

Διαλειμματική άσκηση υψηλής έντασης: φυσιολογικές αποκρίσεις και προσαρμογές



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Διαλειμματική άσκηση υψηλής έντασης High Intensity Interval Training ή HIIT

Μορφή εκγύμνασης κατά την οποία σύντομες περίοδοι
έντονης άσκησης εναλλάσσονται με περιόδους ήπιας
άσκησης ή ανάπαυσης

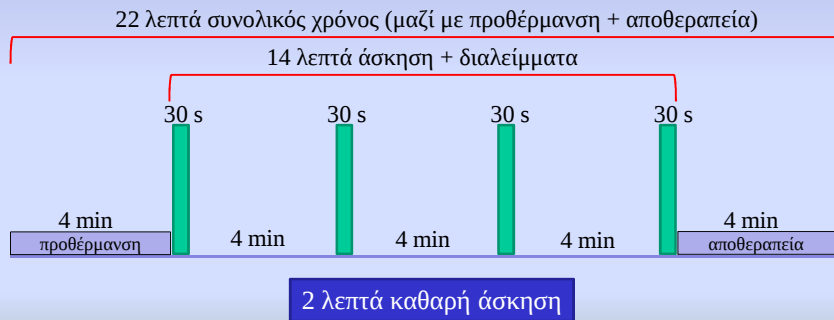
Sprint Interval Training ή SIT

- μέγιστη ένταση (σπριντ) $>250\%$ VO_2max
- άσκηση: 5-30 s
- διάλειμμα 1:6 (30 s) έως 1:9 (4.5 min)
- 4-10 επαναλήψεις

High Intensity aerobic interval training

- ένταση (90%-100% VO_2max)
- Άσκηση: 1-4 min
- διάλειμμα 1:1 (1 min) έως 1:0.8 (3-4 min)
- 4-12 επαναλήψεις
- π.χ. 4 x 4 min ή 10 x 1 min

Διαλειμματική άσκηση υψηλής έντασης (Sprint Interval Training)



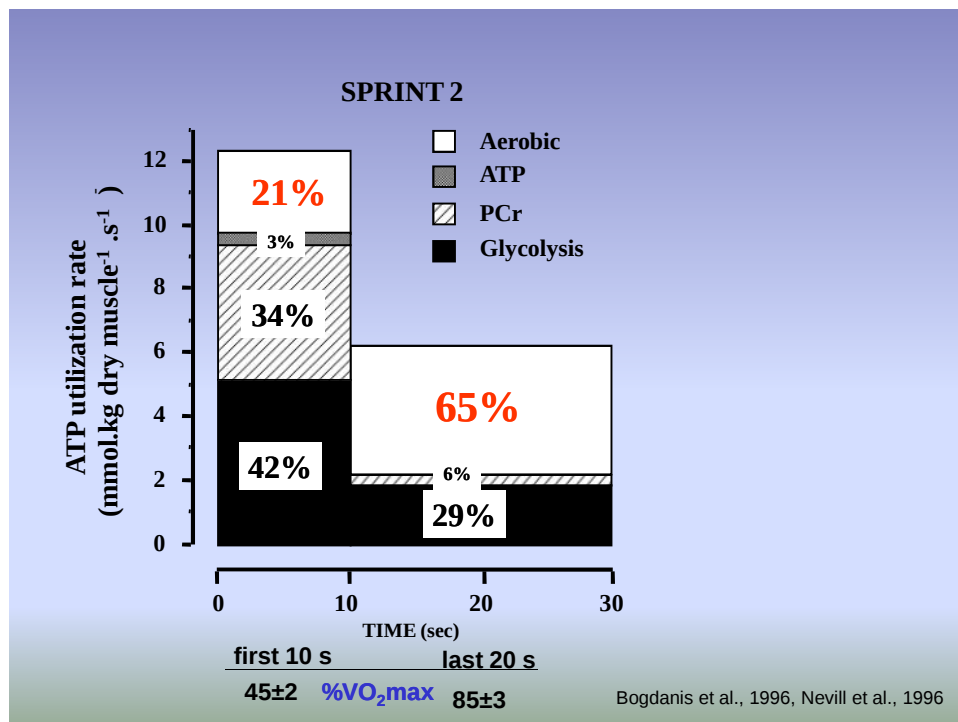
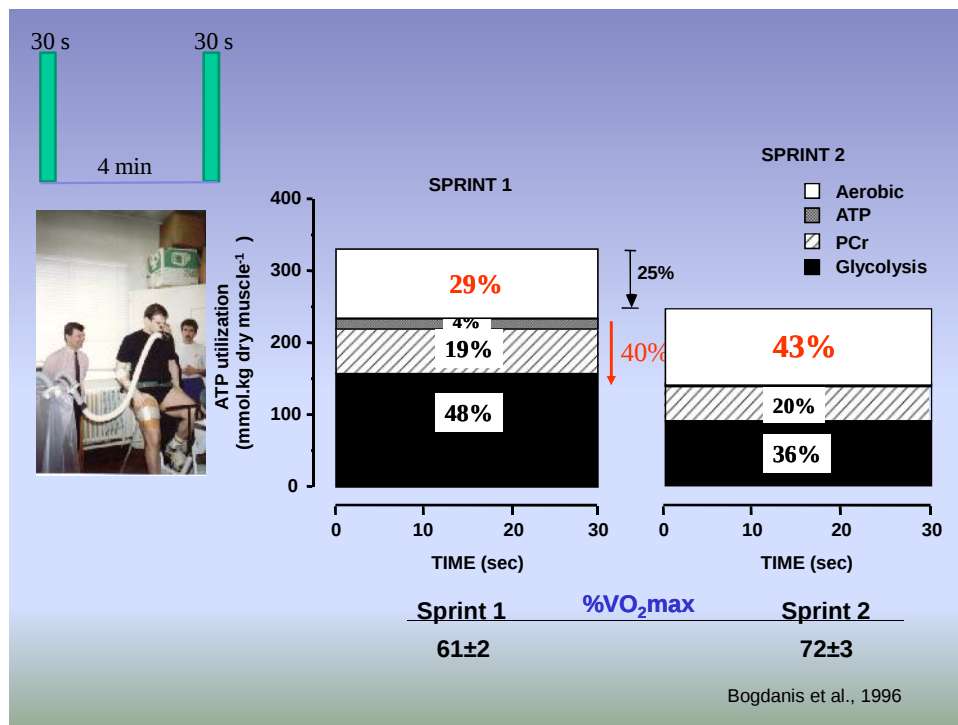
Η HIIT θεωρείται από πολλούς ως μια πολύ αποδοτική μορφή εκγύμνασης.

