Muscoli Respiratori ed Esercizio

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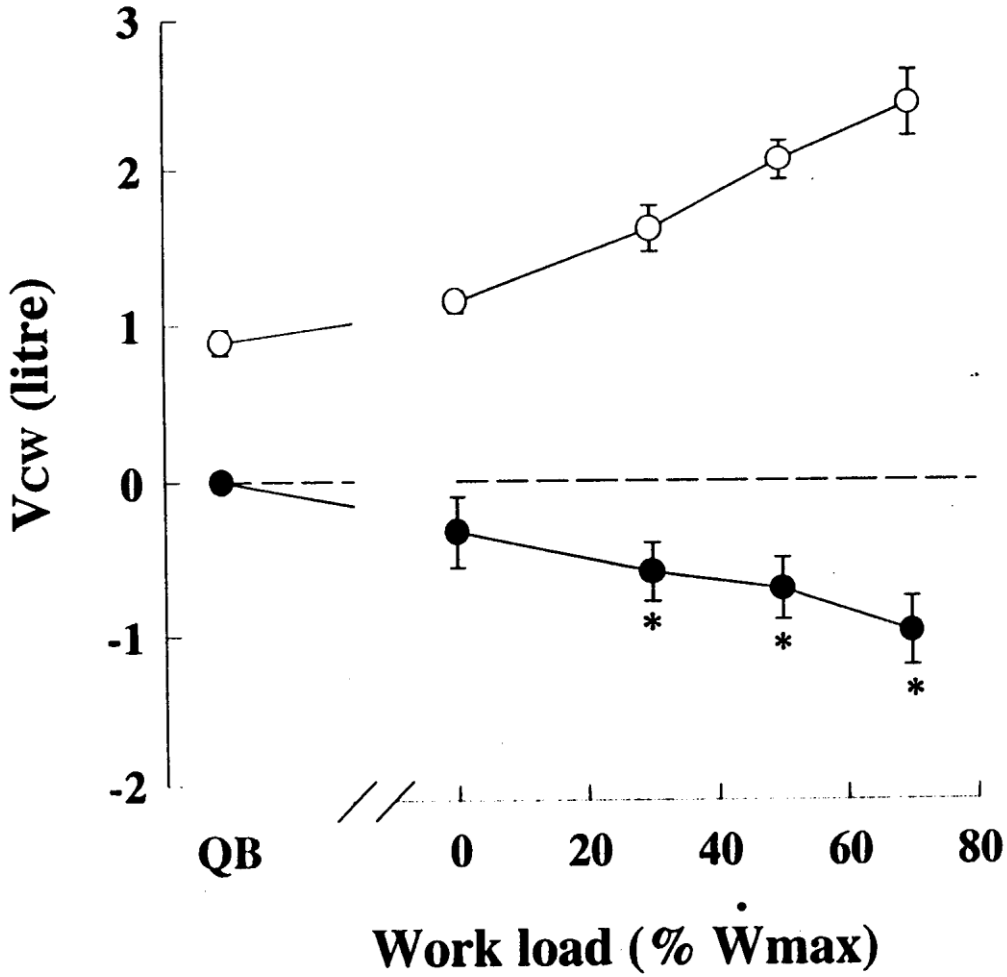
