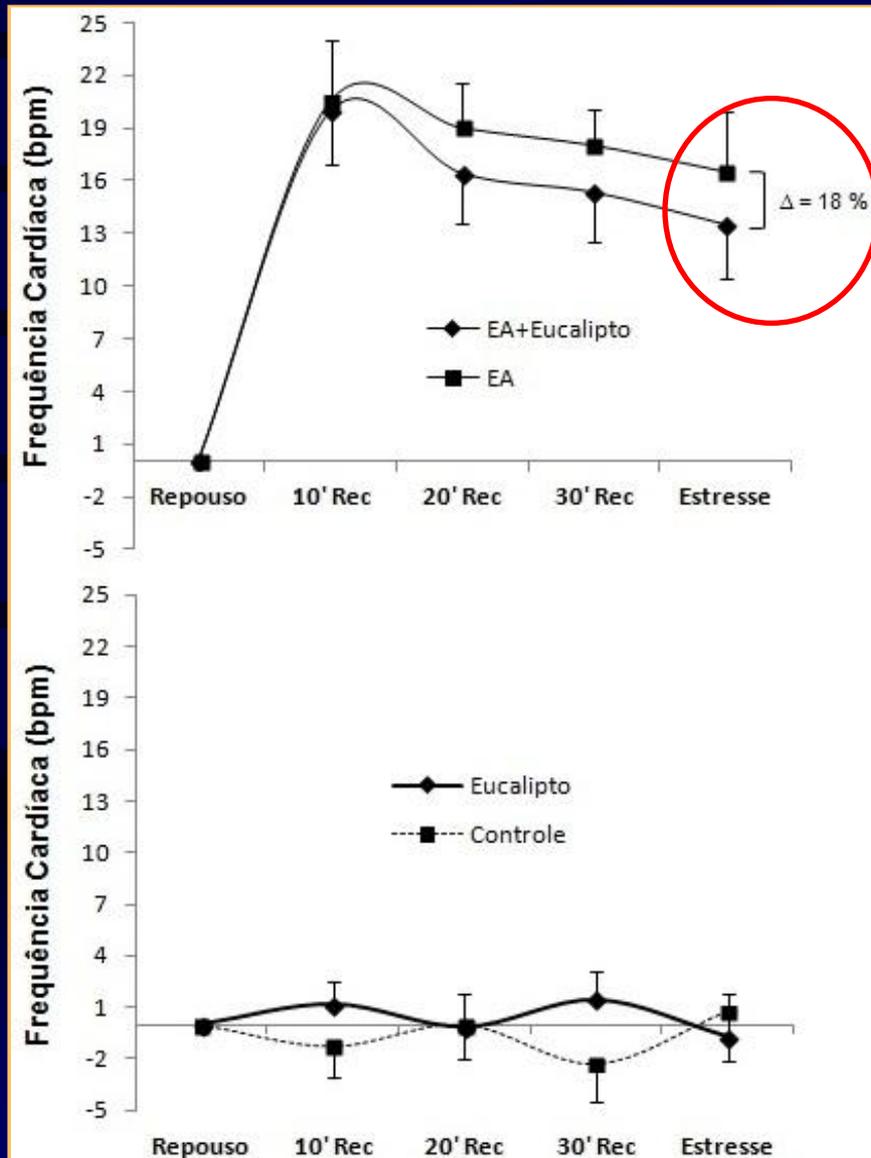


FIGURA 5. Média (\pm EPM) da variação (Δ) da frequência cardíaca (FC) nos diferentes momentos (10-30min da recuperação – Rec e estresse cardiovascular induzido) das sessões Controle e Eucalipto (inferior), Exercício Aeróbio (EA) e EA+Eucalipto (superior) (n=12).