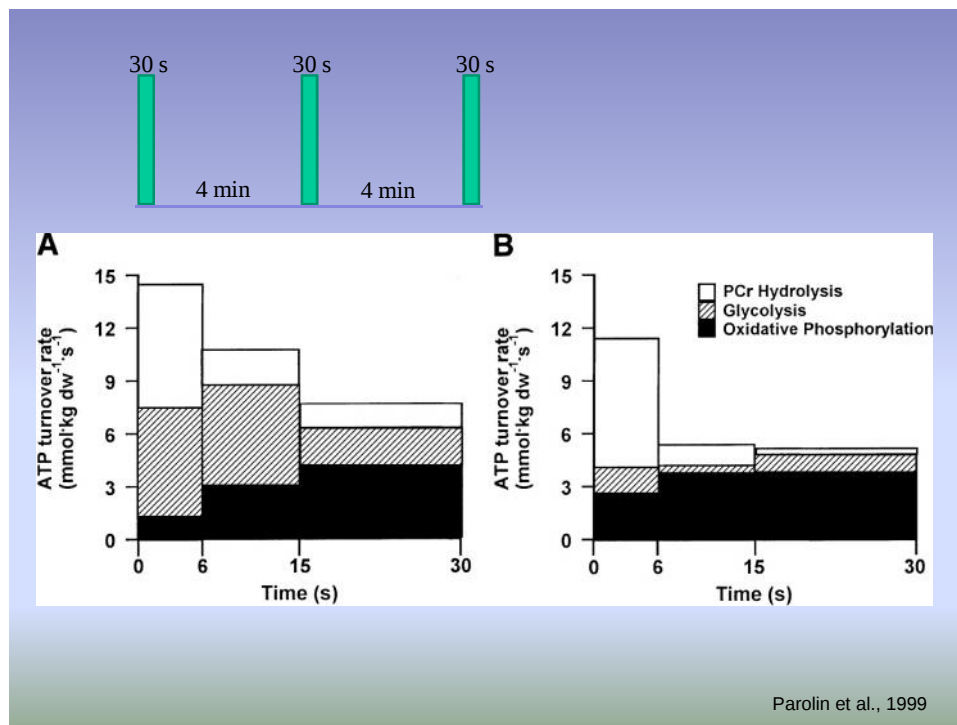


20 Minutes HIIT

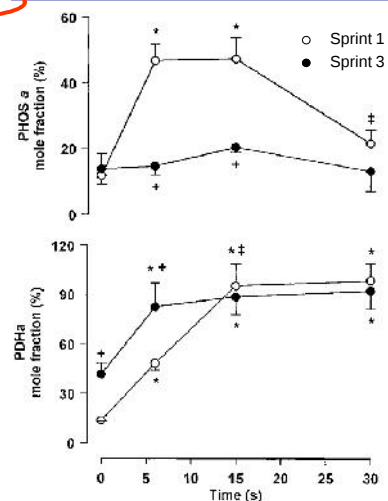
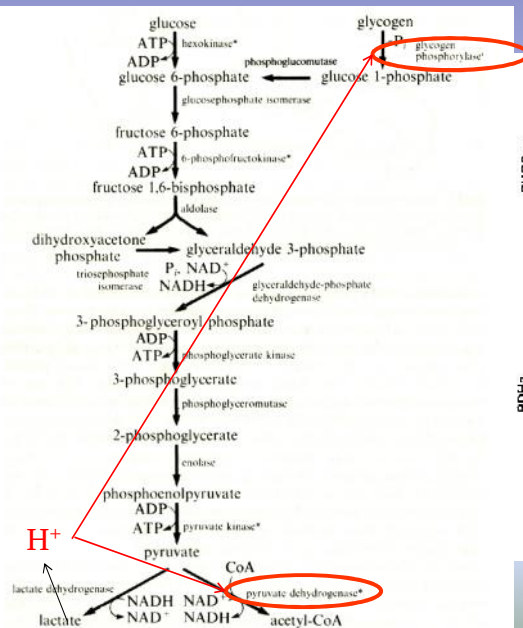
- Five 5 minutes warm-up and stretching
- Two minutes at a moderate pace
- 30 seconds of sprinting
- Two minutes at a moderate pace
- 30 seconds of sprinting
- Two minutes at a moderate pace
- 30 seconds of sprinting