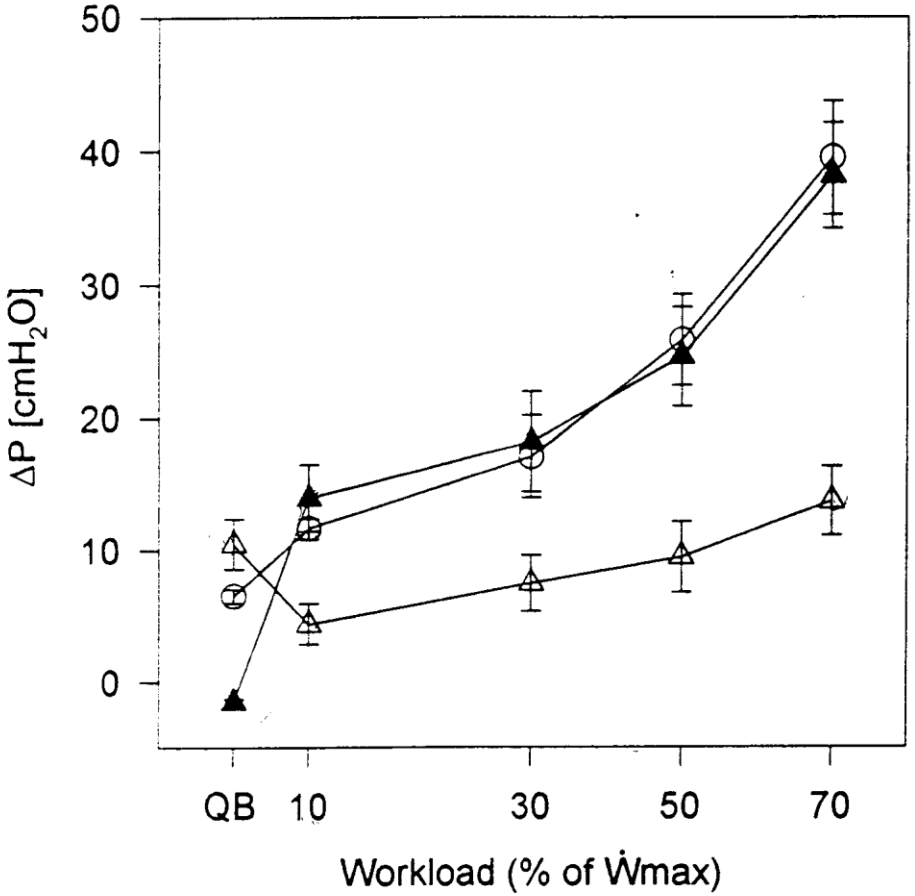
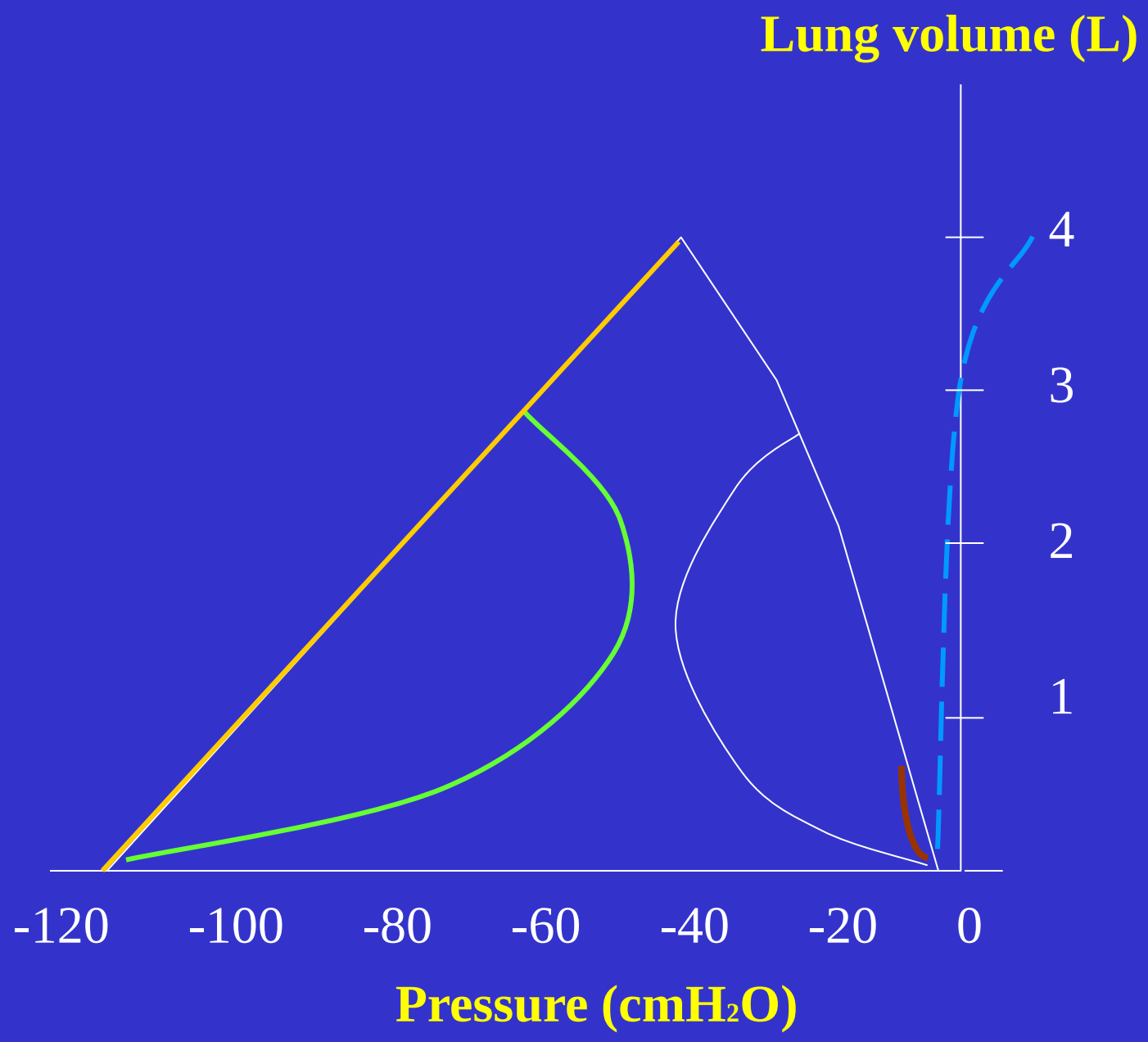
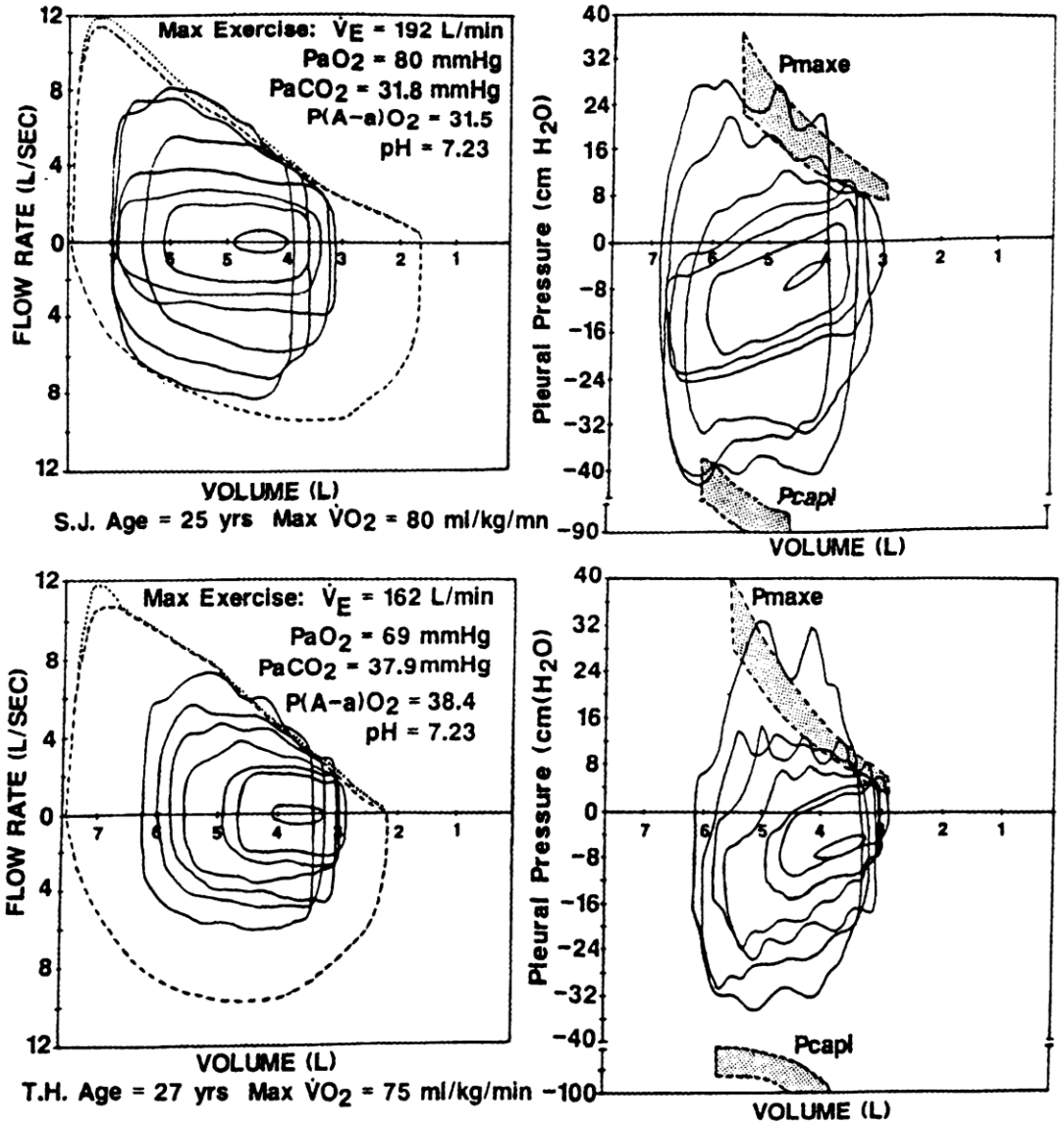
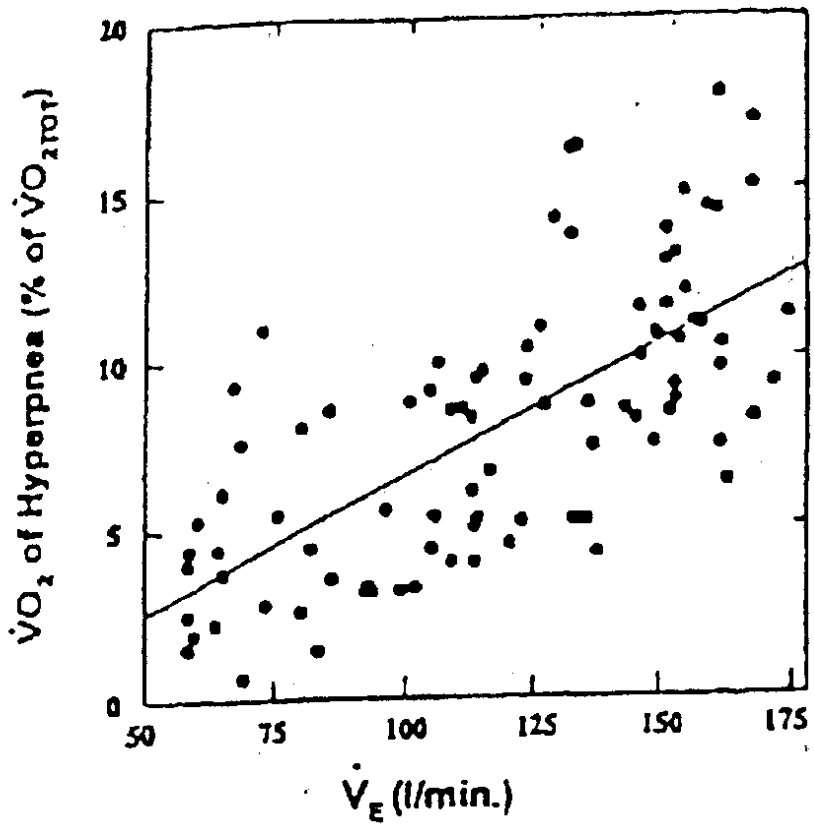