Duplo Produto (PAS*FC)

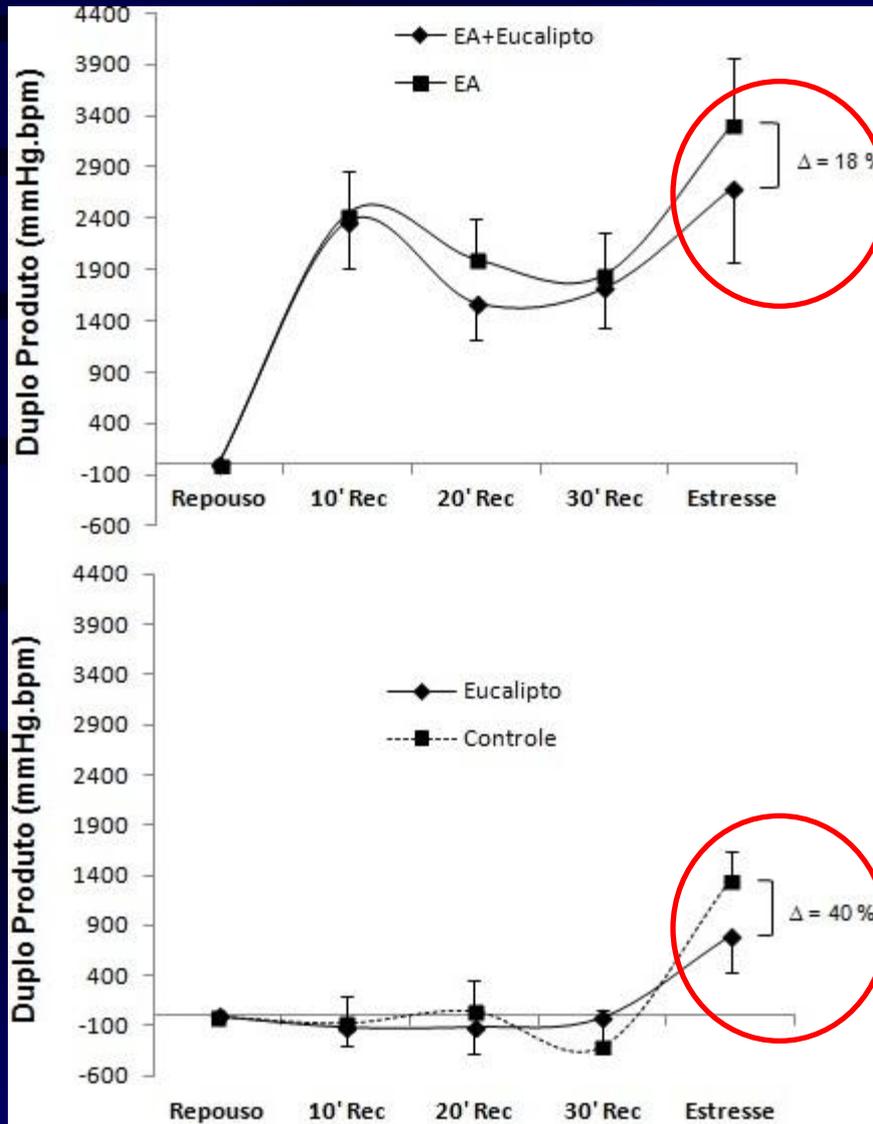


FIGURA 6. Média (\pm EPM) da variação (Δ) do duplo produto (PAS*FC) nos diferentes momentos (10-30min da recuperação – Rec e estresse cardiovascular induzido) das sessões Controle e Eucalipto (inferior), Exercício Aeróbio (EA) e EA+Eucalipto (superior) (n=12).