- Two minutes at a moderate pace
- 30 seconds of sprinting
- Five minutes of cool-down and stretching.





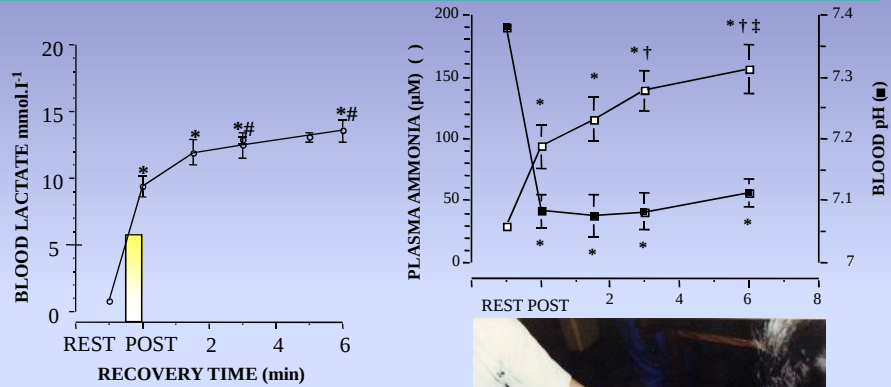


ΑΝΑΕΡΟΒΙΑ ΓΛΥΚΟΛΥΣΗ



Parolin et al., 1999

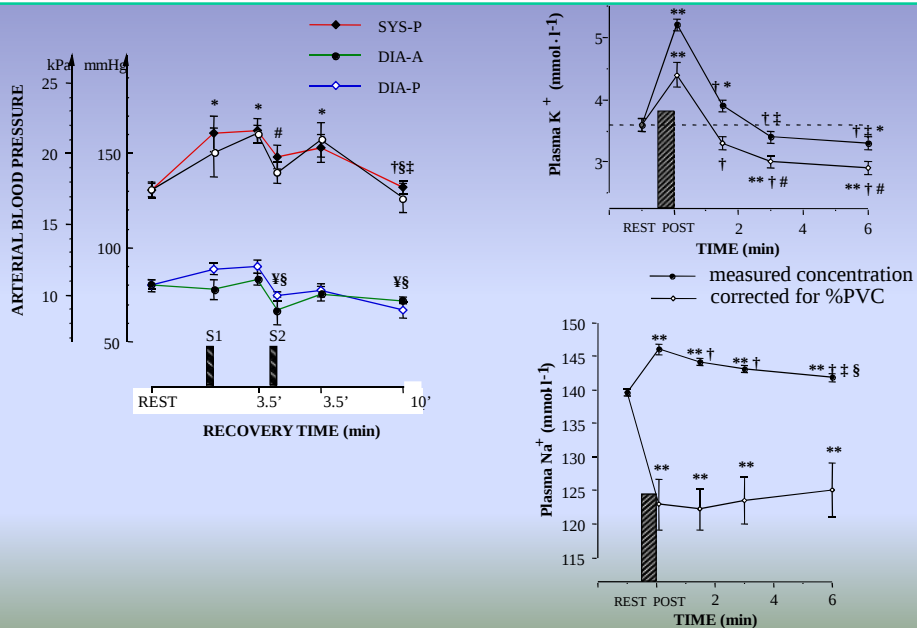
Μεταβολές στη συγκέντρωση γαλακτικού, στο pH, στη συγκέντρωση αμμωνίας και στον όγκο πλάσματος μετά από ένα σπριντ διάρκειας 30 s