3
2
1
0
-1
-2
VCW (litre)
QB
0
20
40
60
80
Work load (% Ẇmax)
*
*
*

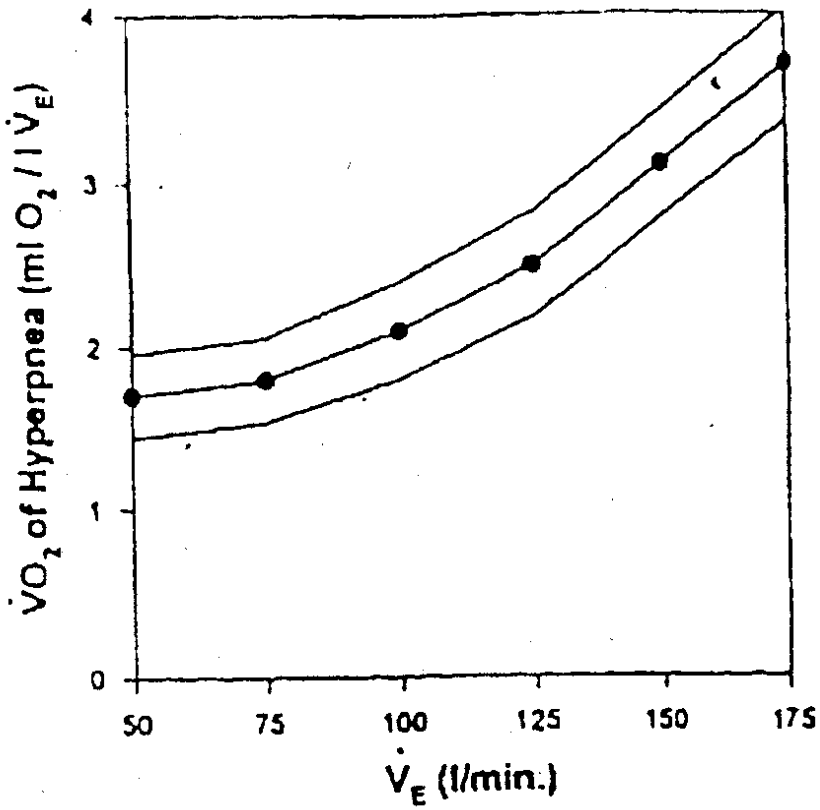

50
40
30
20
10
0
ΔP [cmH2O]
QB
10
30
50
70
Workload (% of Ẇmax)


Lung volume (L)
4
3
2
1
-120
-100
-80
-60
-40
-20
0
Pressure (cmH2O)



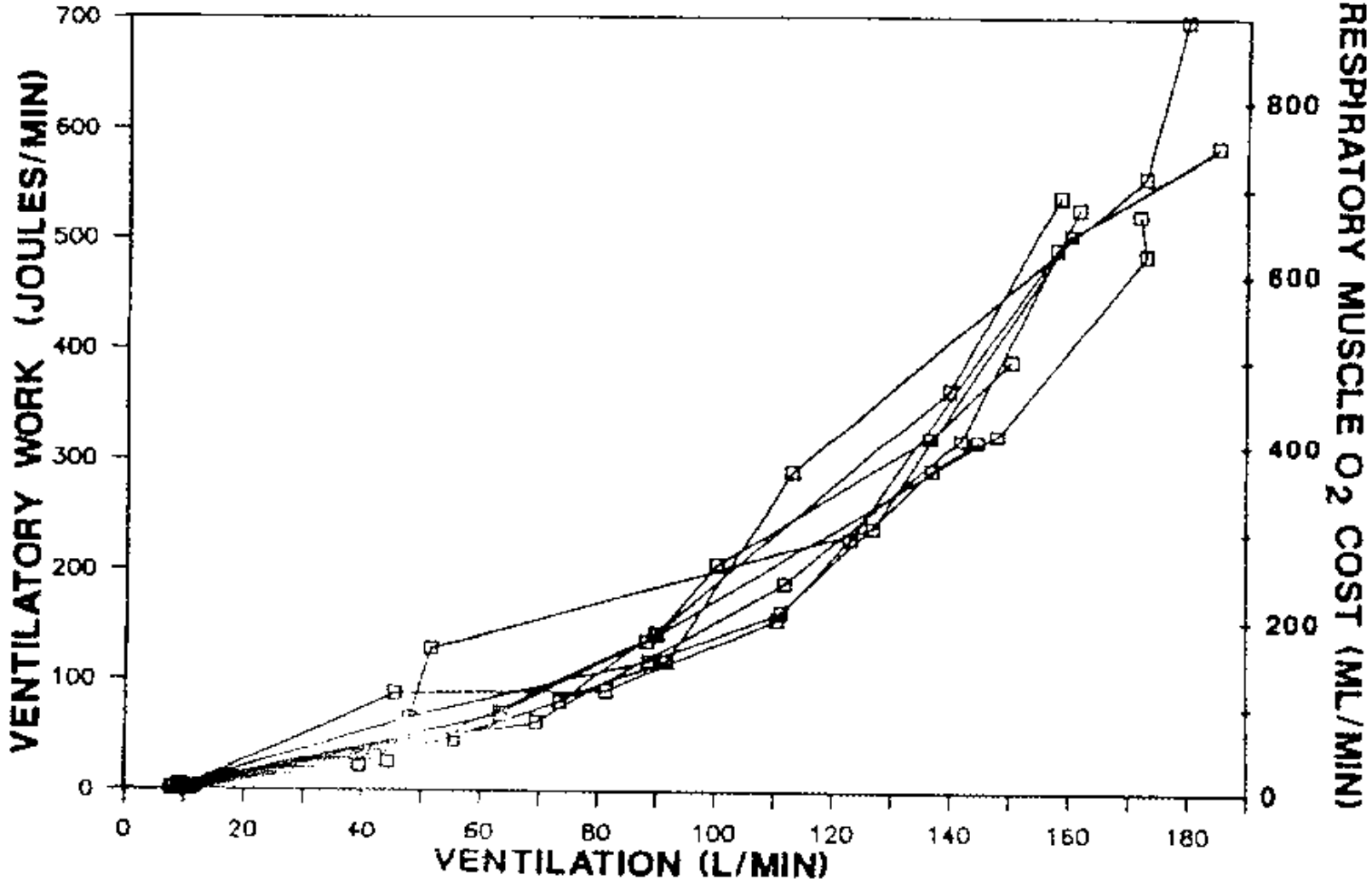
Johnson B JAP 1992





Dempsey Med Sci Sports Exerc 1995

MECHANICAL LIMITS TO EXERCISE VENTILATION



Johnson B JAP 1992

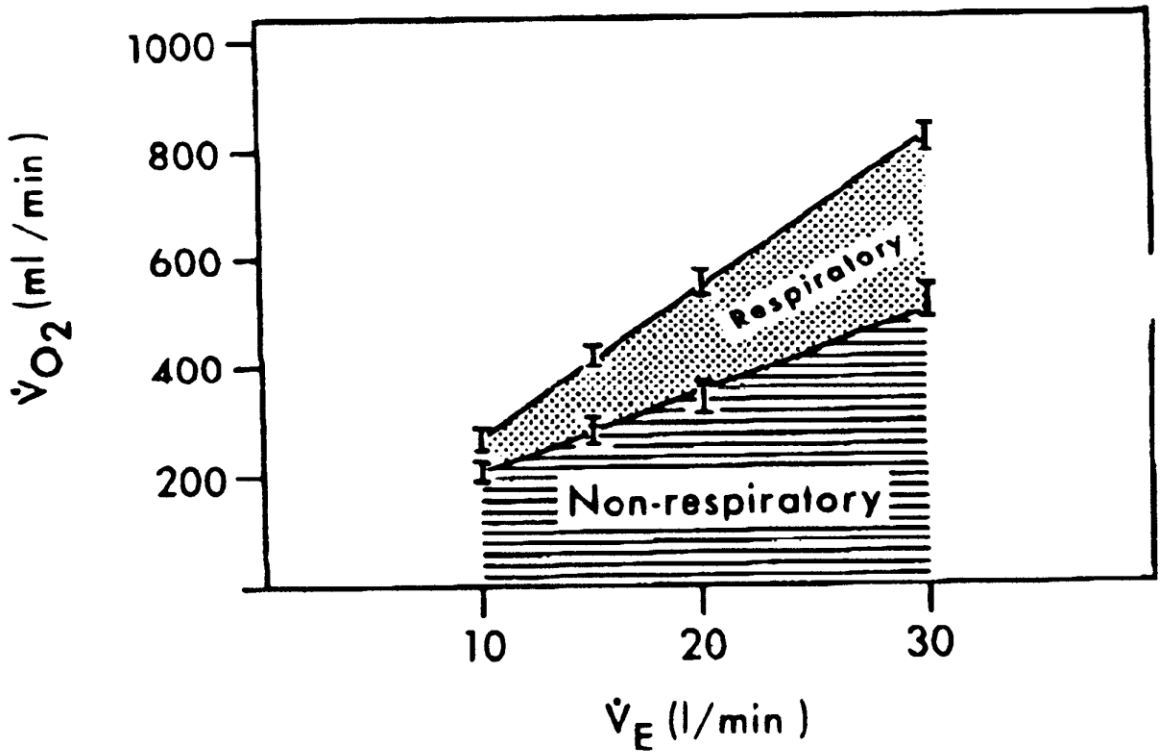


FIG. 5. Relationship between ventilation and total oxygen consumption and its respiratory and nonrespiratory components during exercise in 17 patients with chronic obstructive pulmonary disease. Means and standard errors are shown.

