NEW SCIENTIFIC ADVANCES IN EXERCISE PHYSIOLOGY



A. Mezzani

S. Maugeri Foundation Veruno Scientific Institute – Cardiology Division Veruno (NO) – Italy 'Critical power' as the upper limit for prolonged aerobic exercise or, in other words, as the maximum prescriptible 'dose' of continuous aerobic training intensity in both normal subjects and cardiac patients.







Jones AM, J Appl Physiol 2008



Jones AM, J Appl Physiol 2008

Specifically, the CP appears to demarcate a range of work rates within which muscle [PCr], [Pi], and pH can be rapidly stabilized and sustained close to resting values from those (...) that might predispose the muscle to the development of fatigue. The CP concept therefore has theoretical and practical utility in exercise physiology as a model for exploring the mechanistic bases of muscular fatigue and the determinants of human exercise tolerance.





Mezzani A, Med Sci Sports Exerc in press

	CHF	UNTR-N	TR-N
Exercise time (min)	29.9±0.6	30±0	30±0
CP (w)	80±21 *	129±17 †	199±35
%peak power	66±6	66±6	74±3 ‡
SS VO ₂ (ml/kg/min)	17.5±3.7 *	23.8±4.0 †	36.0±4.5
%peak VO ₂	96±5	83±6 [§]	93±10
SS [Lactate] (mmol/l)	5.6±0.6	6.2±0.5	4.8±0.6

Mezzani A, Med Sci Sports Exerc in press

Aerobic exercise as a neuroprotective intervention, based on demonstrable biological effects and determining improvements in cognitive function.



EuroPRevent 2009 Exercise Physiology Poster Prize

PHYSICAL ACTIVITY AND 5-YEAR COGNITIVE DECLINE IN MIDDLE-AGED MEN AND WOMEN

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Aim of the study: to test a possible relationship between changes in the time spent on or the average intensity of weekly physical activities and changes in cognitive function. <u>Methods:</u> 1904 healthy, middle-aged men and women. Physical activity habits and cognitive function assessed twice with an interval of 5 years.

<u>Results</u>: changes in the time spent on physical activities were not related to changes in cognitive function. On the contrary, changes in average intensity of weekly activities were significantly related to processing speed (b 0.063, p < 0.05).

<u>Conclusions</u>: in this longitudinal cohort study, an increase in the average intensity of weekly physical activities was related to a smaller age-related decline in processing speed.

Analysis I.I. Comparison I Aerobic exercise vs. any intervention, Outcome I Cognitive speed.

Review: Physical activity and enhanced fitness to improve cognitive function in older people without known cognitive impairment.

Comparison: I Aerobic exercise vs. any intervention

Outcome | Cognitive speed

Study or subgroup	Treatment		Control		Std. Mean Difference	Weight	Std. Mean Difference
(3) 285000	N	Mean(SD)	N	Mean(SD)	N/Plandom,95% CI	254	MRandom,95% CI
I Simple reaction time							
Panton 1990	17	-274 (28.9)	20	-270 (44.7)	-	12.1%	-0.10[-0.75, 0.54]
Subtotal (95% CI)	17		20		+	12.1 %	-0.10 [-0.75, 0.54]
Heterogeneity not applica	ble						
Test for overall effect $Z =$	0.31 (P = 0.76)	6					
1 Choice reaction time							
Subtotal (95% CI)	0		0			0.0 %	0.0 [0.0, 0.0]
Heterogeneity not applica	ble						
Test for overall effect not	applicable						
3 Trailmaking part A							
Emery 1998	25	-335 (9.7)	23	-405 (16.2)		15.2 %	0.52 [-0.06, 1.10]
Subtotal (95% CI)	25		23		•	15.2 %	0.52 [-0.06, 1.10]
Heterogeneity not applica	ble						
Test for overall effect $Z =$	1.77 (P = 0.07)	0					
4 Digit symbol substitution	- CA						
Blumenthal 1989 a	15	54.6 (8.6)	17	49.2 (11.3)	- -	10.1 %	0.52 [-0.19, 1.23]
Blumenthal 1989 b	16	50.5 (9.3)	17	48.1 (8.5)		10.7 %	0.26 [-0.42, 0.95]
Emery 1990 a	14	35.8 (12.6)	24	32.9 (11.3)	- - -	11.5 %	0.24 [-0.42, 0.90]
Kramer 2001	58	96.5 (3.88)	66	95.7 (6.34)	+	40.4 %	0.15 [-0.20, 0.50]
Subtotal (95% CI)	103		124		•	72.8 %	0.23 [-0.03, 0.50]
Heterogeneity: $Tau^2 = 0.0$;	Chi2 = 0.86, df	f = 3 (P = 0.84); I	2 =0.0%				
Test for overall effect $Z =$	1.73 (P = 0.085	0					
Total (95% CI)	145		167		-	100.0 %	0.24 [0.01, 0.46]
Heterogeneity: $Tau^2 = 0.0$;	$Chi^2 = 2.84$, df	f = 5 (P = 0.72); P	2 =0.0%				
Test for overall effect $Z =$	2.05 (P = 0.040	ŋ					
				-4	-2024		
				Favo	urs control Favours aerobi	c	