Δplasma volume: $15.9 \pm 2.2\%$

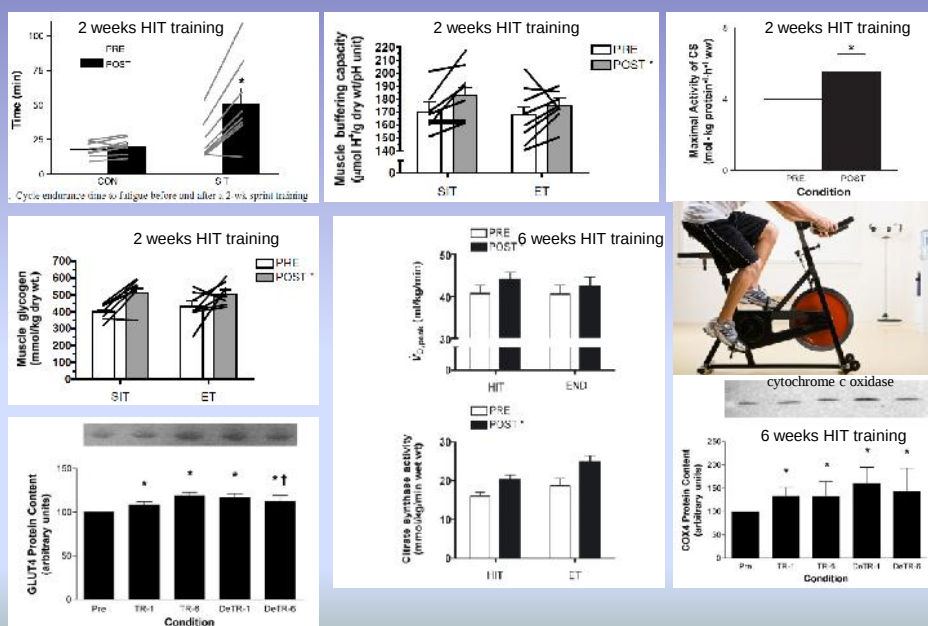


Μεταβολές στην αρτηριακή πίεση και στη συγκέντρωση ηλεκτρολυτών στο πλάσμα



The Gantt chart displays a sequence of tasks on a horizontal timeline. It consists of five green bars, each labeled '30 s', representing 30-second tasks. These are followed by four white bars, each labeled '4.5 min', representing 4.5-minute tasks. The tasks are arranged in a repeating pattern of a 30-second task followed by a 4.5-minute task, starting with a 30-second task and ending with a 30-second task.

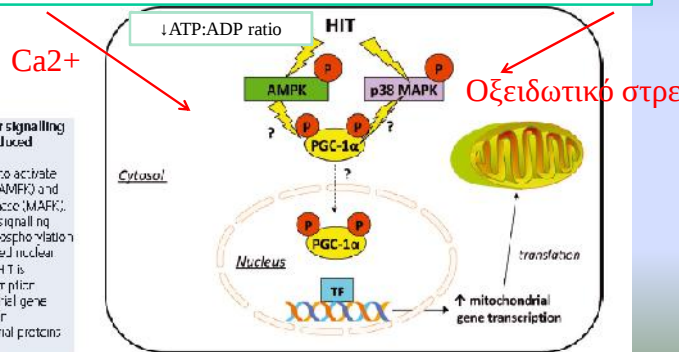
40-60 λεπτά άσκηση στο 65%VO₂max



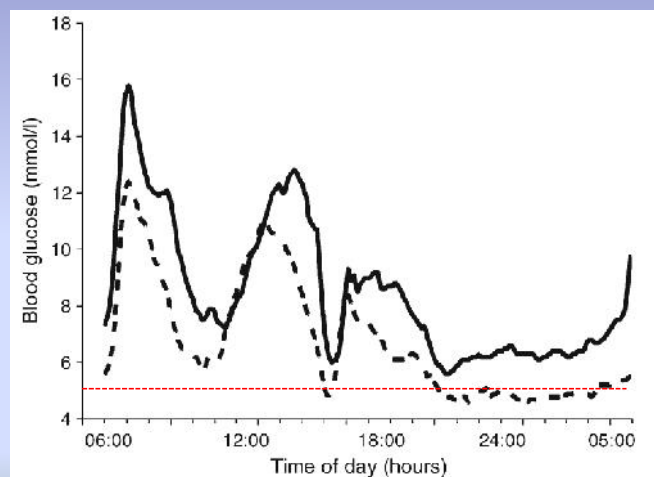


μιτοχονδριακός μεταγραφικός παράγοντας **Peroxisome proliferator-activated receptor gamma coactivator 1-alpha (PGC-1α)**
(συνενεργοποιητής 1α του ενεργοποιούμενου από πολλαπλασιαστές των υπεροξυσωμάτων υποδοχέα γ)
αυξάνει τον αριθμό και τον όγκο των μιτοχονδρίων και κατά συνέπεια την οξειδωτική ικανότητα

