Exercise Training

- Exercise training induces many physiological changes that make a conditioned individual more efficient and better able to deliver and use the oxigen and nutrients and resist fatigue.
- The conditioning effect also offers some protection against cardiovascular mortality and enhances ability to perform activities af daily living.

“Stato di Forma o Condizione Atletica”

L’insieme di caratteristiche cardiorespiratorie, neuromuscolari e psicologiche,naturali od acquisite,che permettono all’atleta di effettuare la prestazione con il massimo rendimento

....l’allenatore

“Stato di Forma o Condizione Atletica”

L’insieme di caratteristiche cardiorespiratorie, neuromuscolari e psicologiche,naturali od acquisite,che permettono all’atleta di effettuare la prestazione con il massimo rendimento ed il minimo pericolo di infortunio

....il medico

A

Attività sportive non competitive con impegno cardio-circolatorio minimo-moderato caratterizzato da attività di pompa a ritmo costante, frequenze sottomassimali e caduta delle resistenze periferiche

Podismo o marcia in pianura	**Sci di fondo**
Footing	**Pattinaggio**
Jogging	**Canoa turistica**
Ciclismo in pianura	**Trekking (non esasperato)**
Caccia	**Golf**
Nuoto	

B

Attività sportive con impegno cardiocircolatorio di tipo "neurogeno"
caratterizzato da incrementi della frequenza cardiaca e non della portata, dovuto, soprattutto
nelle competizioni, ad importante impatto emotivo

1. con incrementi della FC da medi ad elevati.

Tuffi	**Motonautica**
Paracadutismo	**Vela**
Motociclismo velocità	**Equitazione e Polo**
Automobilismo	**Ippica**
Aviazione sportiva	**Attività subacquee**

2.con incrementi della FC da minimi a moderati

Golf	**Pesca sportiva**
Bocce e Bowling	**Sport di tiro (a segno, a volo, arco, etc.)**

C

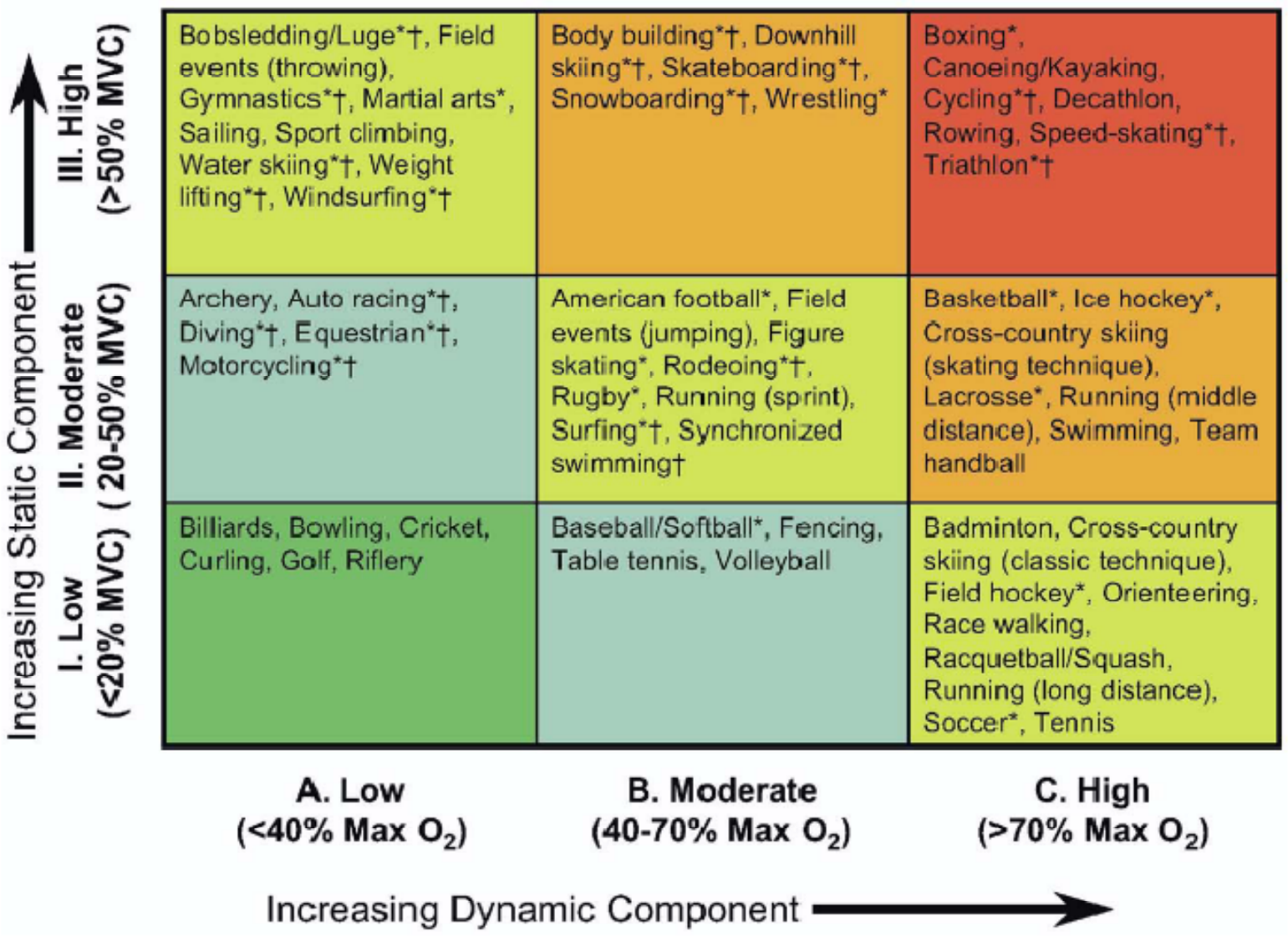
Attività sportive con impegno cardiocircolatorio di "pressione" caratterizzato
da portata cardiaca non massimale, frequenza cardiaca da elevata a massimale
e resistenze periferiche da medie ad elevate

Atletica Leggera velocità	**Eptathlon lanci e salti**
Bob	**Sci slalom, discesa, Km lanciato, sci acrobatico**
Slittino	**Sci nautico**
Ciclismo velocità kerin	**Wind surf**
Nuoto 50 m.	**Tennis tavolo**
Nuoto pinnato 50 m ap., 100 m sub	**Motociclismo, Motocross**
Pattinaggio sul ghiaccio velocità	**Alpinismo**
Pattinaggio a rotelle velocità	**Free Climbing**
Sollevamento pesi	**Nuoto sincronizzato**
Lanci	**Body Building**
Salti	**Decathlon lanci e salti**

D

Attività sportive con impegno cardiocircolatorio da medio ad elevato caratterizzato da numerosi e rapidi incrementi anche massimali, della frequenza cardiaca e della portata, con aumento delle resistenze periferiche particolarmente evidente nelle brusche interruzioni dell'attività muscolare degli arti

Calcio	**Tennis**
Calcio a cinque	**Canoa slalom**
Football americano	**Canoa Polo**
Rugby	**Squash**
Pallacanestro	**Badminton**
Pallavolo	**Tamburello**
Pallamano	**Arti marziali**
Pallanuoto	**Lotta**
Baseball	**Pugilato**
Softball	**Hockey su ghiaccio**
Cricket	**Hockey su pista**
Beach volley	**Hockey su prato**
Ginnastica artistica	**Pattinaggio artistico**
Scherma	


Increasing Static Component
III. High (>50% MVC)
II. Moderate (20-50% MVC)
I. Low (<20% MVC)
Bobsledding/Luge*†, Field events (throwing), Gymnastics*†, Martial arts*, Sailing, Sport climbing, Water skiing*†, Weight lifting*†, Windsurfing*†
Body building*†, Downhill skiing*†, Skateboarding*†, Snowboarding*†, Wrestling*
Boxing*, Canoeing/Kayaking, Cycling*†, Decathlon, Rowing, Speed-skating*†, Triathlon*†
Archery, Auto racing*†, Diving*†, Equestrian*†, Motorcycling*†
American football*, Field events (jumping), Figure skating*, Rodeoing*†, Rugby*, Running (sprint), Surfing*†, Synchronized swimming†
Basketball*, Ice hockey*, Cross-country skiing (skating technique), Lacrosse*, Running (middle distance), Swimming, Team handball
Billiards, Bowling, Cricket, Curling, Golf, Riflery
Baseball/Softball*, Fencing, Table tennis, Volleyball
Badminton, Cross-country skiing (classic technique), Field hockey*, Orienteering, Race walking, Racquetball/Squash, Running (long distance), Soccer*, Tennis
A. Low (<40% Max O_2)
B. Moderate (40-70% Max O_2)
C. High (>70% Max O_2)
Increasing Dynamic Component

Risposta Cardiovascolare all’Esercizio Acuto

Risposta Cardiovascolare all'Esercizio Acuto

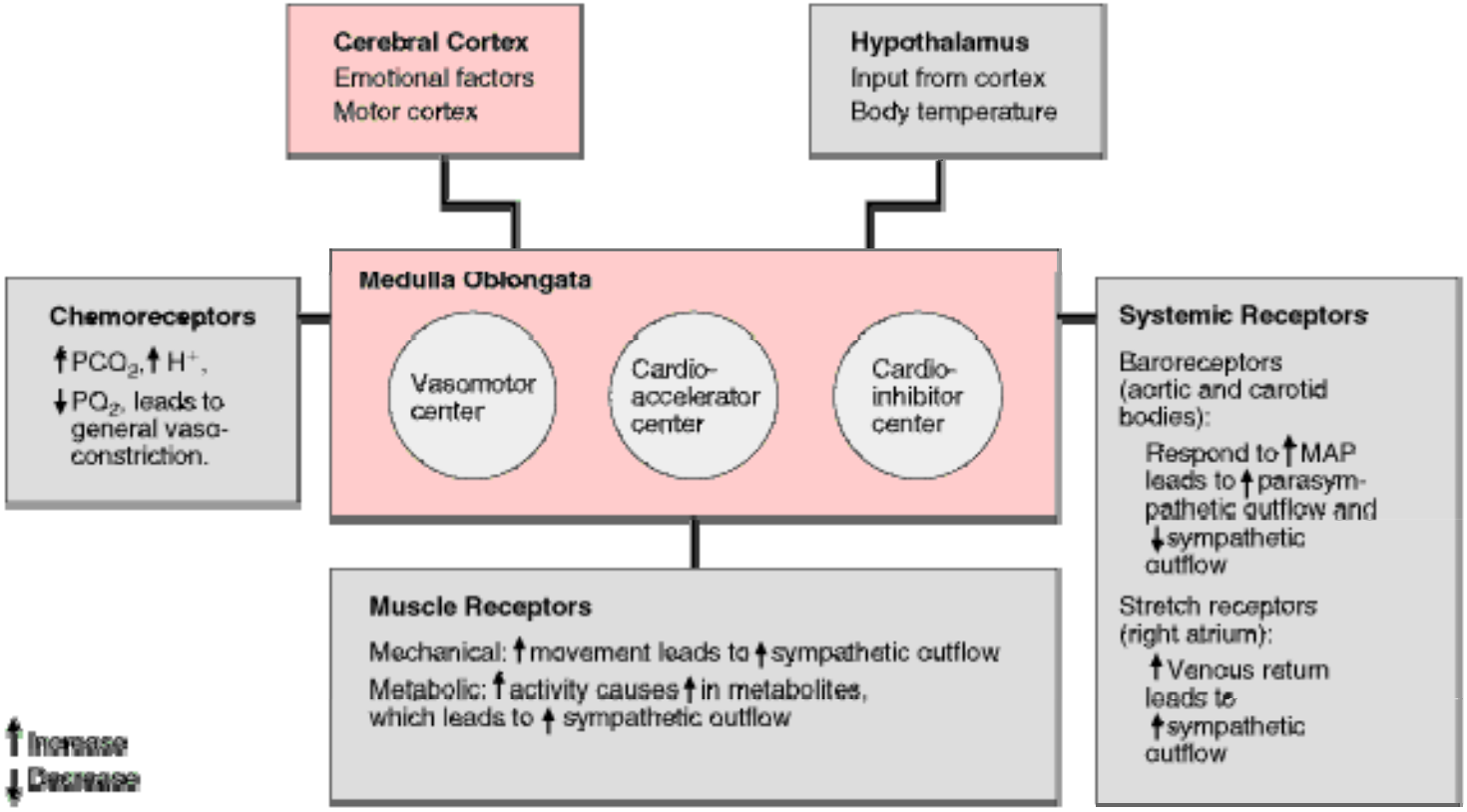
1. Fase preparatoria iniziale
   Stimolazione adrenergica
   Vasocostrizione distrettuale