Angevaren M, Cochrane Database Syst Rev 2008

Analysis 1.9. Comparison I Aerobic exercise vs. any intervention, Outcome 9 Visual attention.

Review: Physical activity and enhanced fitness to improve cognitive function in older people without known cognitive impairment.

Comparison: I Aerobic exercise vs. any intervention

Outcome: 9 Visual attention

Study or subgroup	Treatment	Control			Std. Mean Difference	Weight	Std. Mean Difference
	2	Mean(SD)	N	Mean(5D)	NRandom,95% CI	200394	IV:Random/95% CI
I Digit vigilance							
Emery 1998	25	-198.6 (45.9)	23	-220.3 (50)		16.3 %	0.45 [-0.13, 1.02]
Subtotal (95% CI)	25		23		+	16.3 %	0.45 [-0.13, 1.02]
Heterogeneity: not applic	able						
Test for overall effect: Z =	1.52 (P = 0.1	3)					
2 Tracking (accuracy index	<)						
Subtotal (95% CI)	0		0			0.0 %	0.0 [0.0, 0.0]
Heterogeneity: not app ic	able						
Test for overall effect: not	applicable						
3 2%7 test							
Blumenthal 1989 a	15	-6.3 (4.35)	17	-7.85 (7.1)		11.0 %	0.25 [-0.44, 0.95]
Blumenthal 1989 b	16	-7.25 (5.65)	17	-10.35 (11)		11.3 %	0.34 [+0.35, 1.03]
Subtotal (95% CI)	31		34		-	22.4 %	0.30 [-0.19, 0.79]
Heterogeneity: $Tau^2 = 0.0$	$h \subset h^2 = 0.03$	$df = 1 (P = 0.86); 1^2$	=0.0%				
Test for overall effect: Z =	1.19 (P = 0.2	3)					
4 Letter search primary to	sk RT						
Madden 1969	25	-1012.33 (211.26)	28	-1023.67 (248.14)	+	18.5 %	0.05 [-0.49, 0.59]
Subtotal (95% CI)	25		28		+	18.5 %	0.05 [-0.49, 0.59]
Heterogeneity: not applic	sble						
Test for overall effect: Z =	Q.16 (P = Q.6	6)					
5 Visual search (accuracy)							
Kramer 2001	58	97.75 (3.34)	66	96.95 (3.02)	-	42.8 %	0.25 [-0.10, 0.60]
Subtotal (95% CI)	58		66		-	42.8 %	0.25 [-0.10, 0.60]
Heterogeneity: not applic	able						
Test for overall effect: Z =	1.39 (P = Q.1	7)					
Total (95% CI)	1 39		151		•	100.0 %	0.26 [0.02, 0.49]
Heterogeneity: $Tau^2 = 0.0$; Chi ² = 1.05,	$df = 4 (P = 0.90); I^2$	=0.0%				
Test for overall effect: Z =	216 (P = 0.0	31)					
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				4	-2 0 2 4		
				Favo	uni control Favours aerot	sic.	

Angevaren M, Cochrane Database Syst Rev 2008

Analysis 2.10. Comparison 2 Aerobic exercise vs. no intervention, Outcome 10 Auditory attention.

Review: Physical activity and enhanced fitness to improve cognitive function in older people without known cognitive impairment.