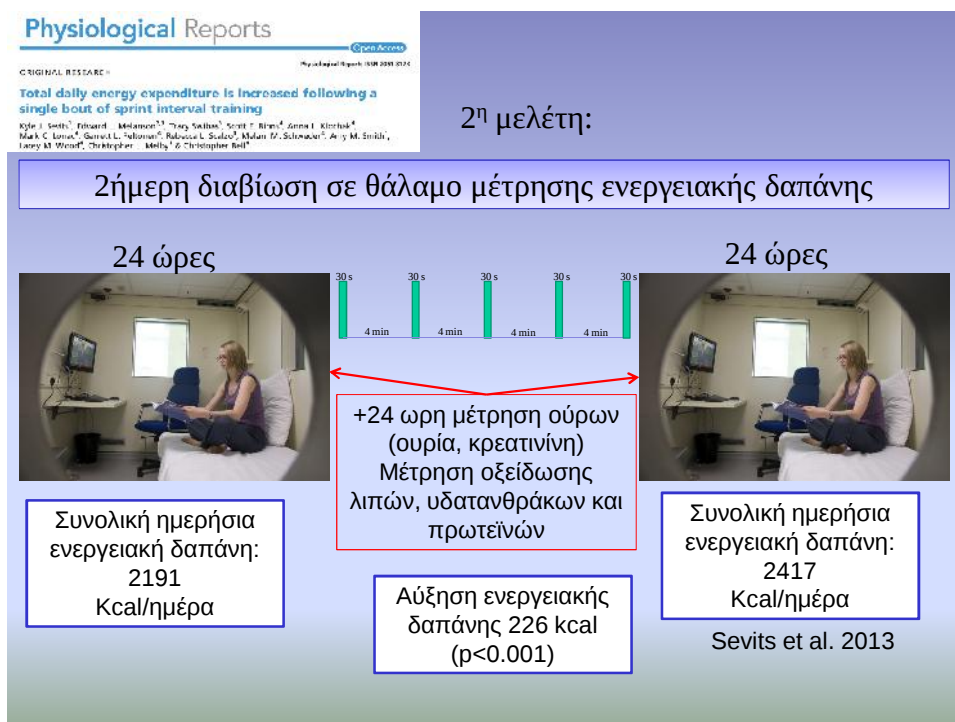
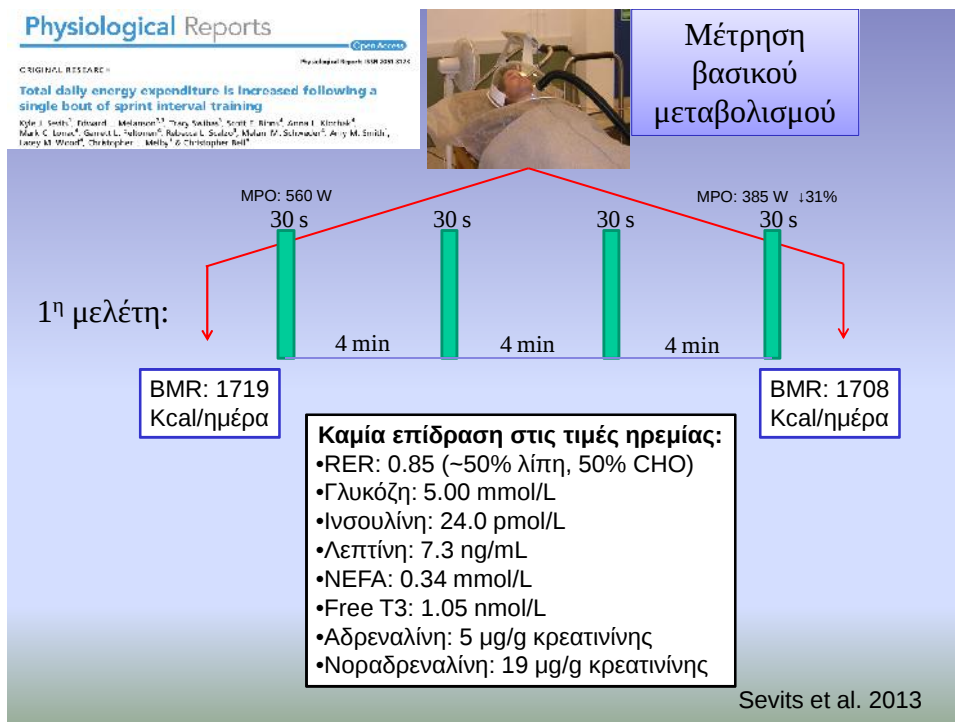
Figure 2. Potential intracellular signalling mechanisms involved in HIT-induced mitochondrial biogenesis.
Low-volume HIT has been shown to activate 5' AMP-activated protein kinase (AMPK) and p38 mitogen-activated protein kinase (MAPK). Both of these serine/threonine signalling kinases are implicated in direct phosphorylation and activation of PGC-1α. Increased nuclear abundance of PGC-1α following HIT is hypothesized to co-activate transcription factors (TF) to increase mitochondrial gene transcription, ultimately resulting in accumulation of more mitochondrial proteins to drive mitochondrial biogenesis.