2. Fase intermedia metabolica
   Fattori locali
   Stimolazione adrenergica

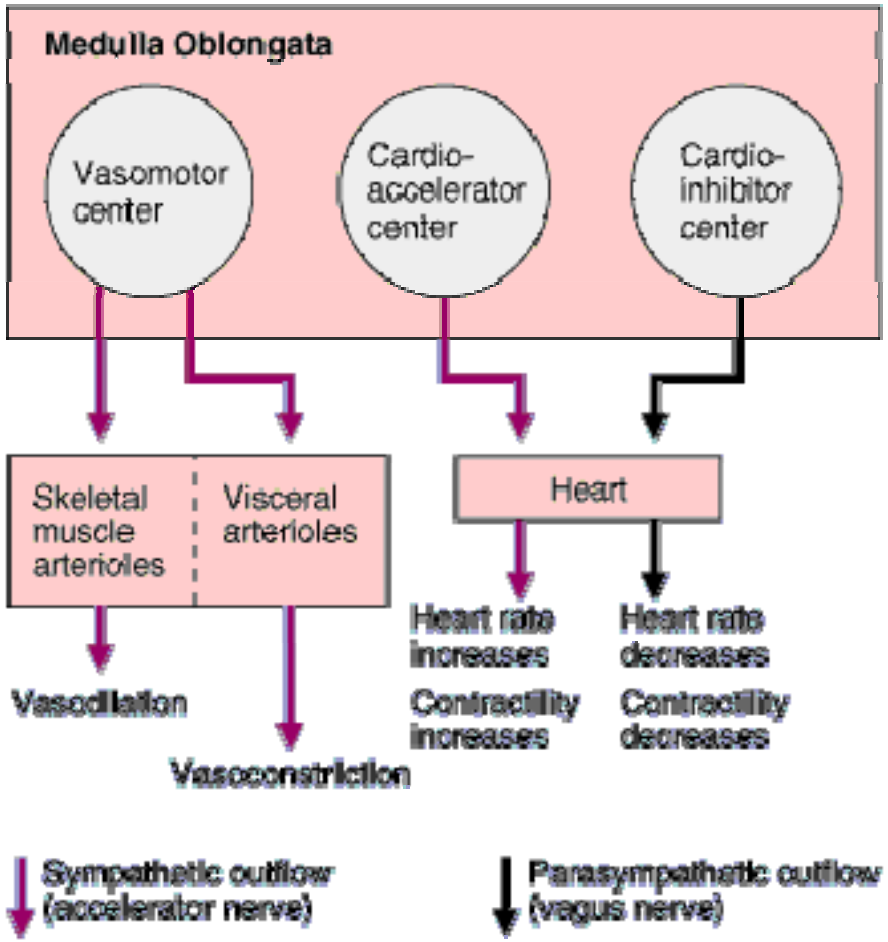
Risposta Cardiovascolare all'Esercizio Acuto

- Fase preparatoria iniziale
- *Stimolazione adrenergica (cuore)*
- *vasocostrizione distrettuale*

Factors Affecting Neural Control of Cardiovascular Function



Neural Control of Cardiovascular Function



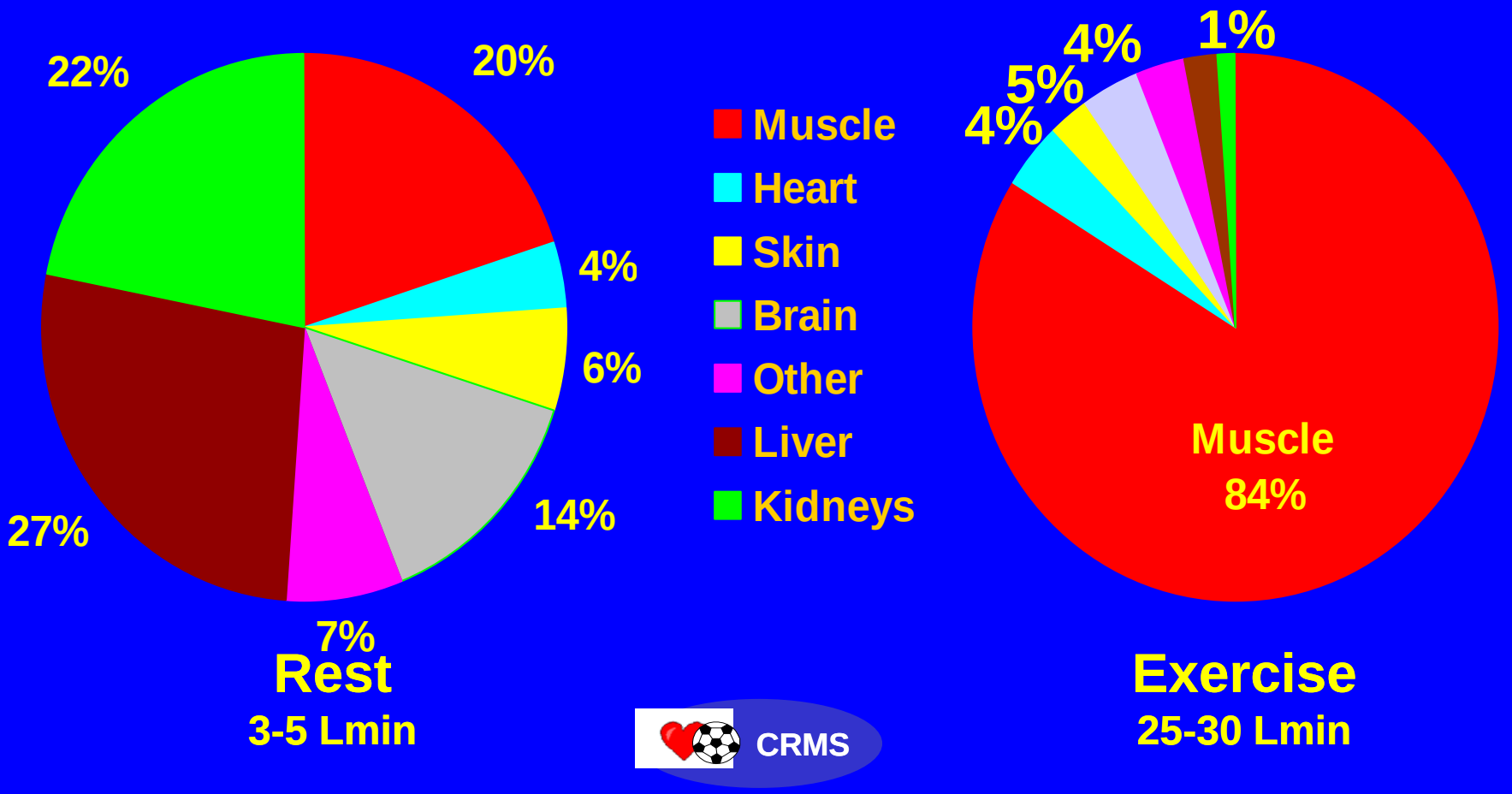
Integreted chemical,neural and hormonal adjustaments prior to and during exercise

Preexercise anticipatory response

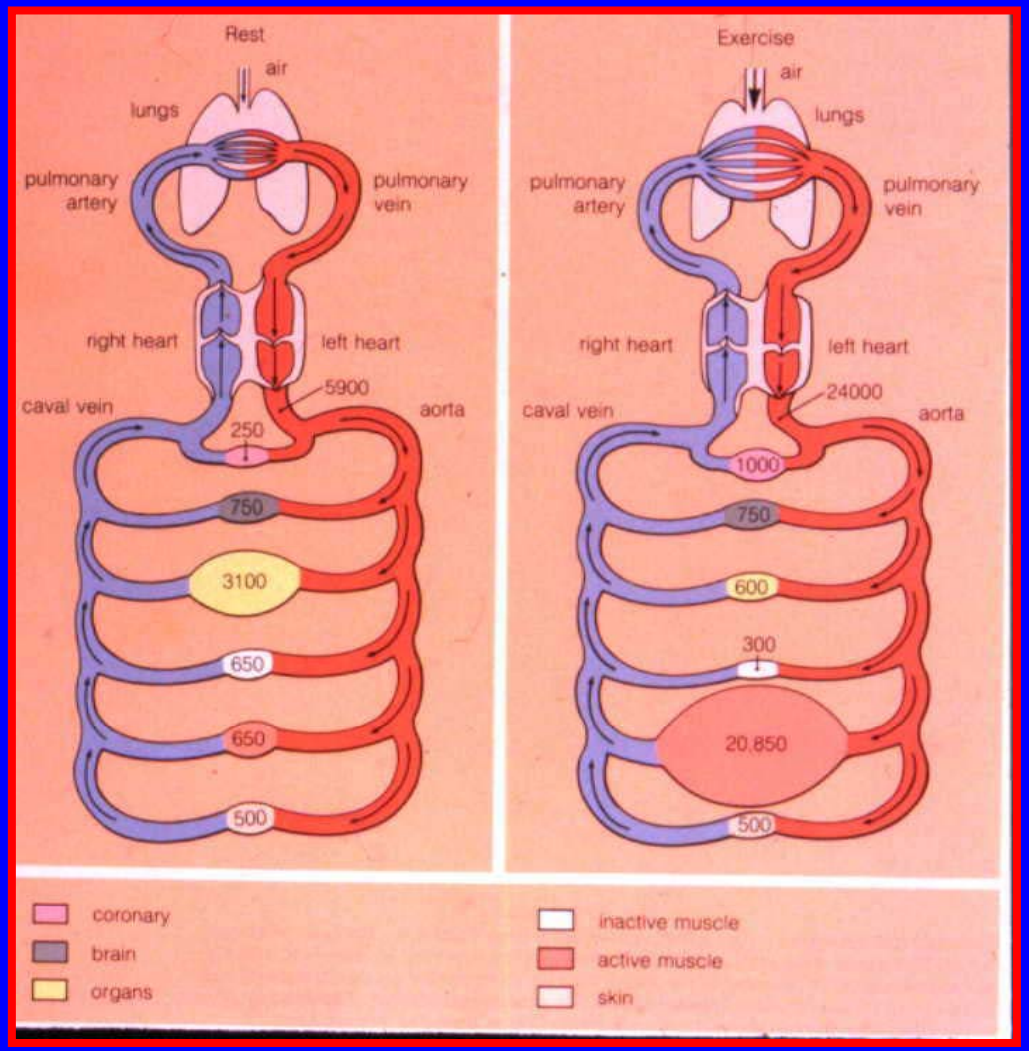
Activator Activation of motor cortex and higer areas of brain causes increase in sympathetic outflow and reciprocal inhibition of parasympathetic activity

Response Acceleration of heart rate; increased myocardial contractility; vasodilatation in skeletal and heart muscle (cholinergic fibres); vasoconstriction in other areas, especially in skin,gut,spleen, liver and kidneys (adrenergic fibres); increase in arterial blood pressure.

