有效運動的關鍵：運動強度的設定

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每日一萬步，健康有保固

（國健局，2002）

https://www.chinatimes.com/realtimenews/20190301001953-260405?chdtv

http://www.slnsin.url.tw/ban-shi-cu/gang-shan/hor-ti-shomin.htm

一碗白飯，要運動多久？

http://www.etnet.com.hk/www/tc/diva/beauty/gloriatsang/30063

教育部的體適能計畫

表 7-4　教育部近年所推行體適能相關計畫之運動處方指引

計畫名稱	年代	具體指標
提升學生體適能中程計畫（簡稱 333 計畫）	1998~2003	• 第一個「3」：每週至少運動 3 天（次） • 第二個「3」：每次約 30 分鐘 • 第三個「3」：每次心跳率約每分鐘 130 次

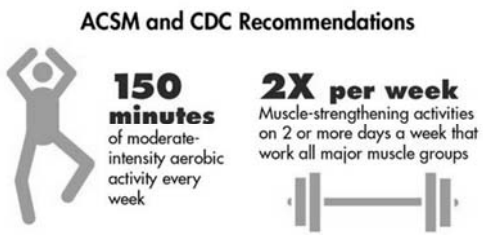
計畫名稱	年代	具體指標
推動中小學生健康體位五年計畫（簡稱 333 再升級計畫）	2004~2007	• 活躍的生活（active），333 再升級，210 增活力： ▷ 新的 333、343、353 政策：指心跳達每分鐘 130 次的運動，每次要有 30 分鐘，國小、國中、高中，每週分別要有 3、4、5 次 ▷ 每天要有 30 分鐘的活躍生活，以養成每週 210 分鐘的動態生活習慣 ▷ 靜態休閒時間（週間課後），指看電視、打電動、上網、用電腦時間，每天少於 2 小時 • 健康的體型意識（image）：建立理解接受、優雅自信的體型意識。 • 健康的飲食（diet）：強調減脂五蔬果、均衡聰明吃
快活計畫~促進學生身體活動，帶給學生健康、活力與智慧（簡稱 210 快活計畫）	2007~	• 各級學校學生每天至少累積 30 分鐘的身體活動時間，且每週累積 210 分鐘的比率，高中及大專校院學生每年提升 10~15%，國中小學生於 2008 年達到 80% • 各級學校學生參加體適能檢測的比率每年提升 20%，學生通過體適能標準的比率每年提升 • 各級學校學生參與運動社團的比率每年提升 4~6% • 以班際為核心舉辦班際及參加校際運動競賽的學校比率每年提升 20%

FITT

American College of Sports Medicine

SUMMARY

The purpose of this Position Stand is to provide guidance to professionals who counsel and prescribe *individualized* exercise to apparently healthy adults of all ages. These recommendations also may apply to adults with certain chronic diseases or disabilities, when appropriately evaluated and advised by a health professional. This document supersedes the 1998 American College of Sports Medicine (ACSM) Position Stand, "The Recommended Quantity and Quality of Exercise for Developing and Maintaining Cardiorespiratory and Muscular Fitness, and Flexibility in Healthy Adults." The scientific evidence demonstrating the beneficial effects of exercise is indisputable, and the benefits of exercise far outweigh the risks in most adults. A program of regular exercise that includes cardiorespiratory, resistance, flexibility, and neuromotor exercise training *beyond* activities of daily living to improve and maintain physical fitness and health is *essential* for most adults. The ACSM recommends that most adults engage in moderate-intensity cardiorespiratory exercise training for ≥30 min·d^{-1} on ≥5 d·wk^{-1} for a total of ≥150 min·wk^{-1}, vigorous-intensity cardiorespiratory exercise training for ≥20 min·d^{-1} on ≥3 d·wk^{-1} (≥75 min·wk^{-1}), or a combination of moderate- and vigorous-intensity exercise to achieve a total energy expenditure of ≥500–1000 MET·min·wk^{-1}. On 2–3 d·wk^{-1}, adults should also perform resistance exercises for each of the major muscle groups, and neuromotor exercise involving balance, agility, and coordination. Crucial to maintaining joint range of movement, completing a series of flexibility exercises for each the major muscle–tendon groups (a total of 60 s per exercise) on ≥2 d·wk^{-1} is recommended. The exercise program should be modified according to an individual's habitual physical activity, physical function, health status, exercise responses, and stated goals. Adults who are unable or unwilling to meet the exercise targets outlined here still



FITT

Garber CE, et al. (2011). Med Sci Sports Exerc;43(7):1334-59.