Levison H. JAP 1968

	At anaerobic threshold			At maximal exercise		
	$\dot{V}_E$ l/min	$\dot{V}_{O_2}$, tot ml/min	$\dot{V}_{O_2}$, resp ml/min	V_E l/min	$\dot{V}_{O_2}$, tot ml/min	$\dot{V}_{O_2}$, resp ml/min
Normal	55	1,500	150[a]	100	2,500	300[b]
COPD	12	300	144[c]	40	1,000	480[c]

V_E = Ventilatory rate (minute ventilation); $\dot{V}_{O_2}$, tot = total body O_2 uptake; $\dot{V}_{O_2}$, resp = respiratory muscle O_2 uptake.

[a] Calculated assuming a $\dot{V}_{O_2}$, resp of 2 ml O_2/min/l ventilated.

[b] Calculated assuming a $\dot{V}_{O_2}$, resp of 3 ml O_2/min/l ventilated.

[c] Calculated assuming a $\dot{V}_{O_2}$, resp of 12 ml O_2/min/l ventilated.

Aliverti & Macklem. 2001

When

$$\Delta VO_2rm/\Delta VE=\Delta VO_2tot/\Delta VE$$

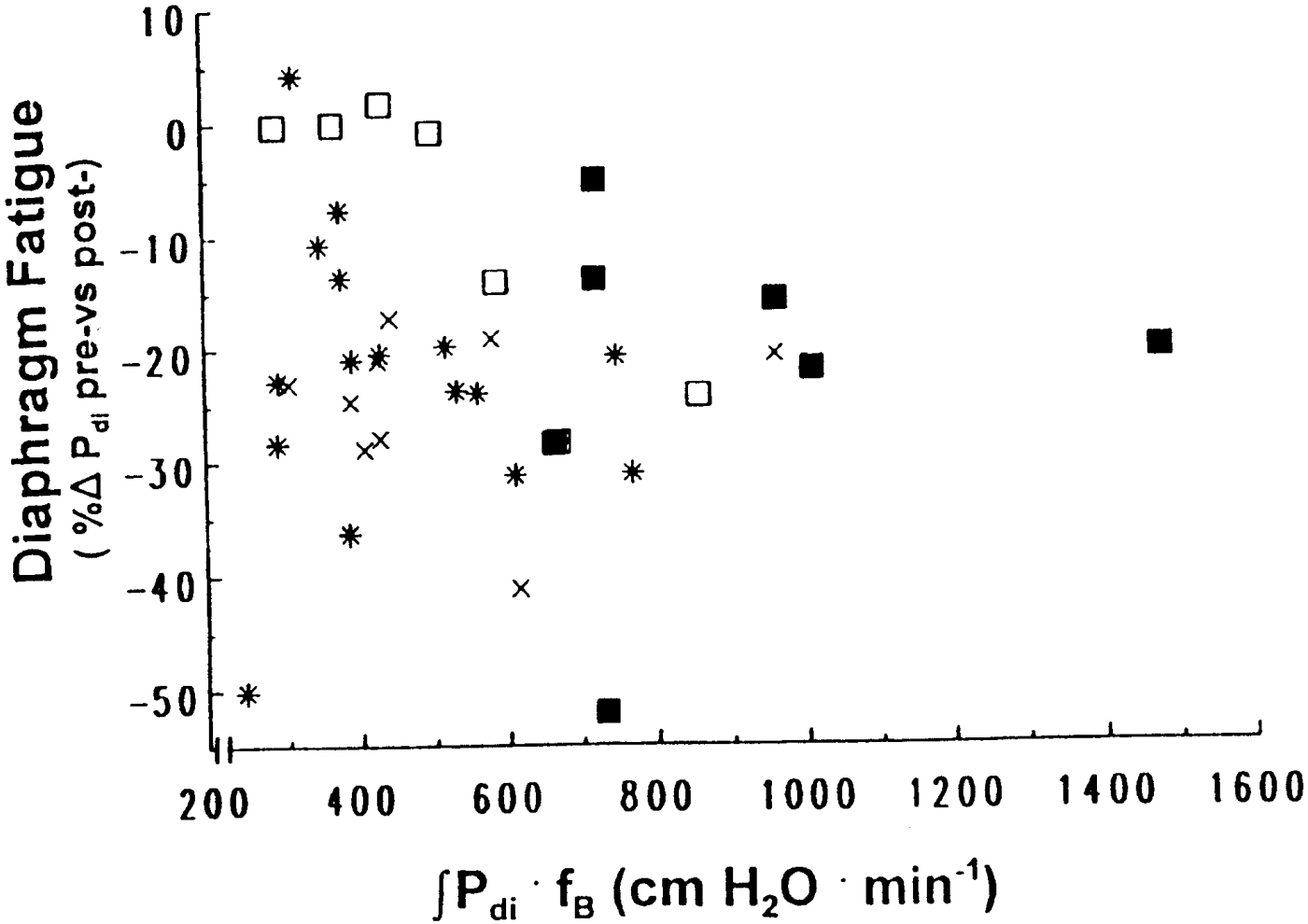
any further increase in VE will result in less energy for doing useful external work because the respiratory muscles will use all the additional O_2 provided by increase in VE

Ventilatory –locomotor muscle competition during exercise in healthy subjects

“fatigue of the RM may be an important mechanism contributing to both redistribution of blood flow and exercise tolerance”.

(Babcock JAP,2001 and 2002)

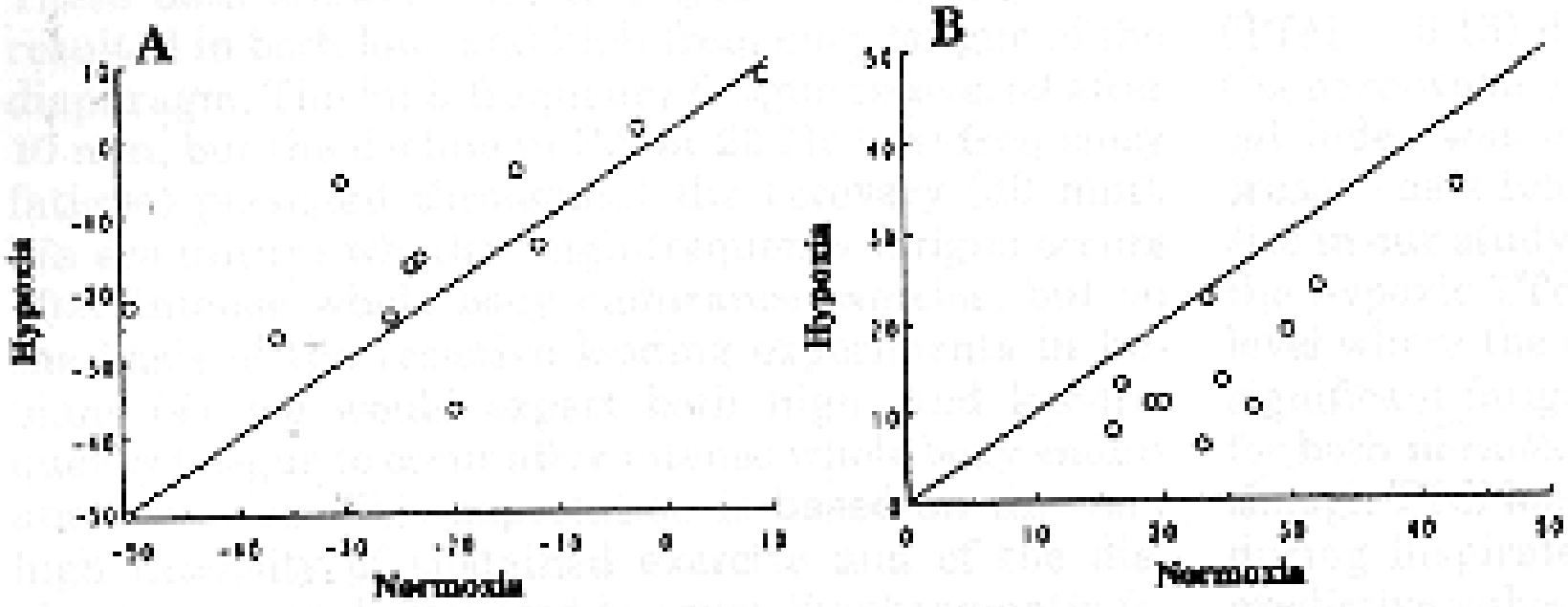
DIAPHRAGMATIC WORK EFFEC'