Distribution of Flow at rest and during Acute Exercise



Distribution of Flow at Rest and during Acute Exercise



Resting, anticipatory, and maximum exercise heart rate in competitive runners and untrained subjects during all-out running

Event	REST		ANTICIP		EXERCISE	
	T	UT	T	UT	T	UT
60 yards	67	69	148	124	177	162
220 yards	67	67	130	115	191	186
440 yards	63	63	129	118	187	189
880 yards	62	70	122	129	186	194
1 mile	58	64	118	128	195	198
2 mile	59	74	108	109	206	199

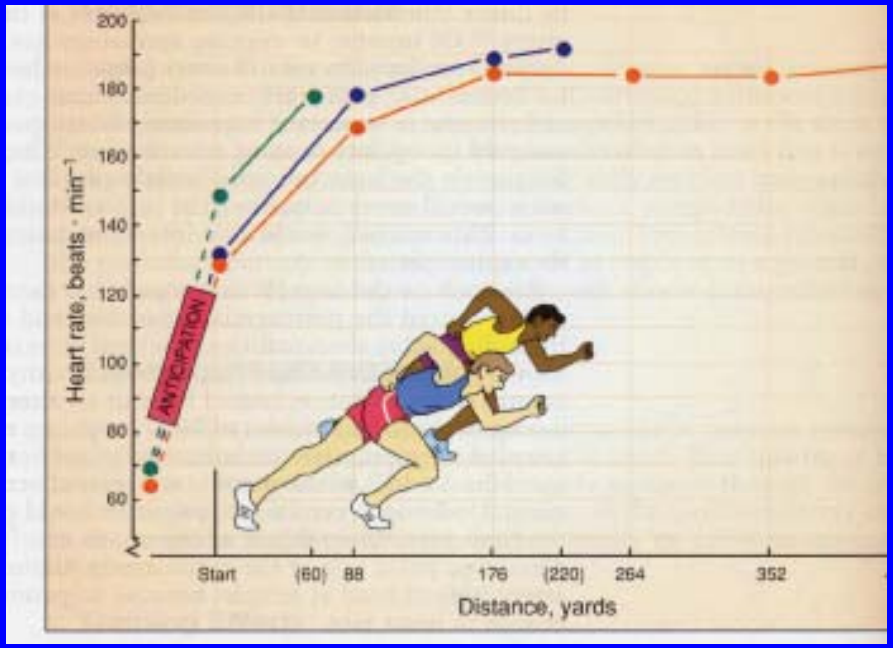
T = Trained
UT = Untrained

McArdle W.D. Telemetred cardiac response to selected running events
J. Appl. Physiol. 23:566,1967

Risposta Cardiovascolare all'Esercizio Acuto

Fase preparatoria iniziale

Stimolazione adrenergica (cuore)



Integreted Chemical,neural And Hormonal Adjustaments Prior To And During Exercise

EXERCISE

Activator Continued sympathetic cholinergig outflow; alterations in local metabolic conditions due to hypoxia, ↓pH, ↓CO2, ↑ADP, ↑Mg++, ↑Ca++, ↑temperature.

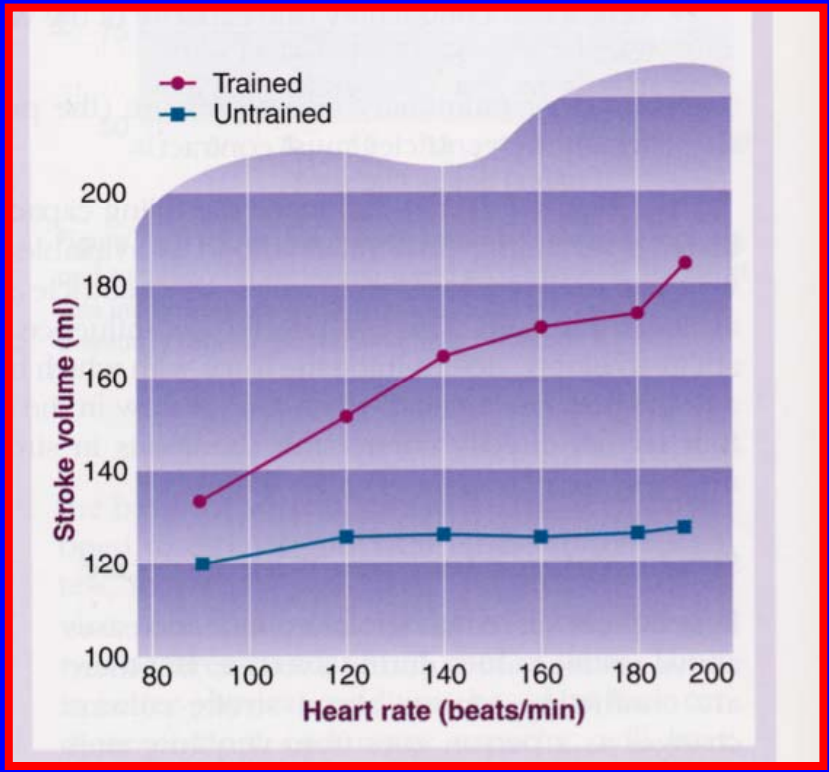
Continued sympathetic adrenergic outflow in conjunction with epineprhine and norepineprhine from the adrenal medulla

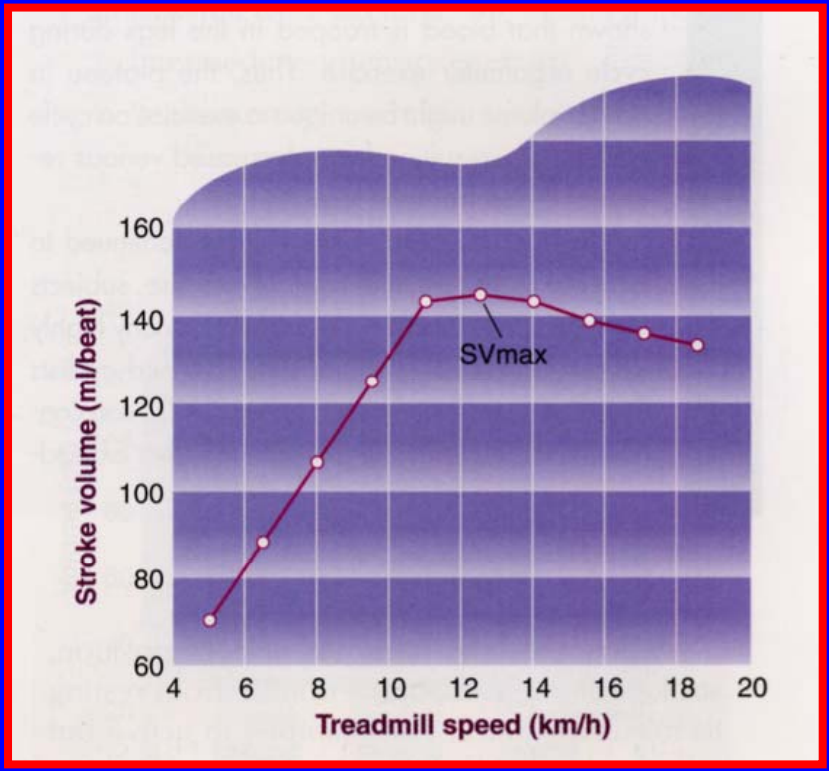
Response Further dilatation of muscle vasculature

Concomitant constriction of vasculature in inactive tissues to maintain adeguate perfusion pressure throu ghout arterial system.Venous vessels stiffen to reduce their capacity. This venoconstrinction facilitates venous return and maintains the central blood volume

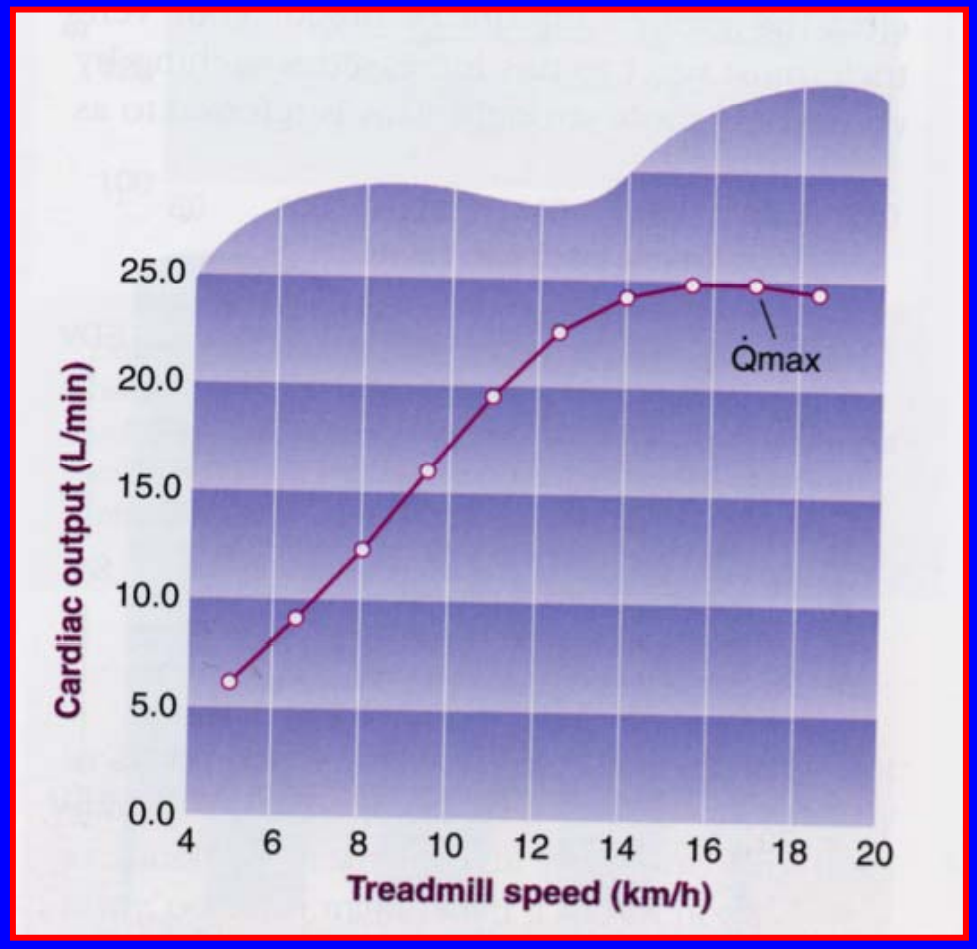
Cardiovascular Response to Acute Exercise