Βελτίωση του γλυκαιμικού ελέγχου μετά από 2 εβδομάδες προπόνησης SIT



Little et al., 2011, Hawley and Gibala, 2012



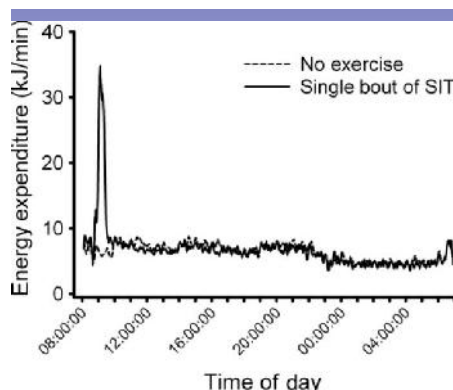


Table 4. Substrate intake and oxidation during a 24-h period on a sedentary day and a day beginning with a single session of sprint interval training (SIT).

	Sedentary	SIT
Energy balance (kJ/day)*	562 ± 184	-326 ± 183
Energy expenditure (kJ/day)*	9169 ± 243	10,111 ± 260
Energy intake (kJ/day)	9878 ± 287	9757 ± 504
Protein balance (g/day)	12.4 ± 4.4	13.3 ± 4.1
Protein oxidation (g/day)	76.2 ± 3.2	67.4 ± 3.5
Protein intake (g/day)	90.5 ± 2.7	89.7 ± 2.7
Carbohydrate balance (g/day)	65.5 ± 16.8	38.5 ± 12.8
Carbohydrate oxidation (g/day)	240.2 ± 19.8	265.8 ± 14.5
Total carbohydrate intake (g/day)	331.2 ± 10.0	330.5 ± 10.0
Fiber carbohydrate intake (g/day)	25.5 ± 2.4	26.3 ± 1.3
Fat balance (g/day)	-9.7 ± 7.9	-70.6 ± 8.2
Fat oxidation (g/day)	90.0 ± 7.3	99.9 ± 8.1
Fat intake (g/day)	80.2 ± 2.4	79.3 ± 2.7

Data are mean ± SE. 1 kcal = 4.1868 kJ.

*Denotes difference between sedentary and SIT day ($P < 0.001$).

All other comparisons are $P > 0.05$.

Table 3. Energy expenditure and respiratory exchange ratio during a 24-h period on a sedentary day and a day beginning with a single session of sprint interval training (SIT).

Time of day	Energy expenditure (kJ/min)		Respiratory exchange ratio	
	Sedentary	SIT	Sedentary	SIT
08:00-09:59	7.05 ± 0.22	10.23 ± 0.85*	0.81 ± 0.01	0.91 ± 0.01*
12:00-13:59	7.25 ± 0.20	5.9 ± 0.43	0.84 ± 0.01	0.86 ± 0.01
16:00-17:59	6.9 ± 0.13	6.60 ± 0.35	0.85 ± 0.01	0.85 ± 0.01
20:00-21:59	6.55 ± 0.13	8.11 ± 0.27	0.85 ± 0.01	0.84 ± 0.01
22:00-23:59	4.82 ± 0.15	4.43 ± 0.40	0.85 ± 0.01	0.84 ± 0.01
24:00-07:00	5.32 ± 0.23	5.01 ± 0.41	0.84 ± 0.01	0.84 ± 0.01

Hazzell, T. J., T. D. Oliver, C. D. Hamilton, and P. W. Lemon. 2012. Two minutes of sprint-interval exercise elicits 24-hr oxygen consumption similar to that of 30 min of continuous endurance exercise. *Int J Sport Nutr Exerc Metab.* 22:276-283.

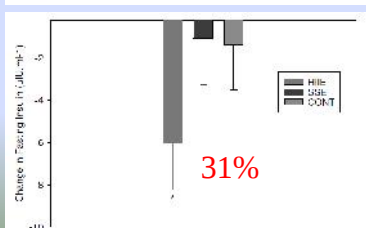
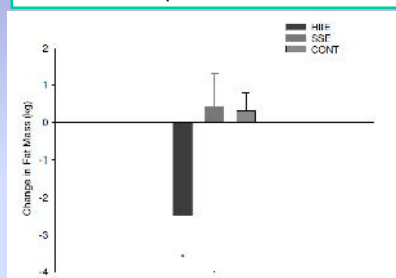
Αύξηση ενεργειακής δαπάνης 50-150 kcal/ημέρα μειώνει την πιθανότητα αύξησης βάρους στο 90% των ανθρώπων