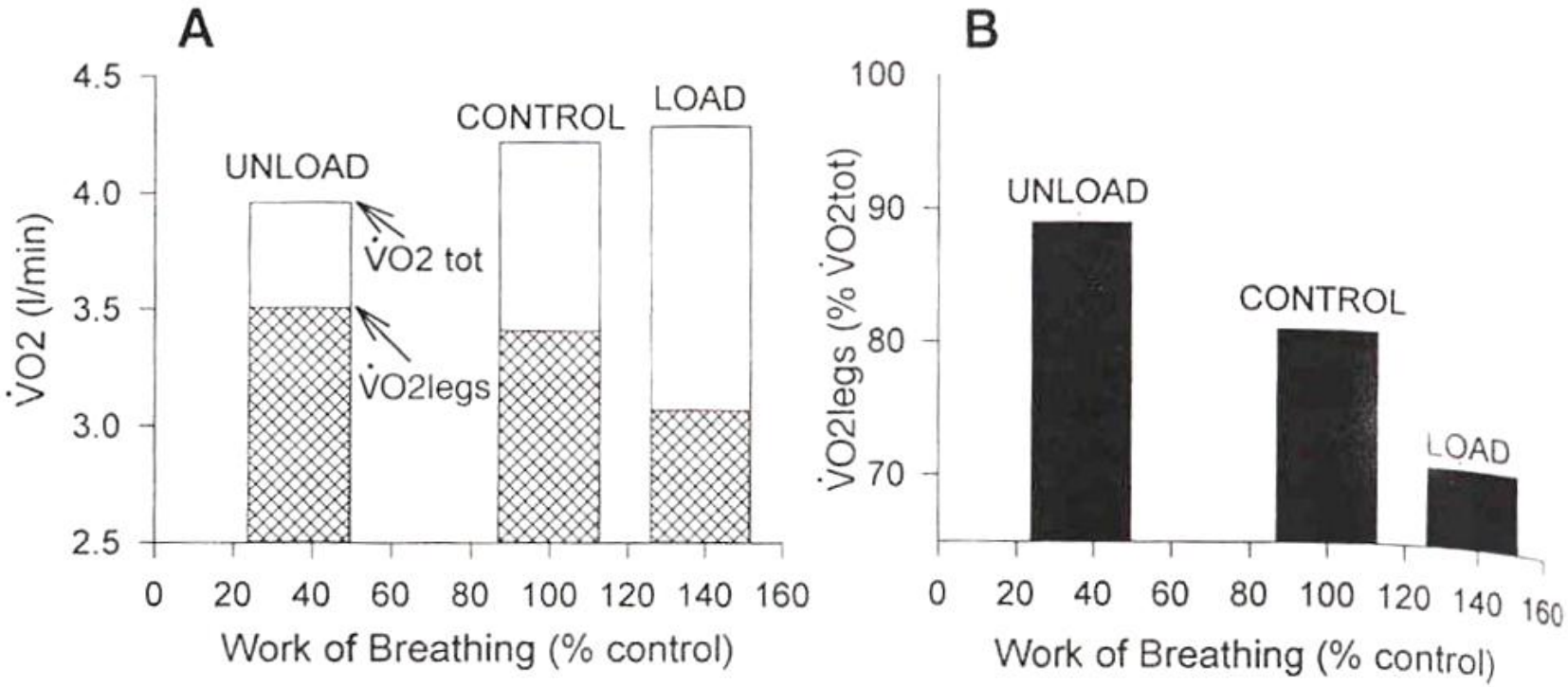
Babcock M.A.. JAP 1995

Fatigue index

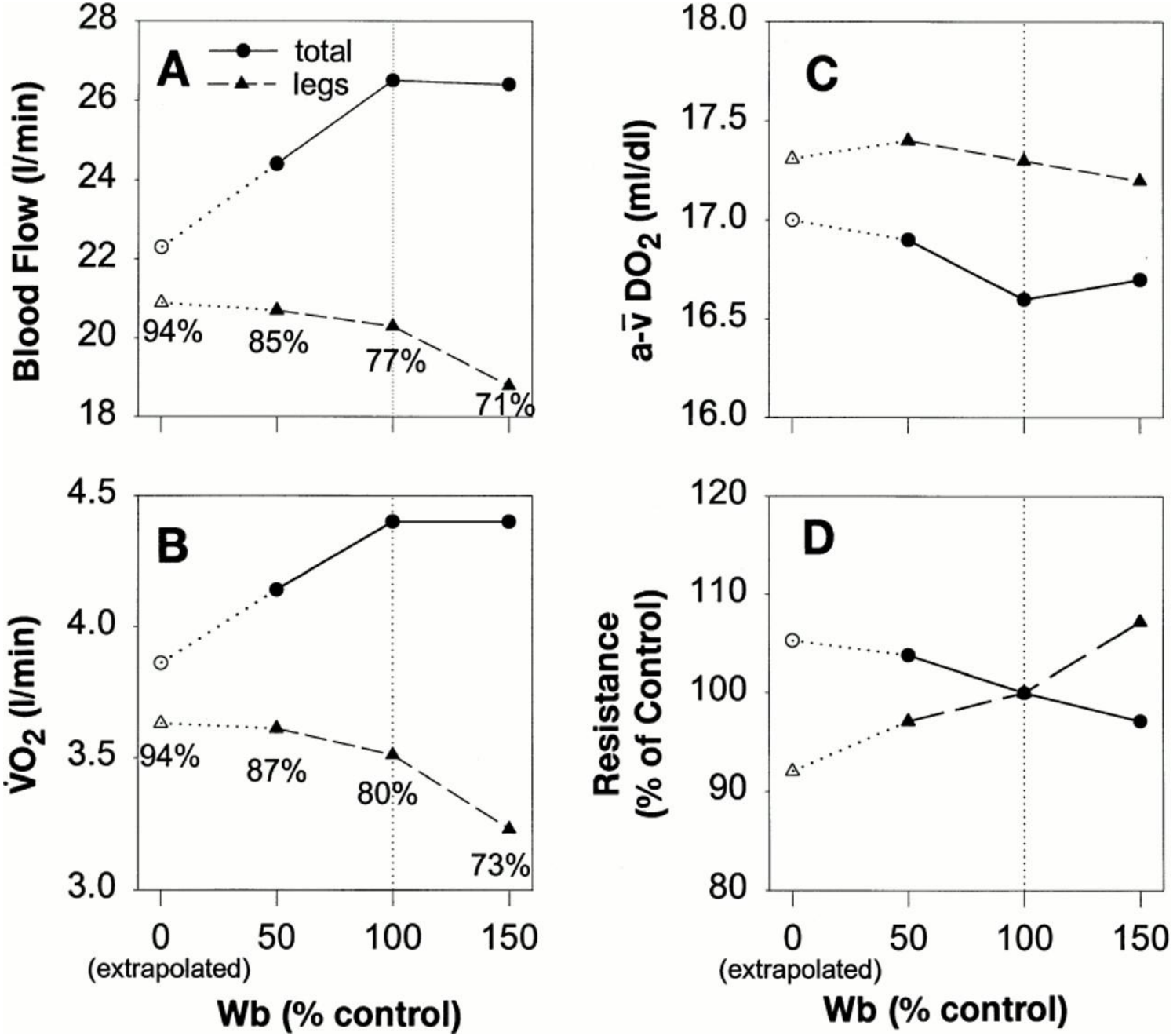
Exercise duration



Babcock MA JAP 1995



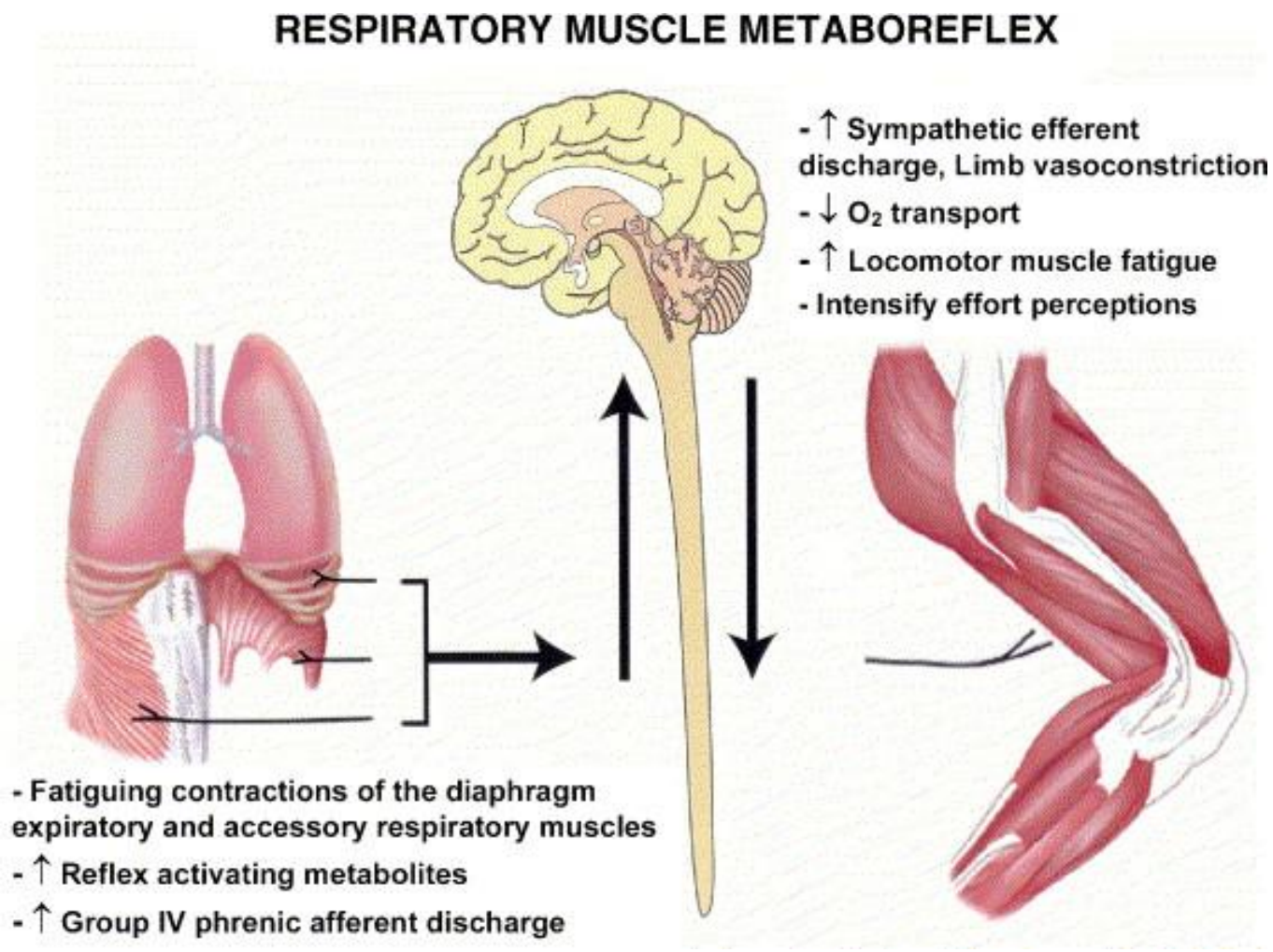
Harms C. J Appl Physiol 1997



Harms C, J Appl Physiol 1998