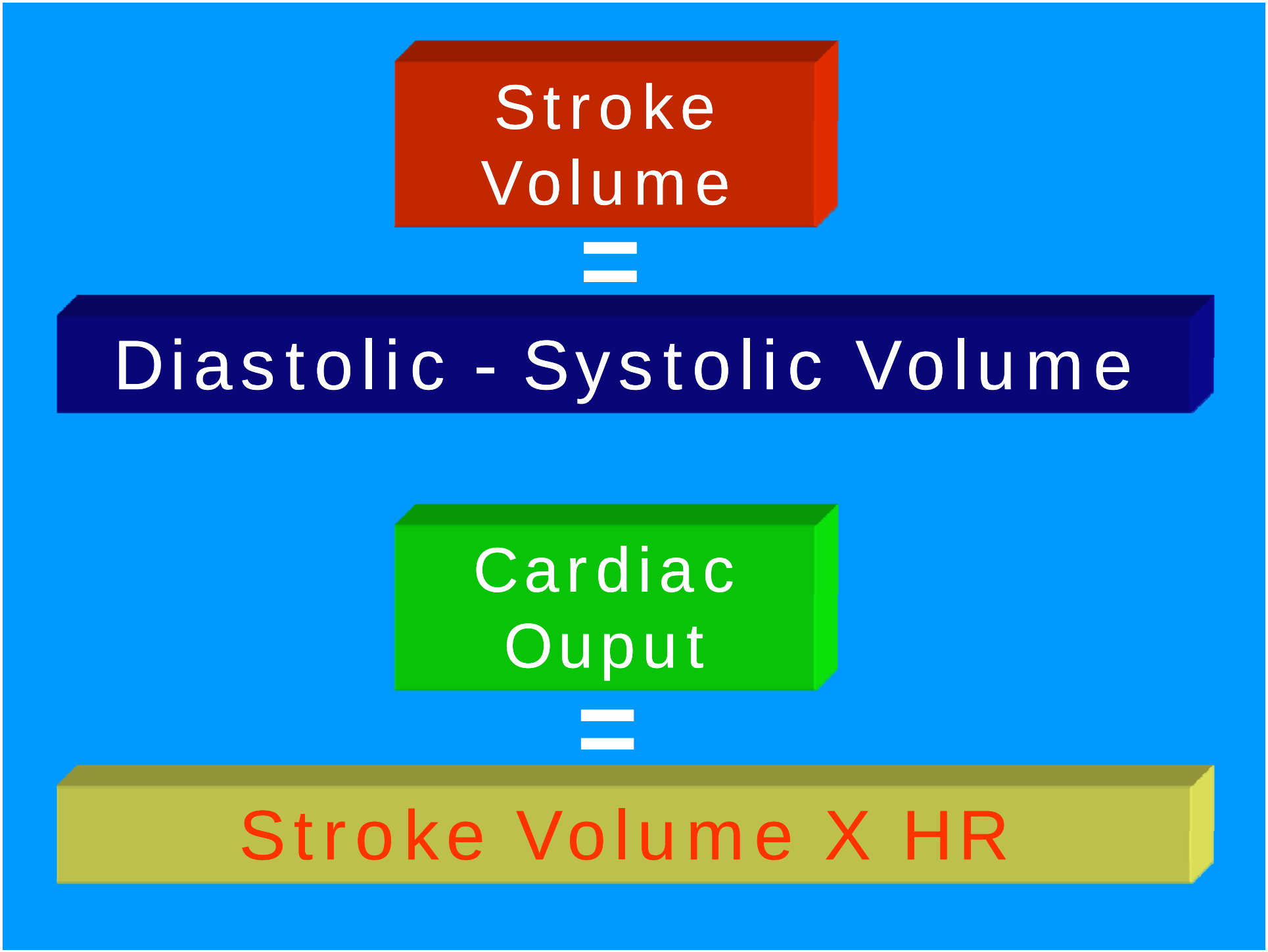
Cardiovascular Response to Acute Exercise (Stroke Volume)



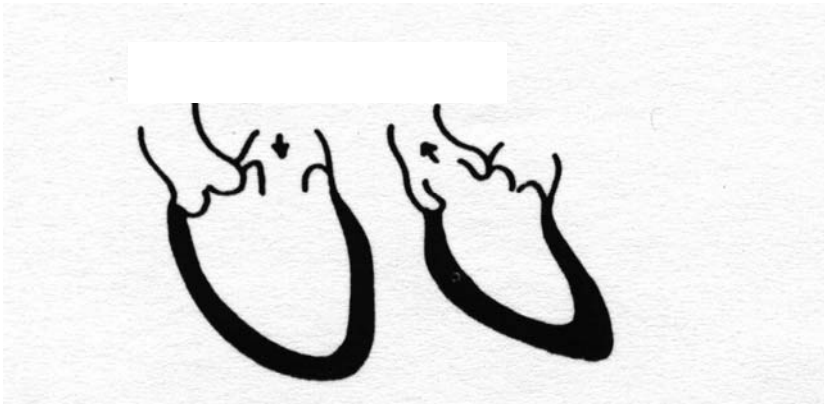


Cardiovascular Response to Acute Exercise (Cardiac Output)




Stroke Volume
=
Diastolic - Systolic Volume
Cardiac Ouput
=
Stroke Volume X HR

CO at rest and during exercise in normal Subject



Diast Vol 120ml Syst Vol 50ml
Stroke vol 70ml
EF%58
Diast Vol 120ml Syst Vol 20ml
Stroke vol 100ml
EF% 83

CO = SV x HR

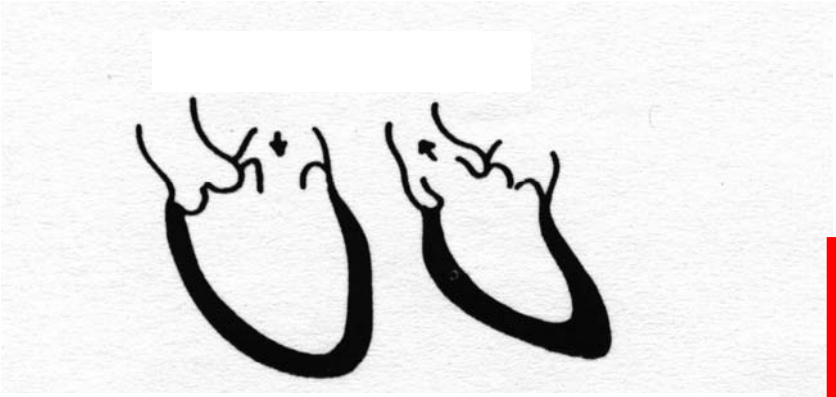
Rest

CO =70mlx50hr=3.5L

Exercise

CO =100mlx180hr=18L

in endurance athlete



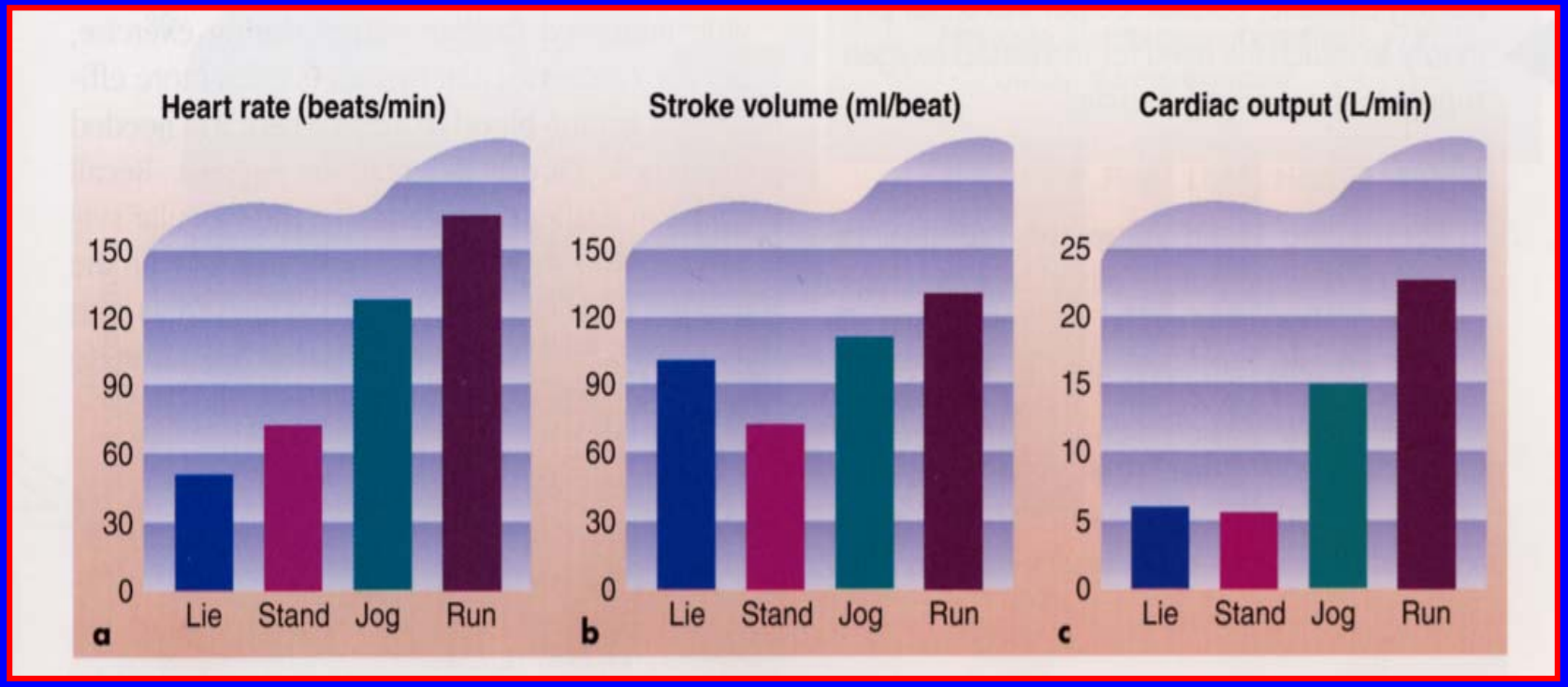
Diast Vol 160ml Syst Vol 90ml
Stroke vol 70ml
EF%48
Diast Vol 160ml Syst Vol 30ml
Stroke vol 130ml
EF%84