Sensação de Prazer

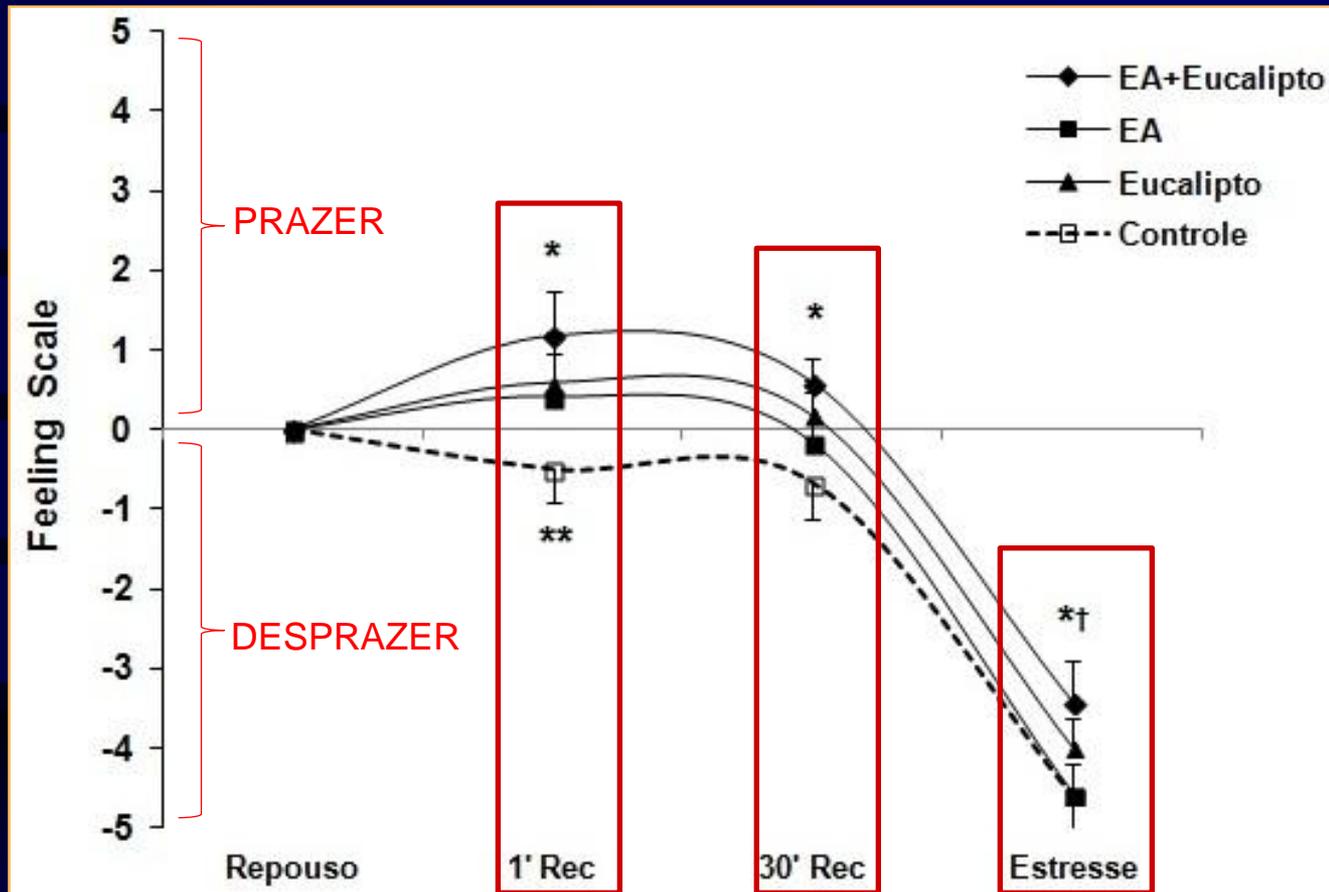


FIGURA 7. Média (\pm EPM) da variação (Δ) da Feeling Scale (sensação de prazer) nos diferentes momentos (1-30min da recuperação – Rec e estresse cardiovascular induzido) das sessões Controle, Eucalipto, Exercício Aeróbico (EA) e EA+Eucalipto (n=12). * $p < 0,05$ em relação a sessão Controle; ** $p < 0,05$ em relação a sessão Eucalipto; † $p < 0,05$ em relação a sessão EA.

Obrigado!