Sevits et al. 2013

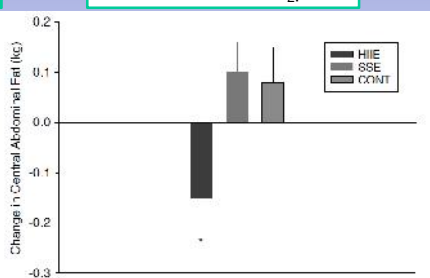
Stroebele et al., 2011

Μείωση του σωματικού λίπους με τη διαλειμματική προπόνηση υψηλής έντασης

15 εβδομάδες προπόνηση
3 φορές/εβδομάδα
20 λεπτά: 8s sprint + 12 s αποκατάσταση



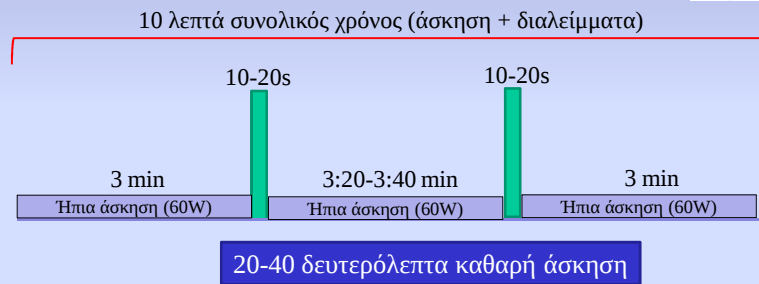
15 εβδομάδες προπόνηση
3 φορές/εβδομάδα
40 λεπτά: 60% VO₂peak



- Αύξηση της VO₂peak
- Μείωση λίπους στα πόδια και στην κοιλιά
- Μείωση της ινσουλίνης ηρεμίας

Trapp et al. 2008

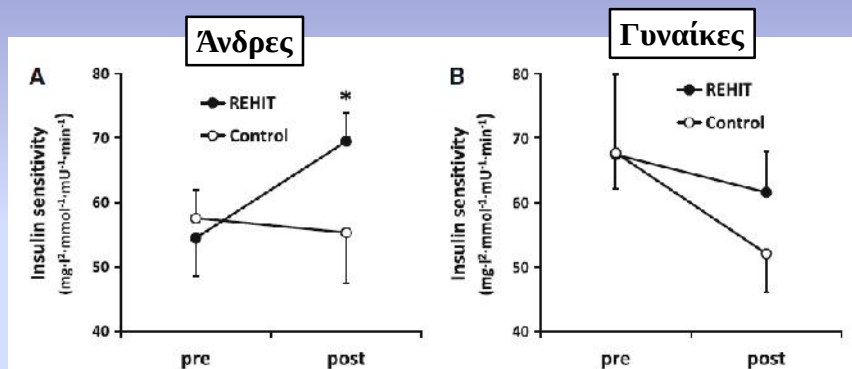
Reduced Exertion High Intensity Interval Training (REHIT)



Metcalf et al., 2012, 2015

Reduced Exertion High Intensity Interval Training (REHIT)

VO₂max: ↑12-14% (χαμηλές αρχικές τιμές)



Metcalf et al., 2012

Reduced Exertion High Intensity Interval Training (REHIT)

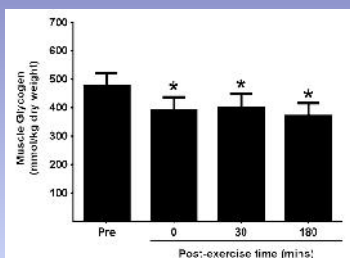
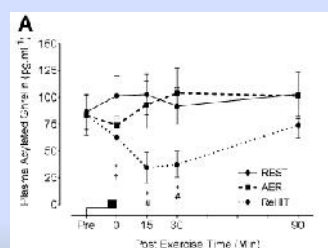
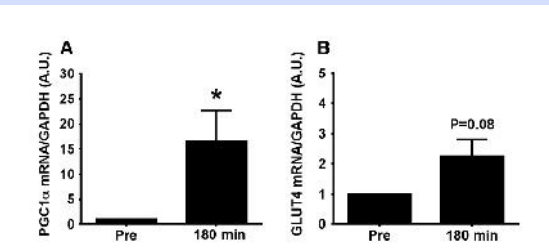
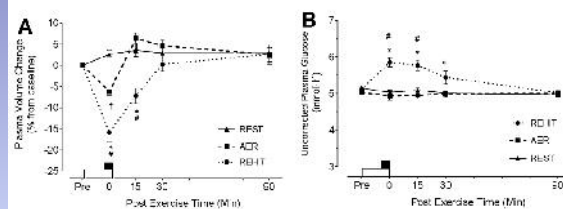


Fig. 1 The effect of REHIT on vastus lateralis glycogen concentration. Data are presented as mean $\pm$ SEM ($n = 11$). * $F < 0.05$ vs. pre.