CO = SV x HR

Rest
CO=70mlx50hr=3.5L

Exercise
CO=130mlx200hr=26.L

Cardiovascular Response to Acute Exercise

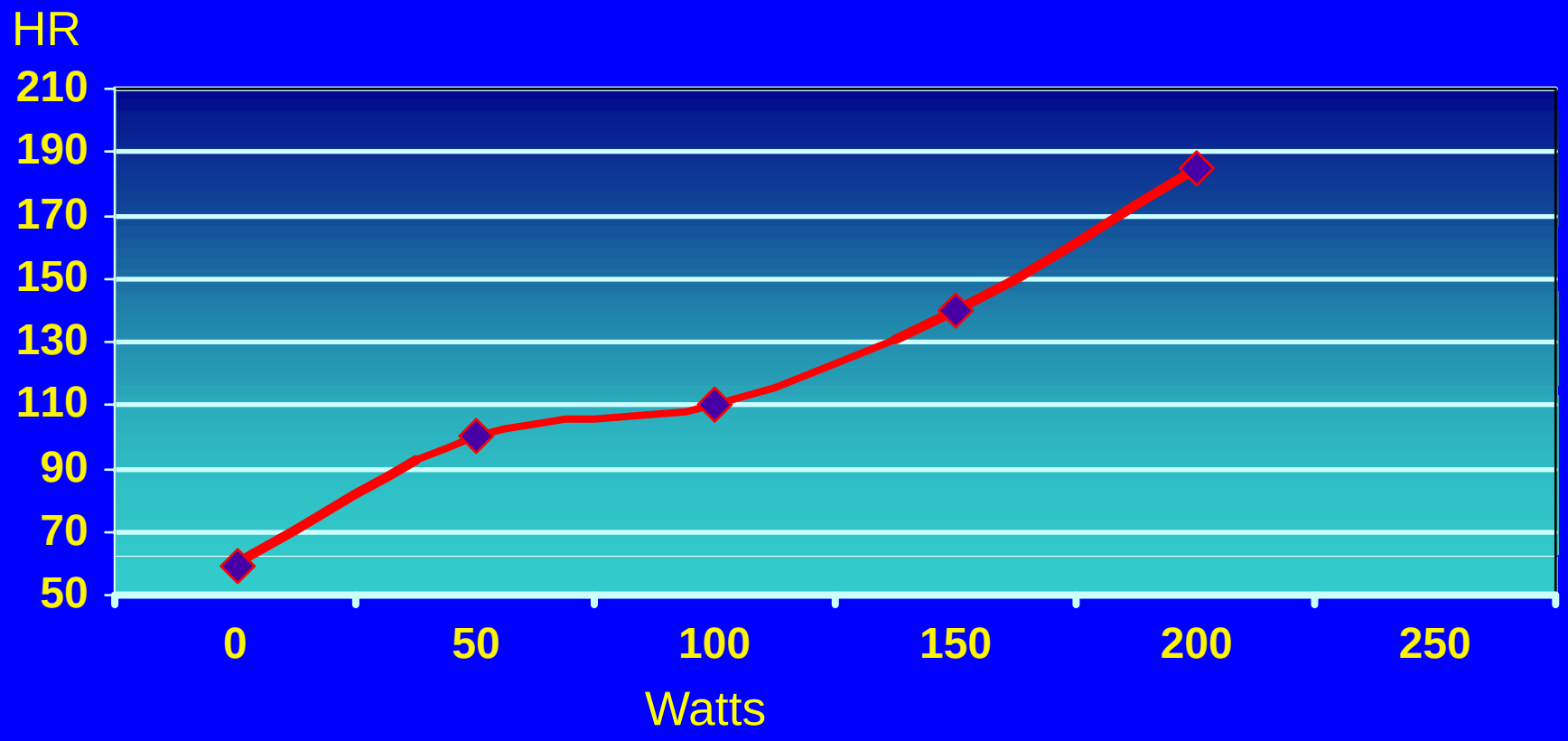


Massimi valori di VO_2, FC, GS e GC in atleti e sedentari

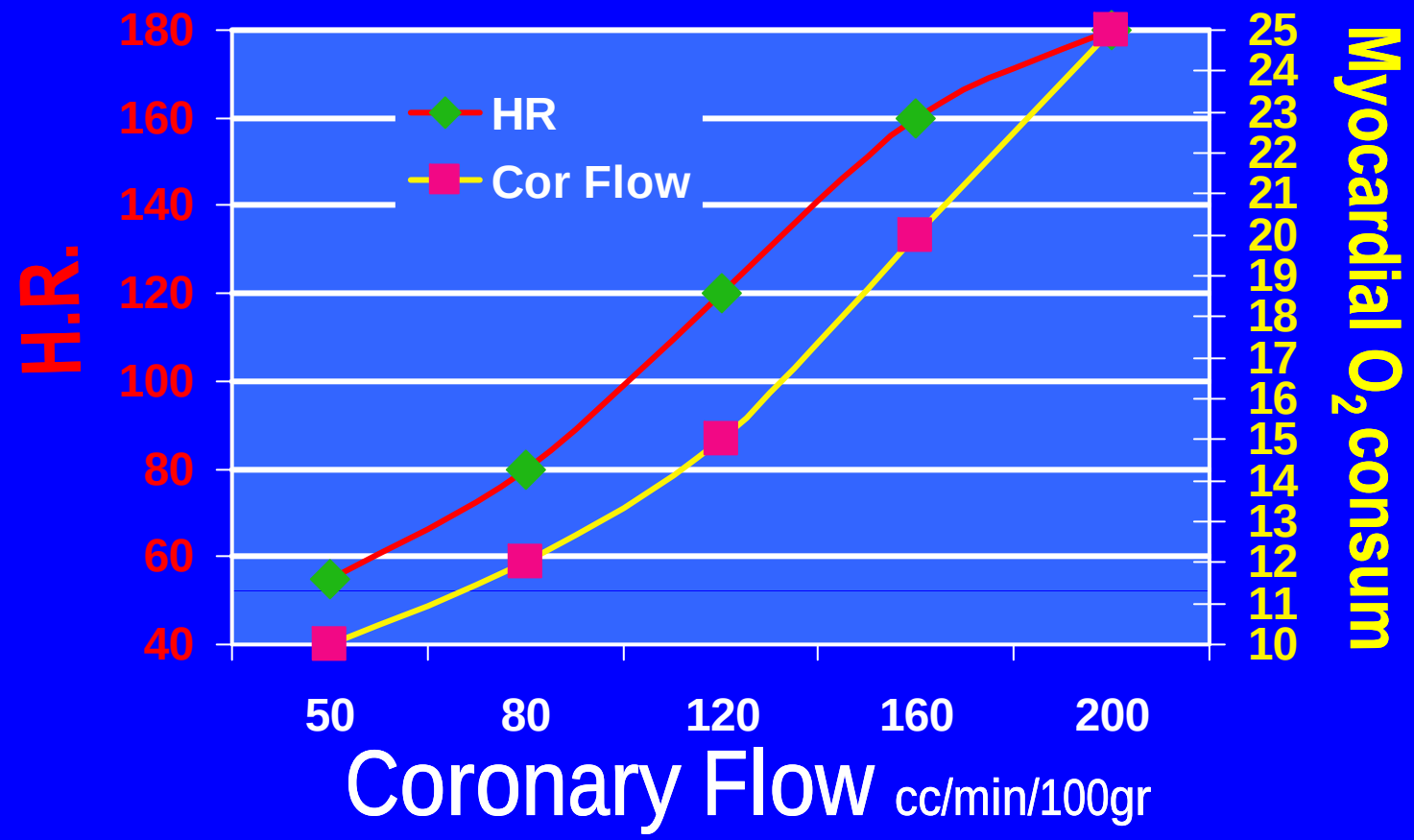
Gruppo	VO2 max (L/min)	FC max (bpm)	GS max (mL)	**GC max (L/min)**
Sedentari	3,2	200	100	20
Atleti	5,2	190	160	30,4