American College of Sports Medicine

TABLE 5. Classification of exercise intensity: relative and absolute exercise intensity for cardiorespiratory endurance and resistance exercise.

	Cardiorespiratory Endurance Exercise											Resistance Exercise
	Relative Intensity				Intensity ($\%\dot{V}O_{2max}$) Relative to Maximal Exercise Capacity in METs			Absolute Intensity	Absolute Intensity (MET) by Age			Relative Intensity
Intensity	%HRR or $\%\dot{V}O_2R$	$\%HR_{max}$	$\%\dot{V}O_{2max}$	Perceived Exertion (Rating on 6–20 RPE Scale)	20 METs $\%\dot{V}O_{2max}$	10 METs $\%\dot{V}O_{2max}$	5 METs $\%\dot{V}O_{2max}$	METs	Young (20–39 yr)	Middle-aged (40–64 yr)	Older (≥65 yr)	% 1RM
Very light	<30	<57	<37	<Very light (RPE < 9)	<34	<37	<44	<2	<2.4	<2.0	<1.6	<30
Light	30–39	57–63	37–45	Very light–fairly light (RPE 9–11)	34–42	37–45	44–51	2.0–2.9	2.4–4.7	2.0–3.9	1.6–3.1	30–49
Moderate	40–59	64–76	46–63	Fairly light to somewhat hard (RPE 12–13)	43–61	46–63	52–67	3.0 to 5.9	4.8–7.1	4.0–5.9	3.2–4.7	50–69
Vigorous	60–89	77–95	64–90	Somewhat hard to very hard (RPE 14–17)	62–90	64–90	68–91	6.0–8.7	7.2–10.1	6.0–8.4	4.8–6.7	70–84
Near–maximal to maximal	≥90	≥96	≥91	≥Very hard (RPE ≥ 18)	≥91	≥91	≥92	≥8.8	≥10.2	≥8.5	≥6.8	≥85

Table adapted from the American College of Sports Medicine (14), Howley (173), Swain and Franklin (344), Swain and Leutholtz (346), Swain et al. (347), and the US Department of Health and Human Services (370).
HR_{max}, maximal HR; $\%HR_{max}$, percent of maximal HR; HRR, HR reserve; $\dot{V}O_{2max}$, maximal oxygen uptake; $\%\dot{V}O_{2max}$, percent of maximal oxygen uptake; $\dot{V}O_2R$, oxygen uptake reserve; RPE, ratings of perceived exertion (48).

訓練變項

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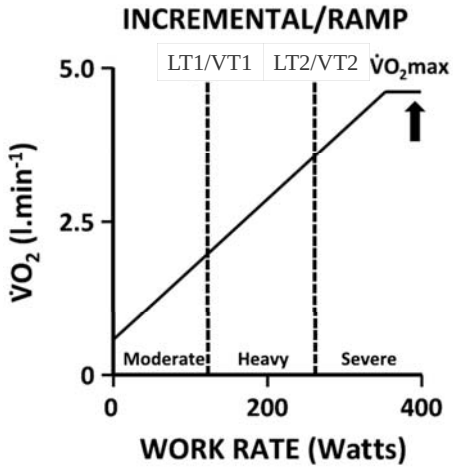


Jones AM, et al. Med Sci Sports Exerc. 2011;43(11):2046-62.

無氧閾值

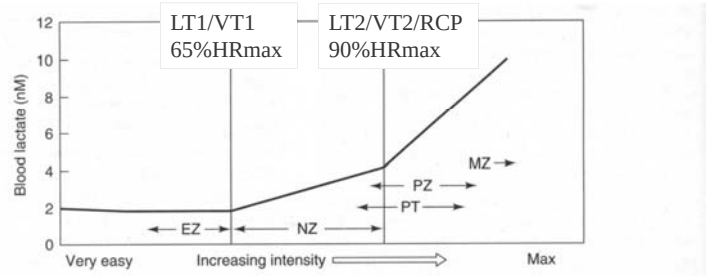


FIGURE 7.2 Blood lactate and training zones. The lactate thresh
The first lactate threshold (LT 1) is associated with the top of the
at LT 1 and extends up to the performance threshold (PT) defin
by the location of PT, the normal range of which is shown by t
minutes, PT generally occurs below the second lactate threshol
The performance zone (PZ) will also depend on PT and extend
lasting less than 5 minutes are typically in the maximal zone (M

- **LT1/VT1: 1-3 hrs**
- **LT2/VT2: 30 min-2 hrs**
- **LSD (long slow-distance)**

Sharkey & Gaskill. (2006). *Sport Physiology for Coaches*.