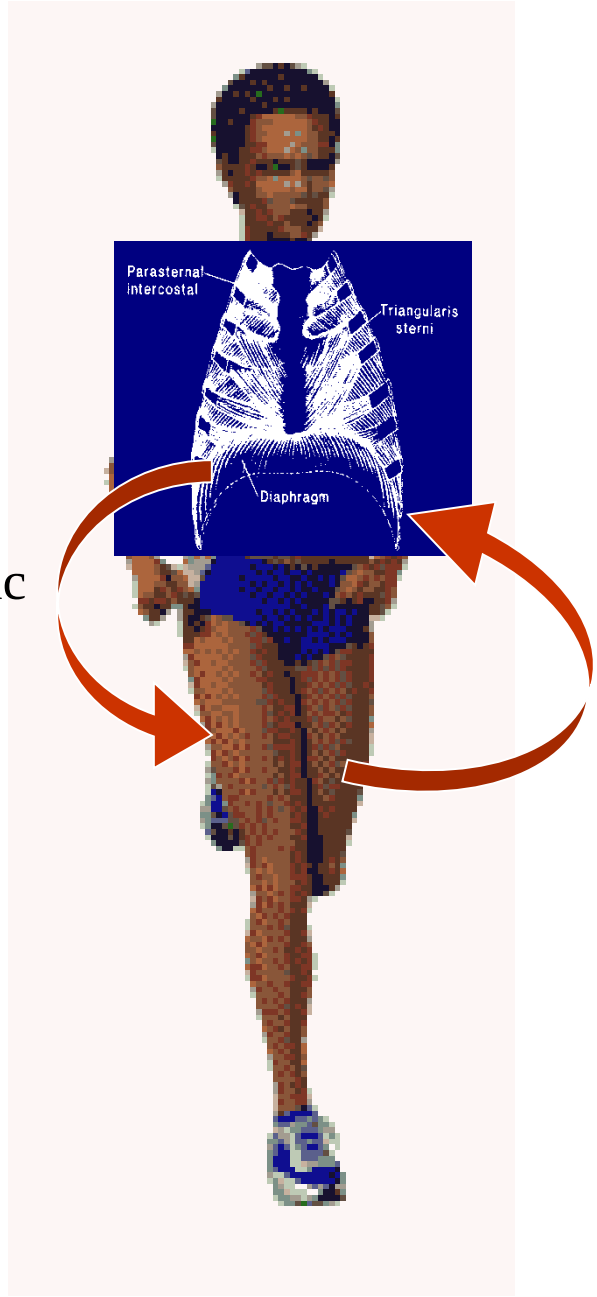
“minimizing mechanical work of breathing and therefore the metabolic cost of breathing allows for a greater amount of cardiac output to be available for delivery to working limb muscles”

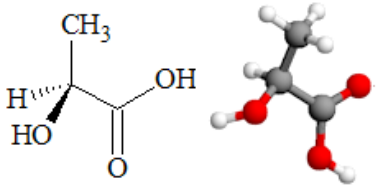
(Harms C, J. Appl. Physiol)