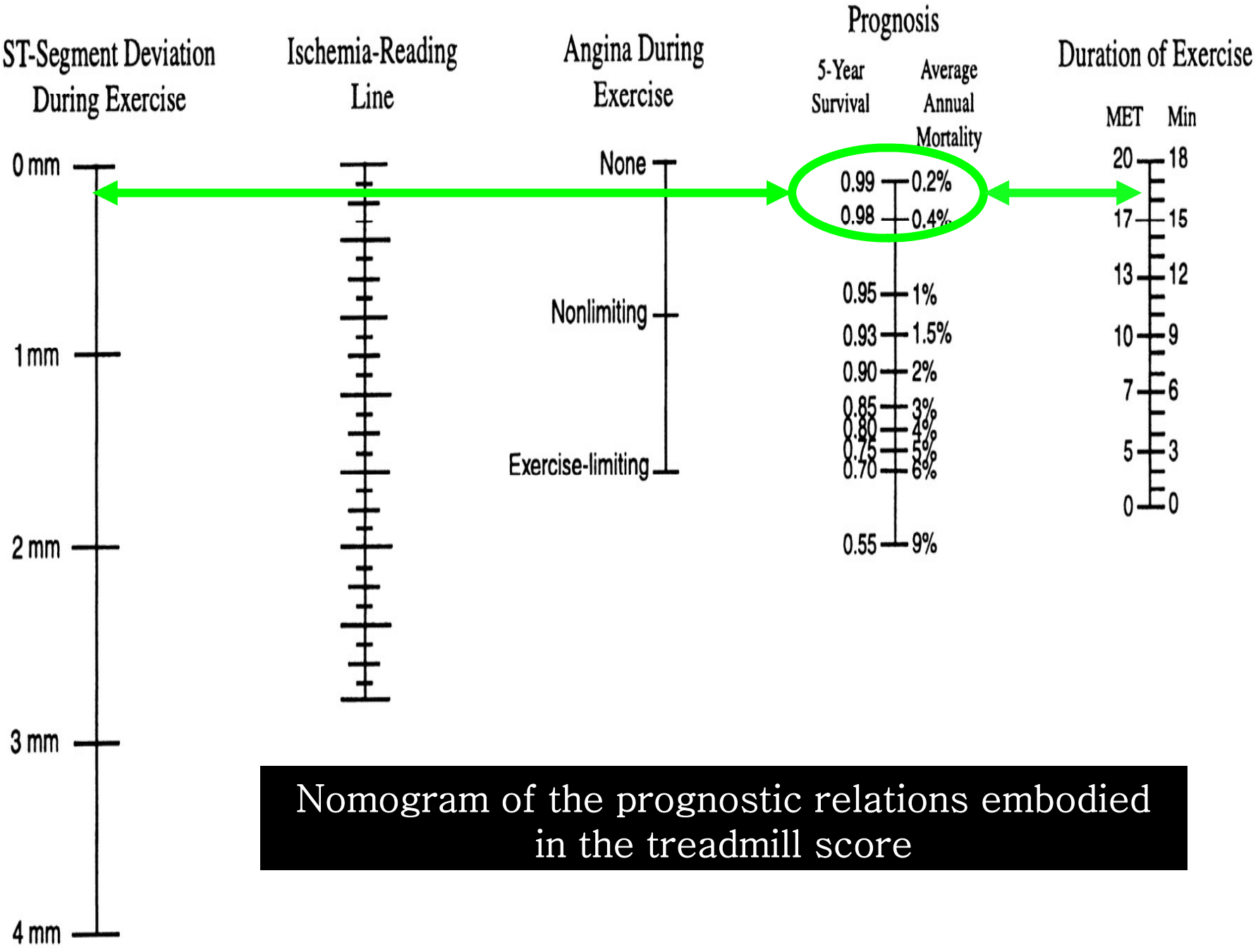
Riflettiamo insieme

Heart Rate in Response to Exercise



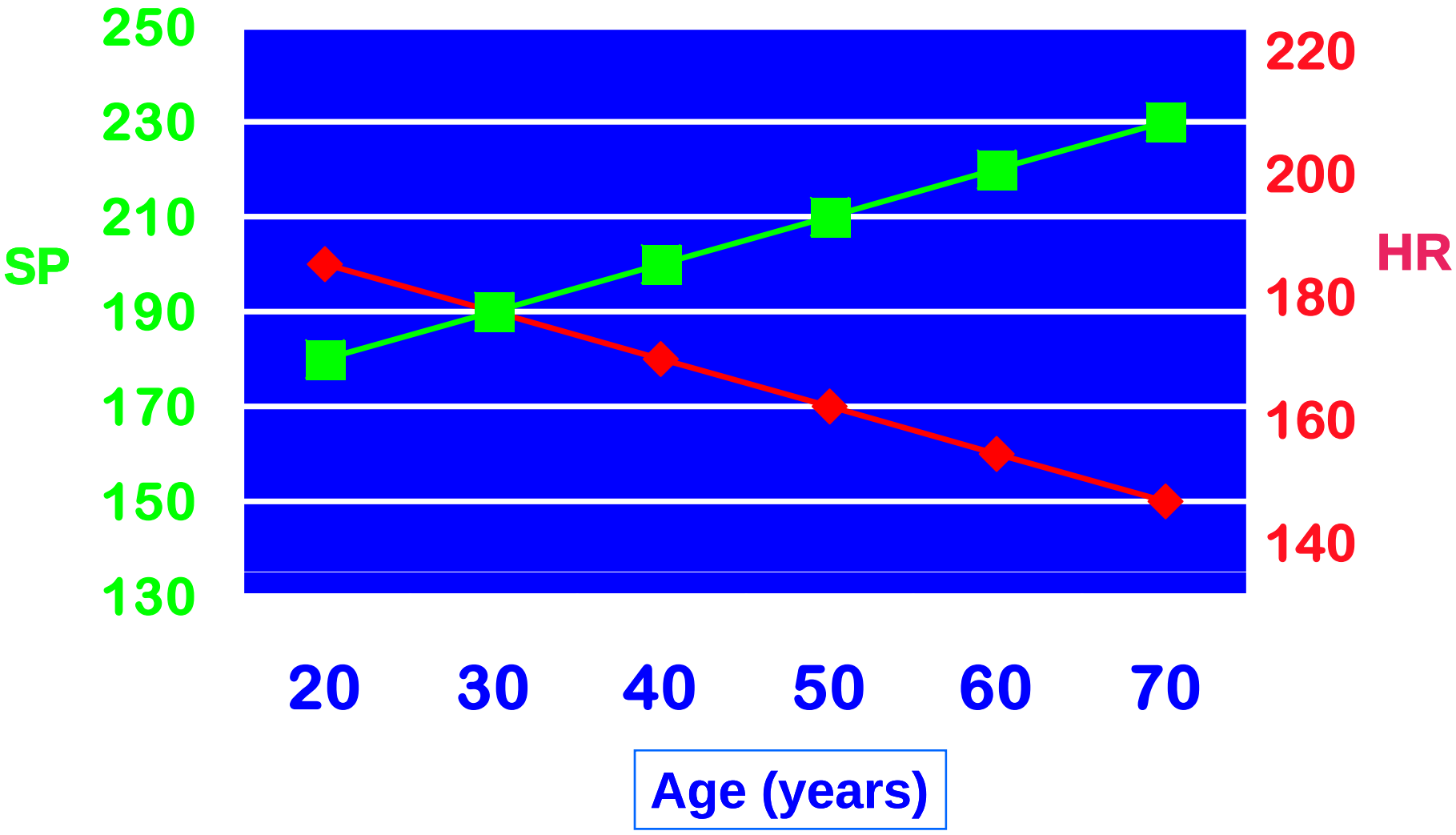
Myocardial O_2 consumption,Heart Rate and Coronary Flow



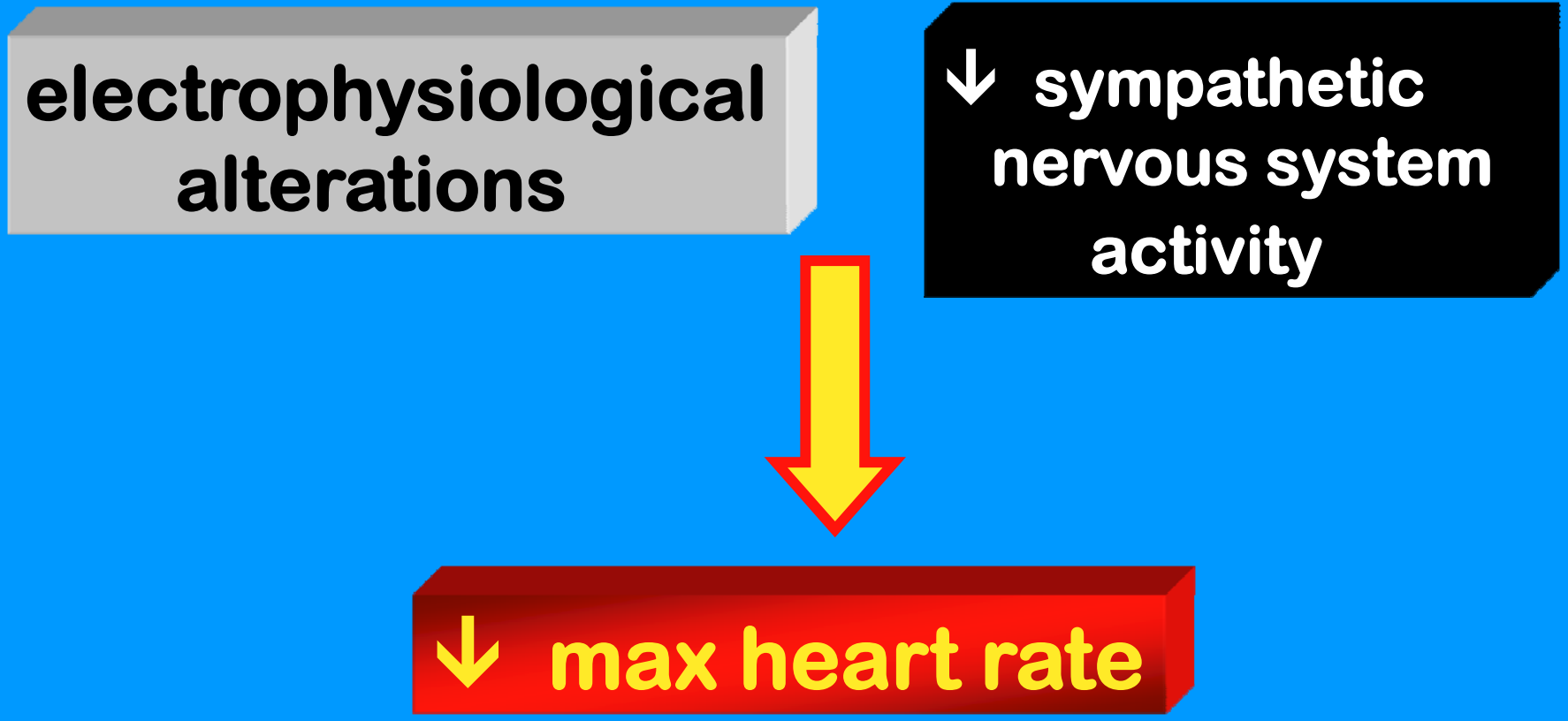


Nomogram of the prognostic relations embodied in the treadmill score

Age,Heart Rate,Systolic Pressure And Acute Exercise



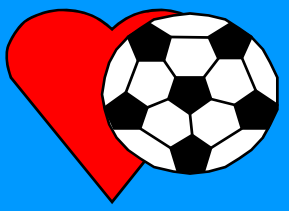
↓ Maximum heart rate



↓Maximum heart rate (Max HR=220-age)

↓ Stroke volume

↓ VO2 max



↓ Stroke volume

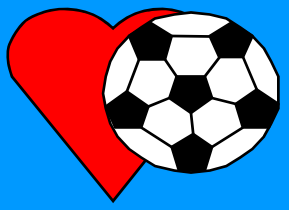
With age arteries begin to lose their elasticity and to reduce capability of vasodilatation