Metcalfe et al., 2015

TABLE 2: Negligence Lawsuits: *Rostai and Proffitt*

Case	Facts What Happened	Harm/Injury to Plaintiff	Negligence Claims Against the Defendants	Court's Ruling For or Against Plaintiff and Court's Reasoning
<i>Rostai v. Noste Enterprises</i> (14)	During his first personal training session, the plaintiff (Rostai), who was 46 years old, overweight, and inactive suffered a heart attack toward the end of his 60-minute session. Continually throughout the workout, the trainer kept pushing Rostai to perform strenuous exercises (repeated sets and fast reps of bench presses and callisthenics with no rest periods) despite signs and symptoms of overexertion and several requests by Rostai for a break. By the end of the session, Rostai was in extreme pain and told his trainer to call 911 because he thought he was having a heart attack.	Heart attack	Rostai claimed that the defendants (the trainer and facility) were negligent because the trainer (a) failed to assess his health and physical condition, in particular, his cardiac risk factors before exercise; (b) aggressively challenged him to perform beyond his level of physical ability and fitness even after observing him exhibiting certain signs/symptoms; and (c) denied his several requests for a break throughout the session.	AGAINST — The court ruled that Rostai "assumed the risks" even though the court acknowledged that the trainer was negligent, that is, did not assess plaintiff's level of fitness and may have interpreted plaintiff's complaints (tiredness, shortness of breath, profuse sweating) as usual signs of physical exertion versus signs/symptoms of a heart attack. The court explained their ruling by stating that there was no evidence of intentional or reckless conduct on the part of the trainer and, therefore, the plaintiff assumed the risks. <i>Note:</i> The primary assumption of risk defense is usually effective in protecting defendants for injuries caused by inherent risks but not for negligent conduct. Legal scholars have disagreed with this court's ruling and reasoning.
<i>Proffitt v. Global Fitness Holdings, LLC</i> et al. (13)	The personal fitness trainer, in the first session with the plaintiff (Proffitt, who had not worked out in 20 years and was overweight), had him perform numerous bouts of strenuous squatting exercises and directed him to continue the exercises even after signs and symptoms of overexertion and requests by Proffitt to stop. For many hours after the session, Proffitt experienced extreme pain and fatigue and, after 36 hours, he noticed his urine was dark brown. He went to the emergency room where he was diagnosed as having rhabdo and was hospitalized for 8 days.	Rhabdo resulting in permanent injuries, including 30% loss of muscle tissue in both quadriceps muscles	The plaintiff filed a negligence lawsuit against the trainer and the facility listing numerous negligence claims. Some of these included that the personal trainer failed to (a) assess the health/fitness status of the client, (b) provide an exercise program within client's safe fitness capacity, and (c) respond to the client's complaints of fatigue during the training session. The lawsuit also claimed that the facility failed to ensure that the fitness trainer was properly trained to assess the plaintiff's health history, assess his fitness abilities, and design an appropriate training program. The claims also were filed as gross and willful/wanton negligence.	SETTLED — for \$75,000 that included medical expenses of \$20,000 and lost wages of \$6,000. <i>Note:</i> Other similar lawsuits involving rhabdo against fitness trainers and facilities also have occurred. In addition, several athletes in collegiate and high school athletic programs have been hospitalized with rhabdo after completing intense workouts. One of these programs involved 13 football players at the University of Iowa in 2011. The University of Iowa's Board of Regents report indicated that the strength and conditioning coaches had no knowledge of rhabdo (16).

ACSM's HEALTH & FITNESS JOURNAL, Eickhoff_Shemek & Keiper, 2014



- Ταχύτερες φυσιολογικές προσαρμογές
- Γρήγορη επιστροφή μετά από διακοπή προπόνησης
- Gateway to exercise
- Πιο ευχάριστος τρόπος άσκησης
- Μείωση της όρεξης (γκρελίνη, πεπτίδιο ΥΥ)

- Μεγάλη φυσιολογική επιβάρυνση (καρδιακή συχνότητα, αρτηριακή πίεση, μεταβολές όγκου πλάσματος, μεταβολική οξέωση)
- Αρκετά επίπονη (αλλά σύντομη) άσκηση
- Αυξημένη πιθανότητα εμφάνισης σοβαρών ιατρικών συμβαμάτων (ισχαιμία μυοκαρδίου), σε άτομα που έχουν πρόβλημα και δεν το γνωρίζουν

- Πλήρης ιατρικός έλεγχος (να περιλαμβάνει και δοκιμασία κόπωσης)
- Ενημερωμένοι αθλητικοί επιστήμονες
- Προσαρμογή των προγραμμάτων άσκησης στις δυνατότητες και το επίπεδο του ασκούμενου
- Προοδευτική αύξηση της επιβάρυνσης
- Συνεχής παρακολούθηση του ασκούμενου
- Παρουσία ιατρού κατά την άσκηση (σε ασθενείς)

Hazell et al. 2012, Williams et al. 2013, Deighton et al. 2013, Bartlett et al., 2011, Eickhoff_Shemek & Keiper, 2014