Comparison: 2 Aerobic exercise vs. no intervention

Outcome: 10 Auditory attention

Study or subgroup	Treatment	Control			Mean Difference	Weight	Mean Difference
	Ν	Mean(SD)	Ν	Mean(SD)	NRandom,95% CI		IV/Random, 95% CI
I Digit span forward							
Blumenthal 1989 a	15	8 (2.3)	18	8.3 (2)		6.9 %	-0.30 [-1.79, 1.19]
Blumenthal 1989 b	16	9.8 (2.6)	16	9.3 (2.4)		4.7 %	0.50 [-1.31, 2.31]
Fabre 2002	8	6.1 (0.7)	8	5.6 (0.3)	-	54,7 %	0.50 [-0.03, 1.03]
Hassmo 1997 a	10	8 (1.3)	10	7.4 (1.3)		11.7 %	0.60 [=0.54, 1.74]
Hassmn 1997 b	10	7.6 (0.95)	10	6.8 (0.95)		22.0 %	0.80 [-0.03, 1.63]
Total (95% CI)	59		62		•	100.0 %	0.52 [0.13, 0.91]
Heterogeneity: Tau ² = 0	0; Chi ² = 1.63,	df = 4 (P = 0.80);	12 =0.0%				
Test for overall effect: Z	= 2.62 (P = 0.00	087)					

Angevaren M, Cochrane Database Syst Rev 2008

Analysis 2.11. Comparison 2 Aerobic exercise vs. no intervention, Outcome 11 Motor function.

Review: Physical activity and enhanced fitness to improve cognitive function in older people without known cognitive impairment.

Comparison: 2 Aerobic exercise vs. no intervention

Outcome: 11 Motor function

Study or subgroup	Treatment	Control				Mean Difference		Weight	Mean Difference
	N	Mean(SD)	N	Mean(SD)		MRan	dom,95% Cl		IV,Random,95% CI
I Finger tapping									
Blumenthal 1989 a	15	1151 (144)	18	1165 (19.1)	4		-	0,7 %	-1.40 [-12.84, 10.04]
Blumenthal 1989 b	16	131.6 (143)	16	131.4 (17.5)	4		+	0.8 %	0.20 [-10.87, 11.27]
Emery 1998	25	43.3 (2.1)	25	42,1 (1,4)			-	98.5 %	1.20 [0.21, 2.19]
Subtotal (95% CI)	56		59				+	100.0 %	1.17 [0.19, 2.15]
Heterogeneity: $Tau^2 = 0.0$;	CHP = 0.23, d	$f = 2$ (P = 0.89); I^2	=0.0%						
Test for overall effect $Z = 2$	2.34 (P = 0.019	ŋ							
2 Pursuit rotor task (trackin	ig error)								
Subtotal (95% CI)	0		0					0.0%	0.0 [0.0, 0.0]
Heterogeneity: not applicat	ole:								
Test for overall effect; not a	pplicable								
Total (95% CI)	56		59				+	100.0 %	1.17 [0.19, 2.15]
Heterogeneity: $Tau^2 = 0.0$;	$CHi^2 = 0.23$, d	$f = 2 (P = 0.89); I^2$	=0.0%						
Test for overall effect $Z = 0$	2.34 (P = 0.019	9							
						1			
					-10	-5	0 5 10)	
					Favours	control	Payours aerot	ic .	

Angevaren M, Cochrane Database Syst Rev 2008

PHYSICAL ACTIVITY AND NEUROPROTECTION

- 1) Improved axonal transport
- 2) More efficient neuromuscular synapse communication
- 3) Heigthened gene expression and protein synthesis
- 4) Increased astrocyte proliferation
- 5) Increased angiogenesis
- 6) Increased circulating and tissue growth factors (VEGF, BDNF, GDNF, CNTF, IGF-1)

Exercise Enhances and Protects Brain Function

Carl W. Cotman and Christie Engesser-Cesar

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COTMAN, C.W., and C. ENGESSER-CESAR. Exercise enhances and protects brain function. Exerc. Sport Sci. Rev., Vol. 30, No. 2, pp. 75–79, 2002. Physical activity, in the form of voluntary wheel running, induces gene expression changes in the brain. Animals that exercise show an increase in brain-derived neurotrophic factor, a molecule that increases neuronal survival, enhances learning, and protects against cognitive decline. Microarray analysis of gene expression provides further support that exercise enhances and supports brain function. Keywords: running, BDNF, depression, estrogen, neuroplasticity, neuroprotection



Exerc Sport Sci Rev 2002



White LJ, Sports Med 2008