臨界負荷（Critical Power）

- CP of a muscle (or muscular group) as “the maximum rate (of work) that it can keep up for a very long time without fatigue.” (Monod & Scherrer, 1965)
- CP: oxidative function
- W’: PCr stores, finite anaerobic energy sources

Jones AM, et al. Med Sci Sports Exerc. 2010;42(10):1876-90.

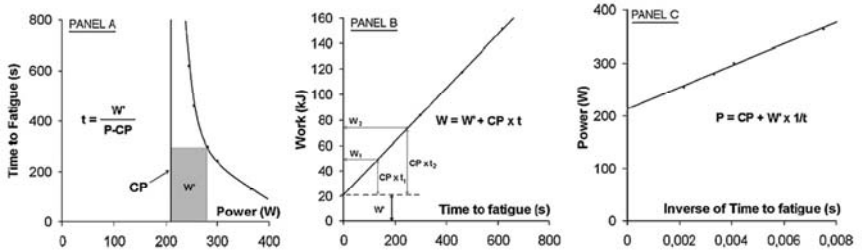
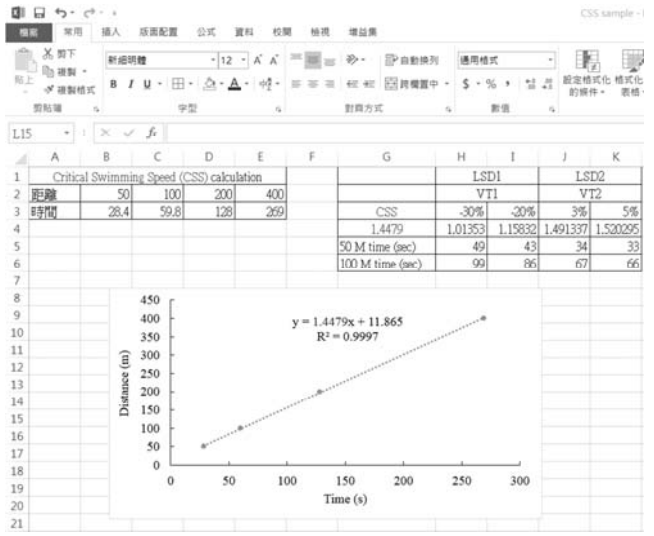


Fig. 1. Illustration of three different, but equivalent representations of the two-parameter model.

Dekerle J., et al. Science & Sports. 2008;23:231–8.

Critical Power

- High-intensity constant power exercise bouts
  - 2-15 min
  - 3-5 bouts
- Critical Swimming Speed (CSS)



Critical Power

- All-out exercise at 100%VO_2max
  - exhaustion at 3-5 min
- P = CP + W′× 1/t

→ P = CP + 0 × 1/t

→ P = CP

(Burnley et al., 2006)

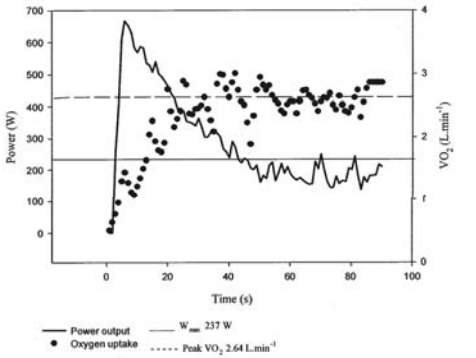


Figure 2. Power output and $\dot{V}O_2$ response to 90-s max isokinetic cycling for one participant.

Williams CA, et al. 2005;30(2):157-71.