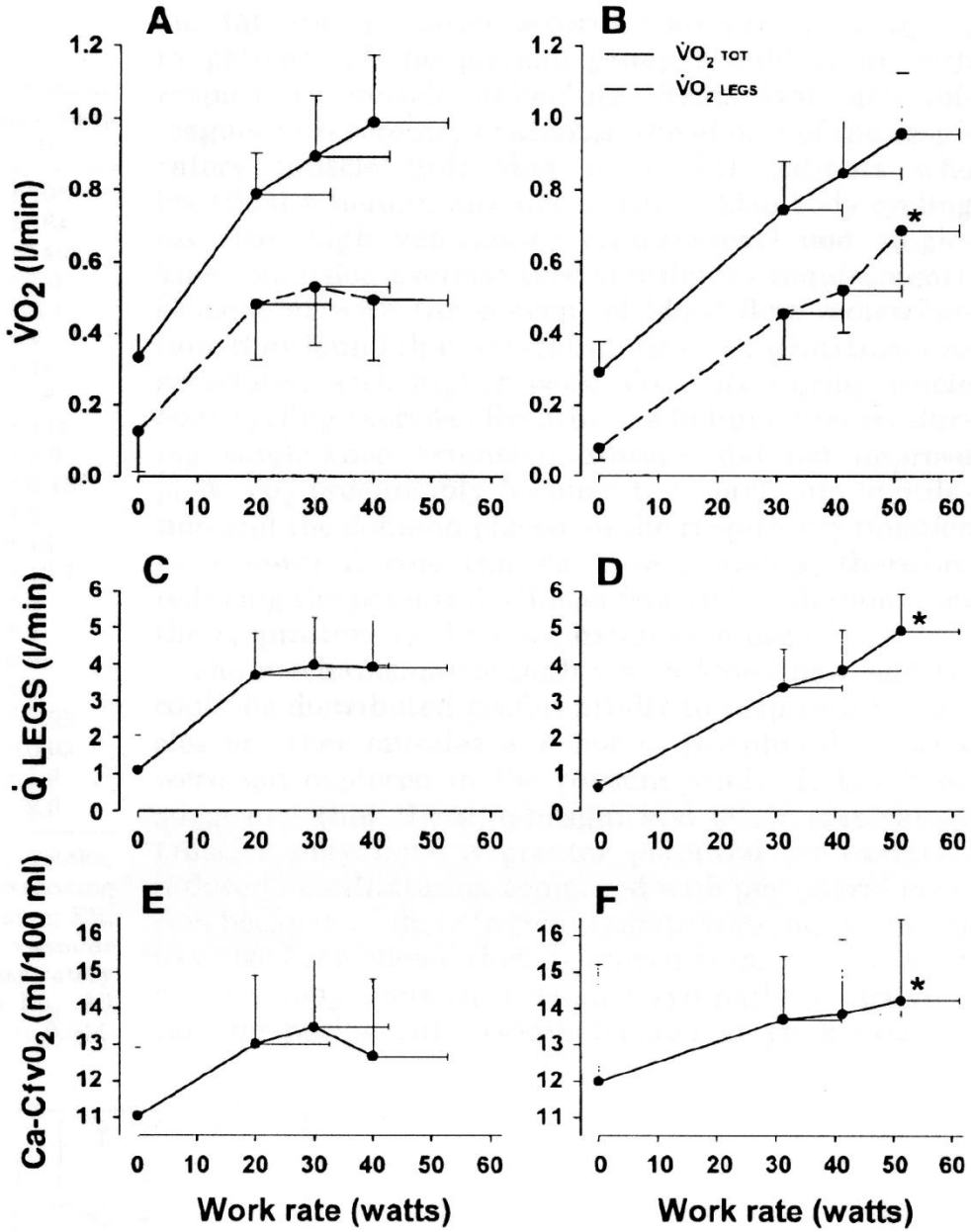
Dempsey 2007

Sympathetic reflex

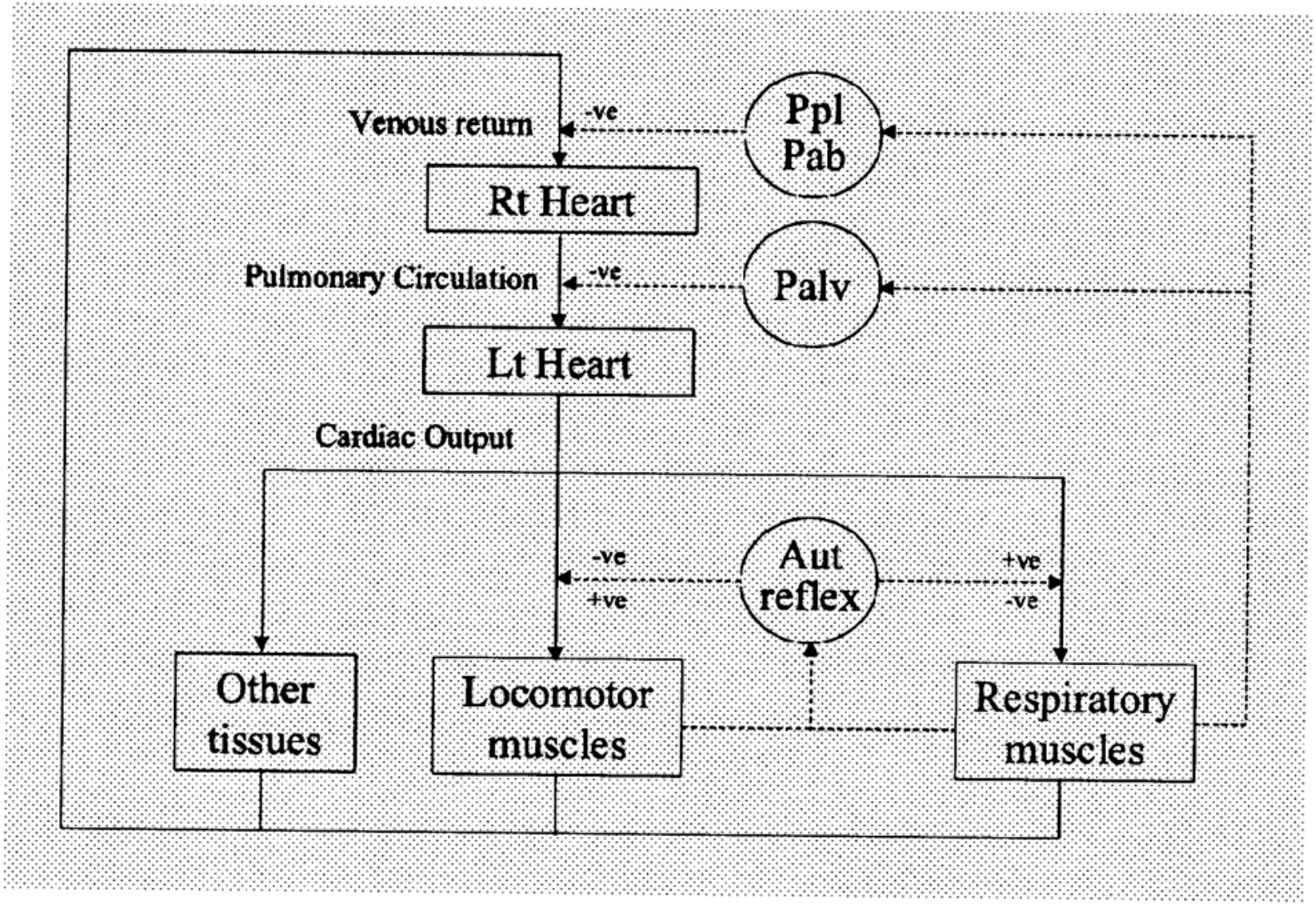




L.A

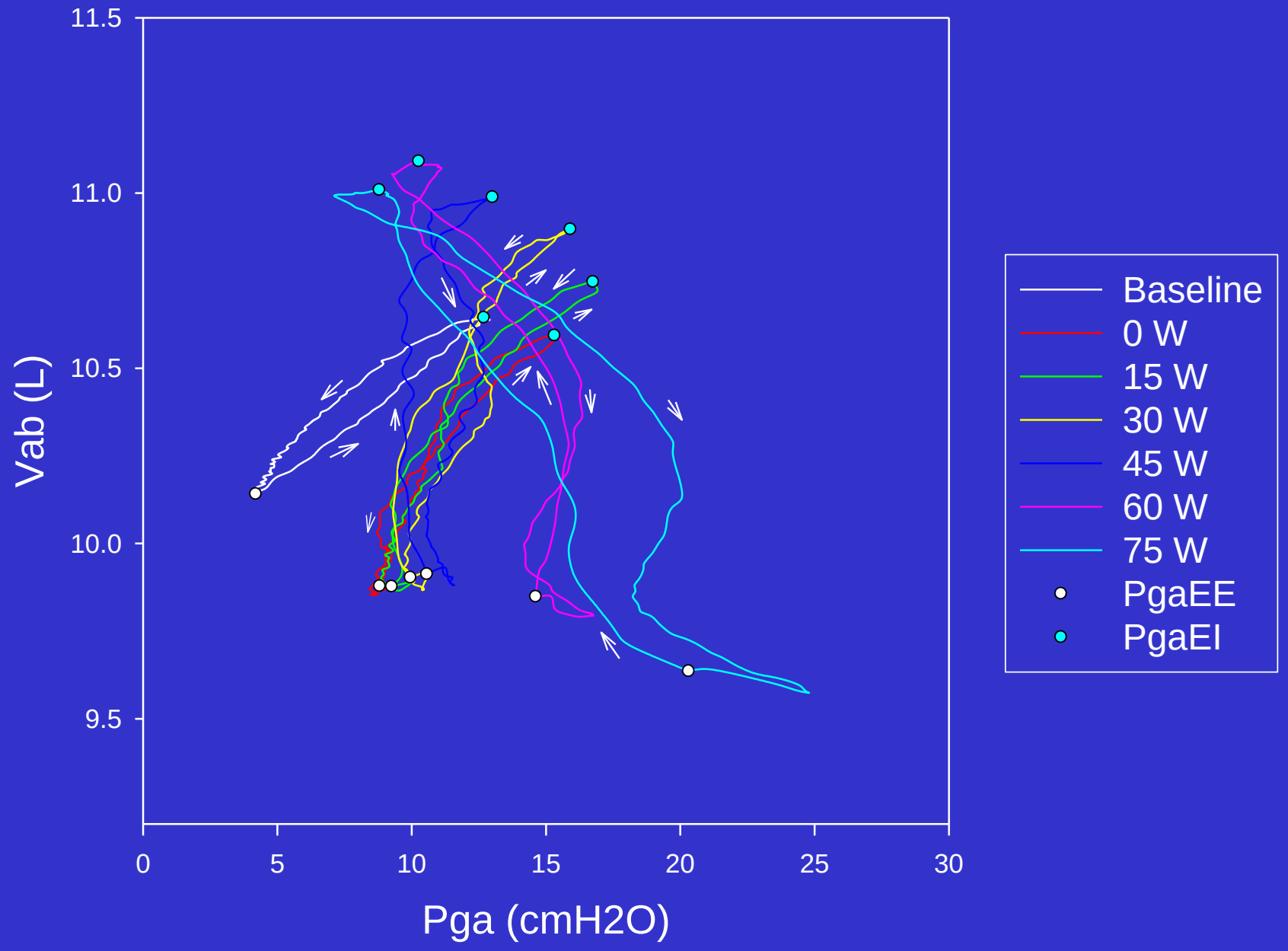


Simon M. J Appl Physiol 2001



Aliverti & Macklem 2001

Niccoli loops Pga/Vab



Potter WA, Olafsson S, Hyatt RE. J Clin Invest 1971; 50: 910-19

Ventilatory mechanics and expiratory flow limitation during exercise in patients with obstructive lung disease

"Exaggerated expiratory muscle action would further increase intrathoracic and abdominal pressures, thus negatively impacting the cardiovascular response to exercise"

Influence of expiratory loading and hyperinflation on cardiac output during exercise

Stark-Leiva et al J Appl Physiol 2005

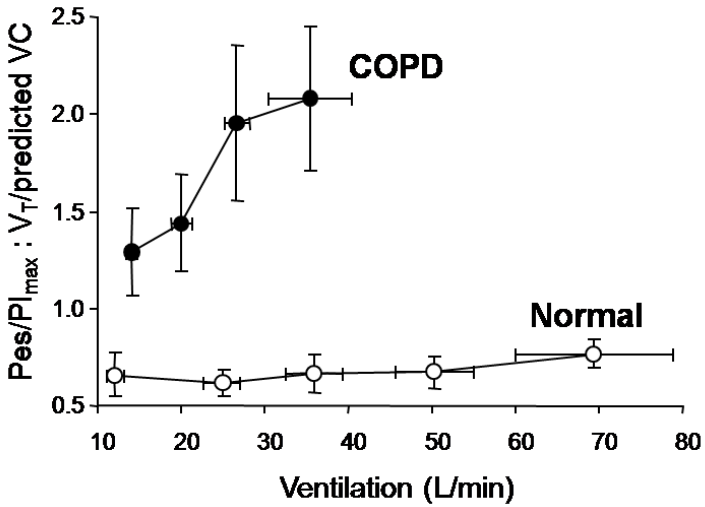
"expiratory load leads to a reduction in CO which appears to be primarily related to increase in expiratory esophageal and gastric pressures"

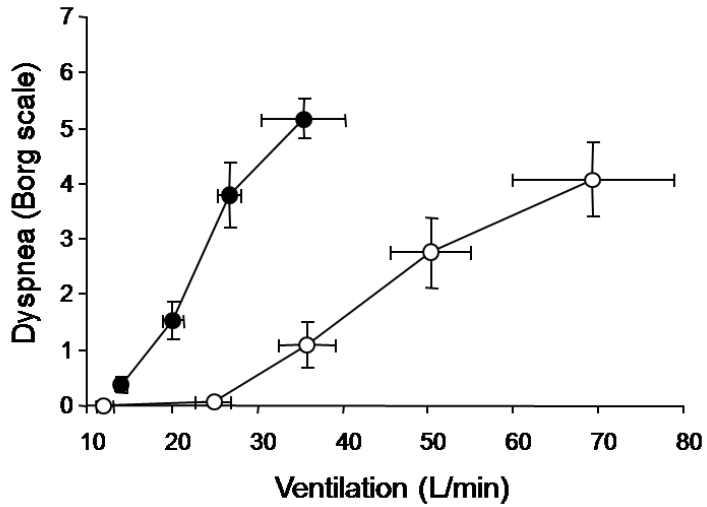
Point- Counterpoint Debate
(J Appl Physiol 2008)

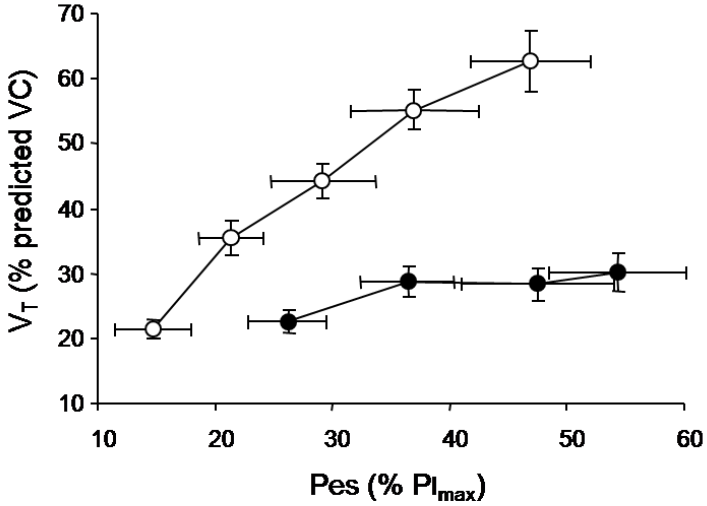