↓

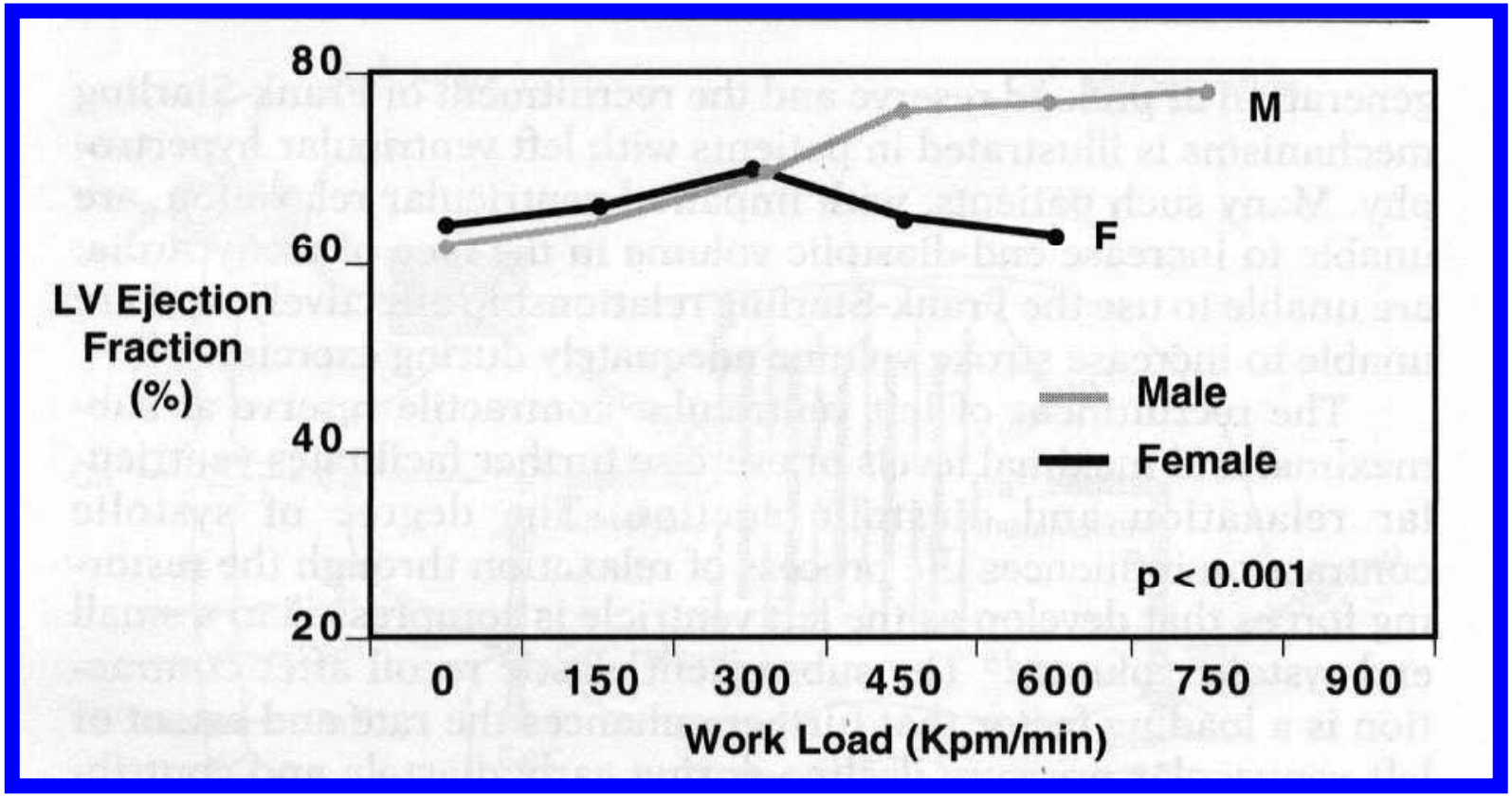
↑ peripheral resistence

↓

↓stroke volume



Cardiovascular Response to Exercise in Men and Women



Cardiovascular response to acute exercise in women

Women' lower stroke volume is related to

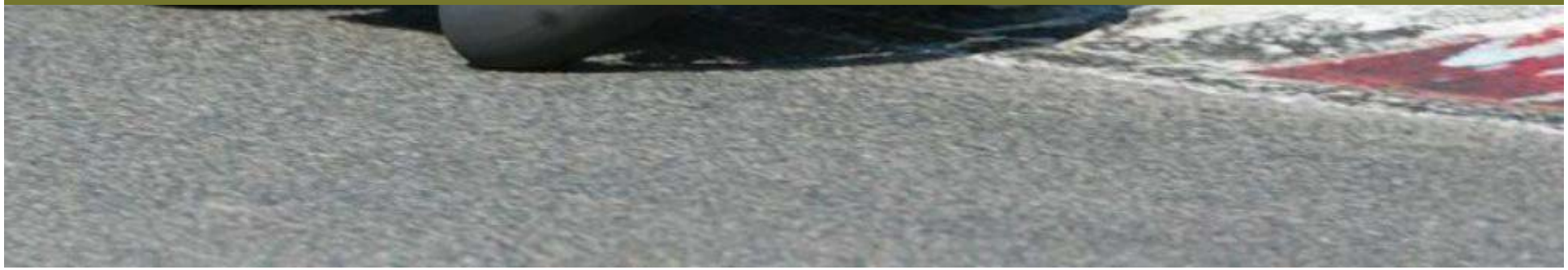
- smaller heart size related to their smaller body surface area (lower testosterone levels)
- Smaller blood volume, also related to smaller body size

Cardiovascular response to acute exercise in women

- women have higher submaximal HR than men
- maximum HR is the same in both sexes
- Cardiac Output (CO) for the same absolute rate of work is the same in both sexes
- increase of CO in women is primarly due to an increase in HR, more than in stroke volume

Exercise and Blood Pressure

(*Blood Pressure=CO x Peripheral Resistance)*



Blood Pressure

=

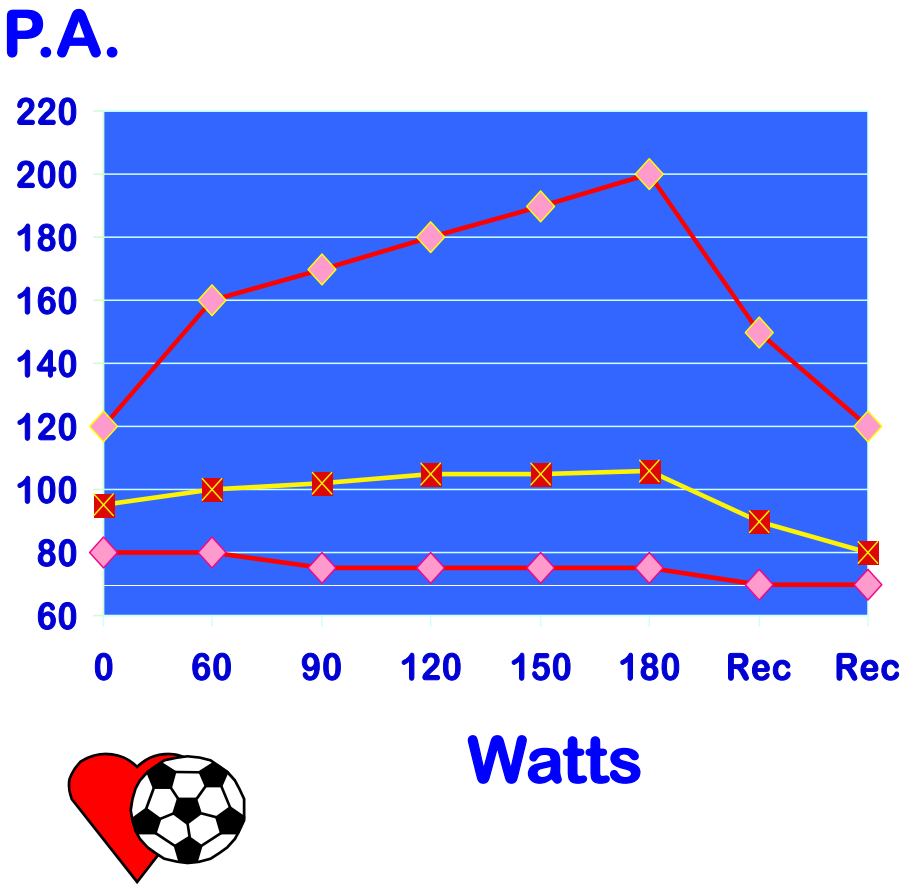
CO x Peripheral Resistance

In normal subjects exercise increases Cardiac Output and/or decreases Peripheral Resistance

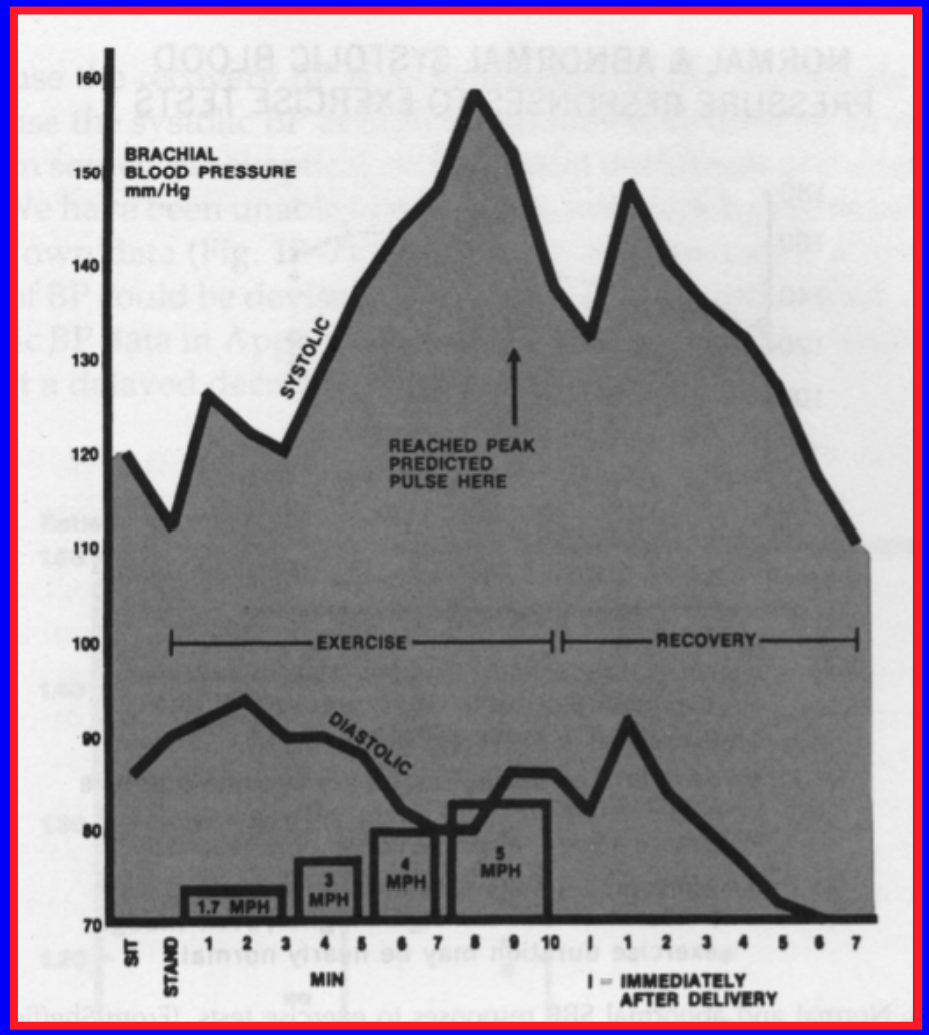
Exercise and Blood Pressure

(*Blood Pressure=CO x Peripheral Resistance)*

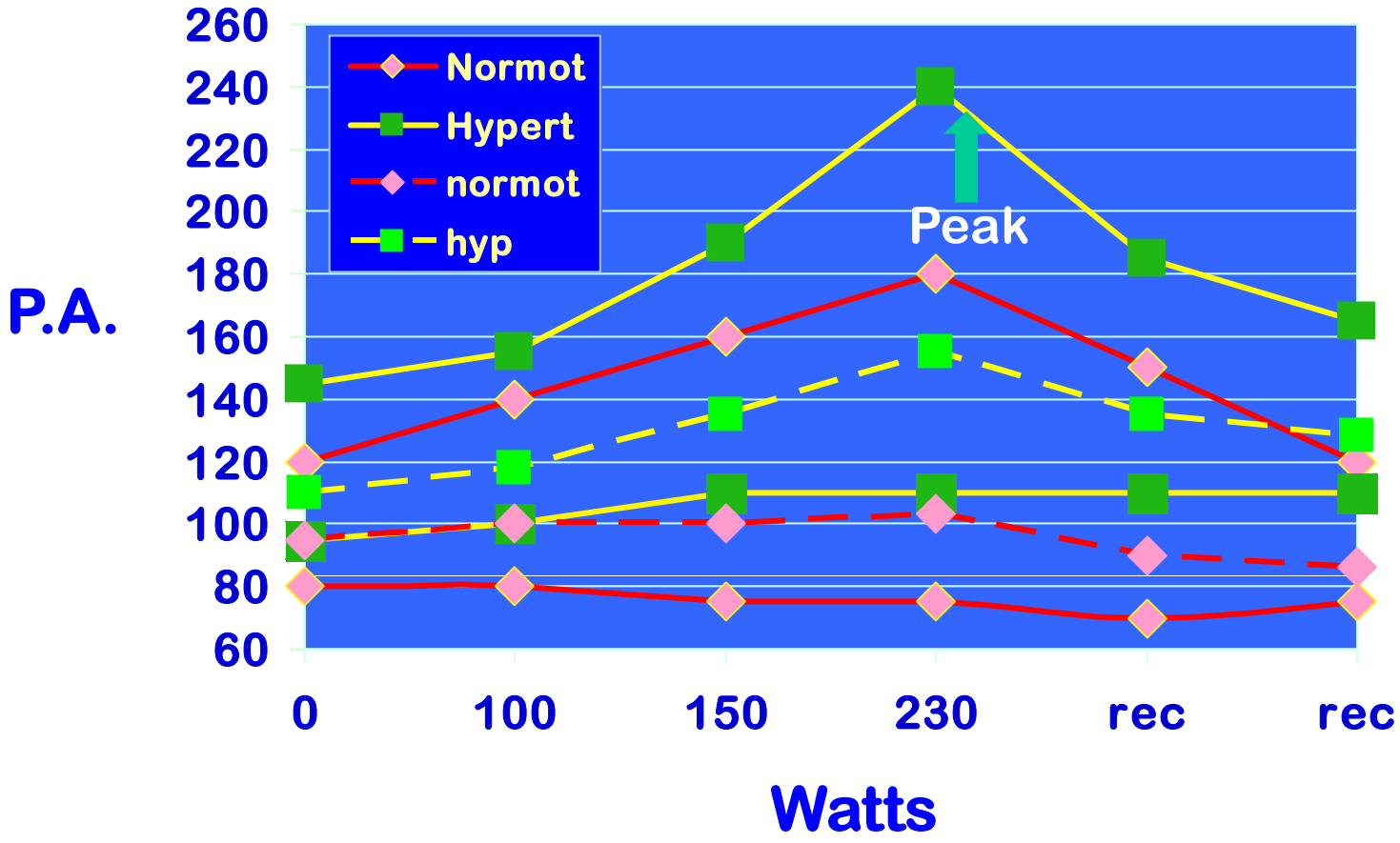
In normal subjects acute exercise increases Cardiac Output and/or decreases Peripheral Resistance with mild increase of Mean Arterial Pressure