The major limitation to exercise performance in COPD is an increase in energy demands (increase in Wresp and V02 resp) combined with a decrease in supplies
(Aliverti and Macklem).

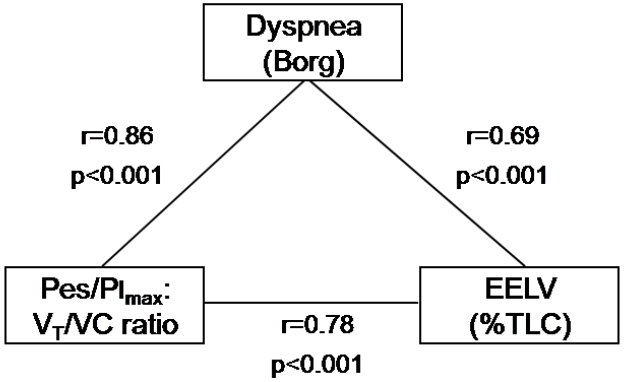
The major limitation to exercise performance in COPD is dynamic hyperinflation
(O'Donnell & Webb)

The major limitation to exercise performance in COPD is lower limb muscle dysfunction
(Debigarre & Maltais)


COPD
Normal
Pes/PImax : VT/predicted VC
Ventilation (L/min)
2.5
2.0
1.5
1.0
0.5
10
20
30
40
50
60
70
80


Dyspnea (Borg scale)
Ventilation (L/min)
7
6
5
4
3
2
1
0
10
20
30
40
50
60
70
80


VT (% predicted VC)
Pes (% PImax)
70
60
50
40
30
20
10
10
20
30
40
50
60


Dyspnea
(Borg)
r=0.86
p<0.001
r=0.69
p<0.001
Pes/PImax:
VT/VC ratio
r=0.78
p<0.001
EELV
(%TLC)

Conclusion

- **Despite the lack of conclusive evidence, the possibility might be considered that mechanical and cardiovascular factors may impact on exercise performance and breathlessness by increasing the respiratory effort and limiting the CO to the respiratory muscles.**