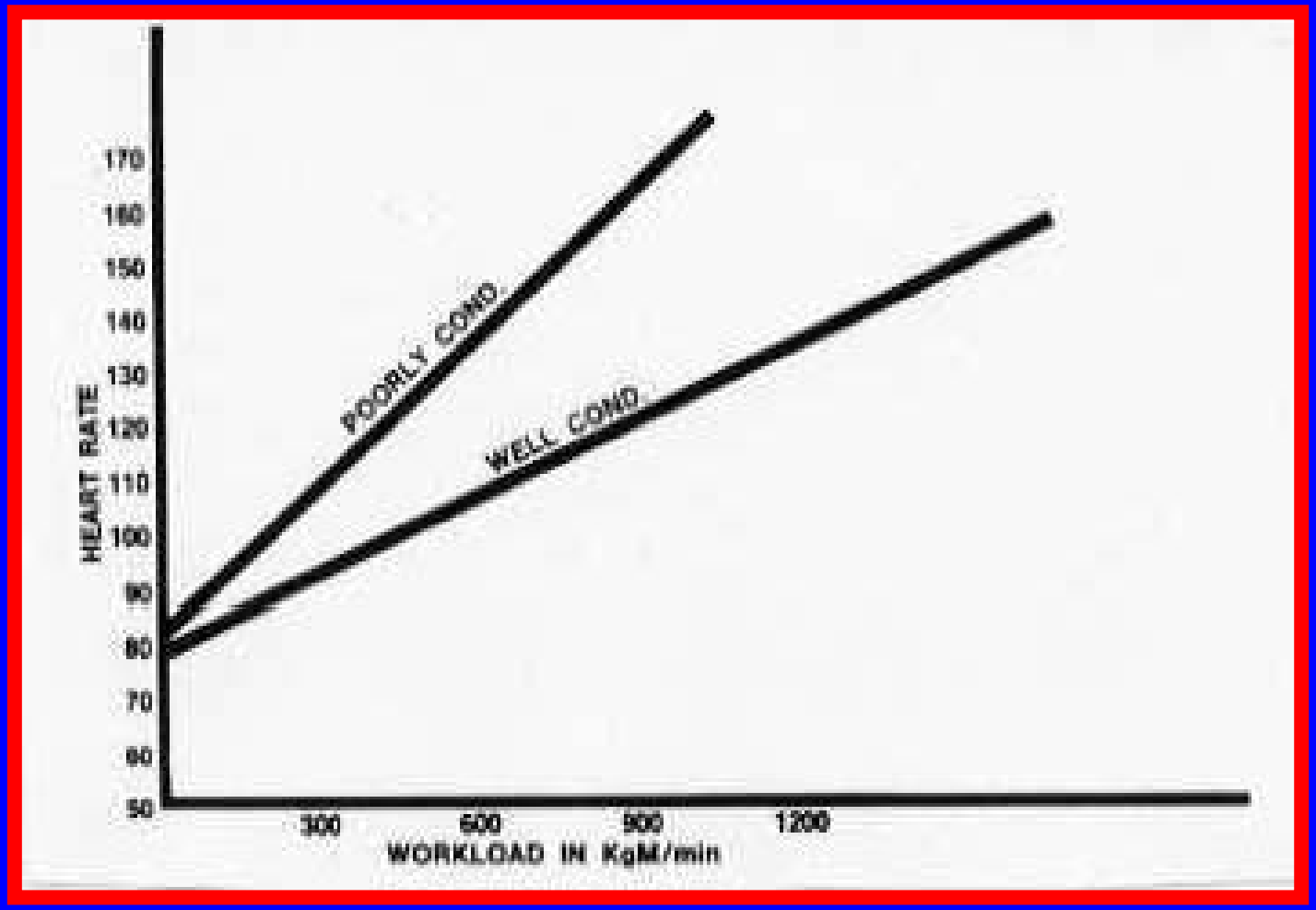
Exercise and Blood Pressure normal subjects



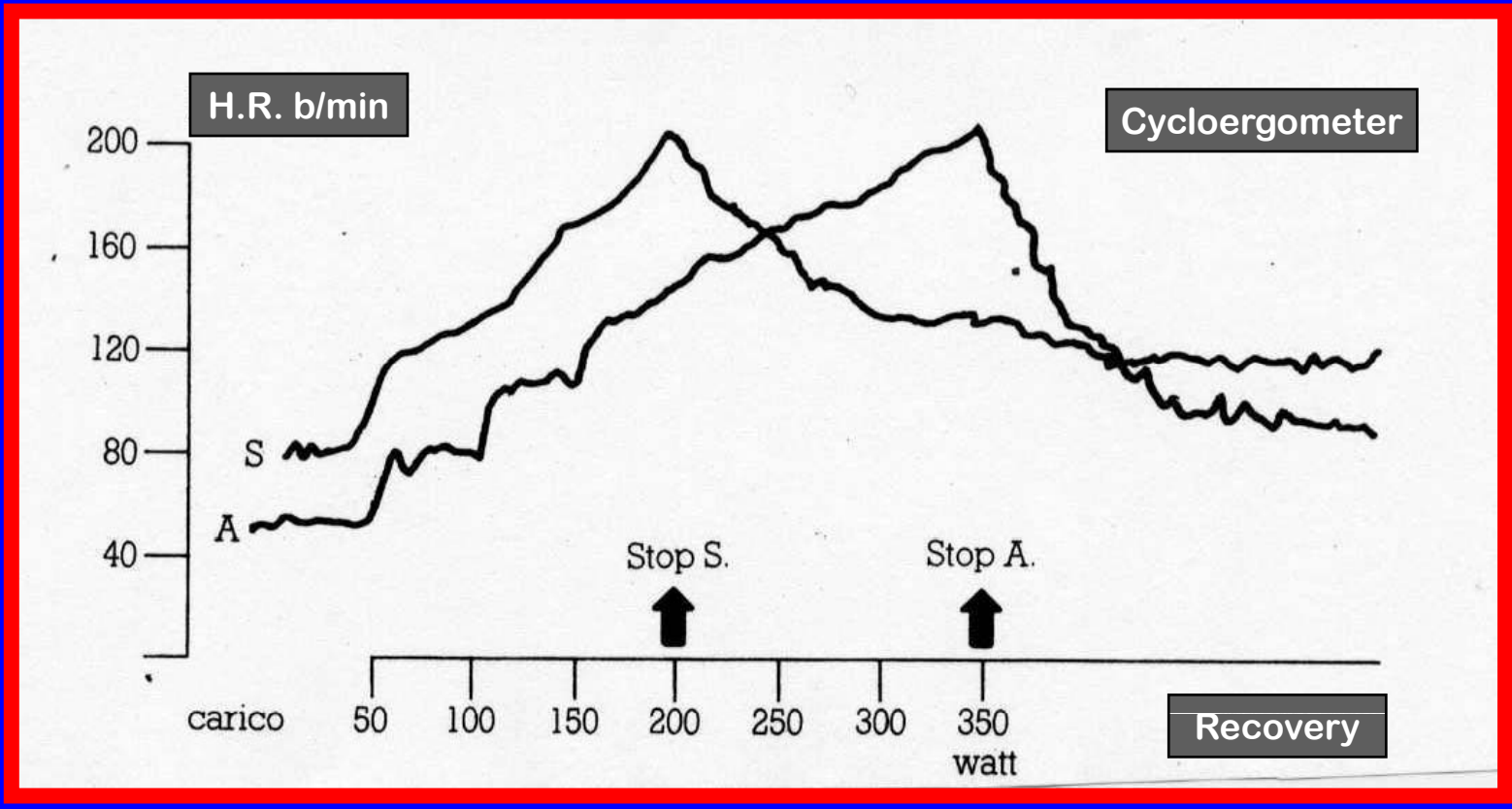
Exercise and Blood Pressure in normal and hypertensive subjects



Cardiovascular Response to Acute Exercise in trained subjects



Cardiovascular Response to Acute Exercise in trained subjects



Risposte cardiovascolari all'esercizio dinamico e statico

ESERCIZIO DINAMICO	ESERCIZIO STATICO
– aumento FC proporzionale alle richieste metaboliche	– minore incremento della FC
– aumento modesto/nullo PA media	– marcato aumento PA media
– prevalente vasodilatazione	– prevalente vasocostrizione
– facilitato ritorno venoso	– ostacolato ritorno venoso
– aumento consumo miocardico O_2	– aumento consumo miocardico O_2
– aumento proporzionale gettata sistolica e portata cardiaca	– aumento "inadeguato" gettata sistolica e portata cardiaca
LAVORO DI VOLUME DEL CUORE	*LAVORO DI PRESSIONE DEL CUORE*

Cardiovascular Response To Exercise

Complete: Any Questions

Heart Rate

(↑ before exercise)

Heart Rate

↑ during exercise

(similar to VO_2)

a-vO_2 difference

(↑ extraction)

Stroke Volume

4 factors

Blood Pressure

↑ Systolic

↔Diastolic

Blood Flow to Muscle

Rest = 20%

Maximal Exercise = 85 - 90%

How?

Cardiovascular Response To Exercise

Complete: Any Questions

Heart Rate
(↑ before exercise)

Heart Rate
↑ during exercise
(similar to VO_2)

Heart rate increases before exercise due to sympathetic nervous system anticipation of exercise

Heart rate during exercise increases similar to VO2 (However, VO2 is more closely related to the actual workout intensity)

Cardiovascular Response To Exercise

Complete: Any Questions

a-vO_2 difference
(↑ extraction)

a-vO2 difference shows enhanced extraction of oxygen at capilaries in muscle cells

Cardiovascular Response To Exercise

Complete: Any Questions

Blood Flow to Muscle

Blood flow to muscle is dramatically enhanced
Utilizing the redistribution

Cardiovascular Response To Exercise

Complete: Any Questions

Stroke Volume

Four Factors of Stroke Volume:

1) Increased venous blood return (EDV)

2) Ventricular stretch (capacity to enlarge):Also referred to as Preload or Frank-Starling mechanism

3) Ventricular contractility

4) Aortic and pulmonary artery blood pressure

Cardiovascular Response To Exercise

Complete: Any Questions

Systolic blood pressure increases with exercise intensity.

Diastolic pressure should stay pretty stable in health individuals.

Heart rate increases before exercise due to sympathetic nervous system anticipation of exercise

Heart rate during exercise increases similar to VO2 (However, VO2 is more closely related to the actual workout intensity)

Four Factors of Stroke Volume:

1) Increased venous blood return (EDV)
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3) Ventricular contractility
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Blood flow to muscle is dramatically enhanced