3-min All-out Test

- 2 visits
- Incremental exercise test
  - GET and VO_2max
- 3-min all-out test
  - GET + 50% (VO_2max − GET)
  - 3 min unloaded cycling
  - 3 min sprint
  - EP (end-test power): avg. power at final 30-s

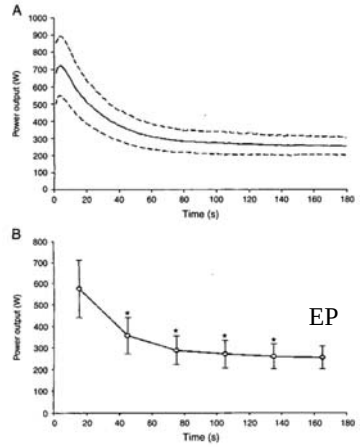
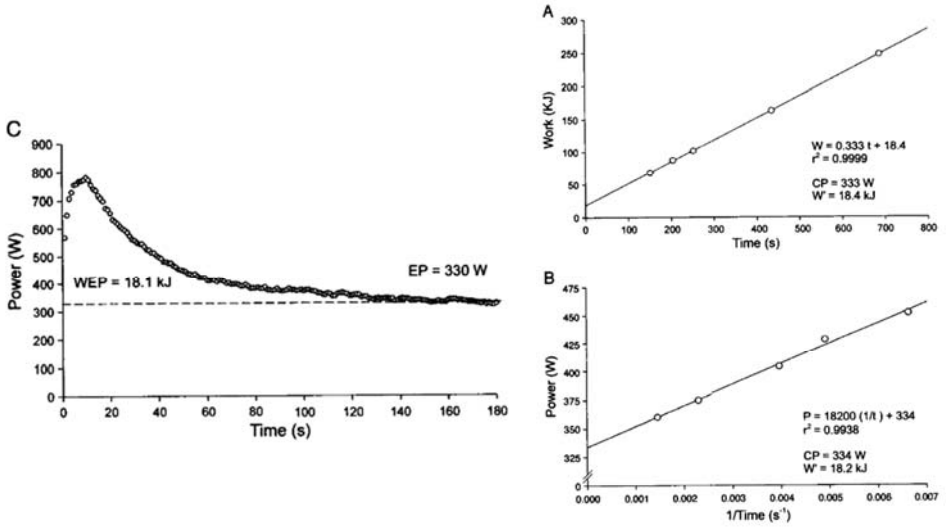


FIGURE 2—Group mean power output during the 3-min all-out test (panel A). *Dashed lines* represent the standard deviation. Panel B shows the group mean power output averaged every 30 s. *Asterisks* indicate a significant difference in power output from the previous time period. Note that power output reaches a plateau in approximately 120 s in panel A and that end-test power output is not significantly different from the preceding power output in panel B, in contrast to all other time points.

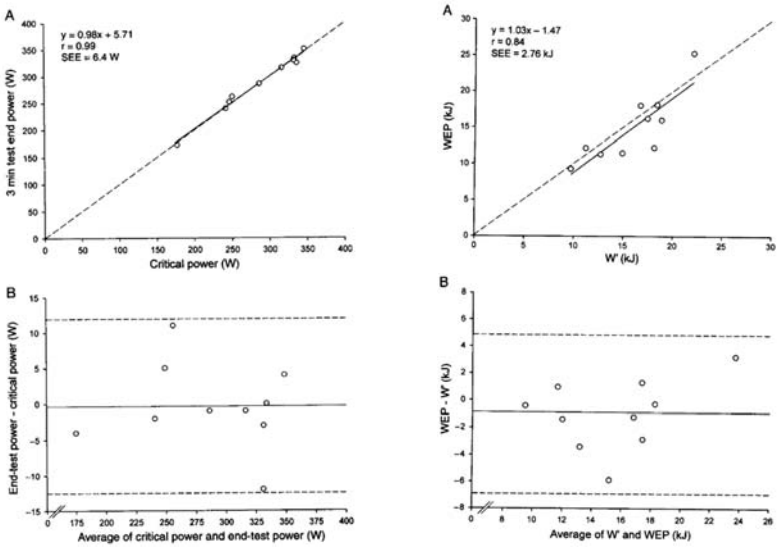
Burnley M, et al. Med Sci Sports Exerc. 2006;38(11):1995-2003.

3-min All-out Test



Vanhatalo A, et al. Med Sci Sports Exerc. 2007;39(3):548-55.

3-min All-out Test



Vanhatalo A, et al. Med Sci Sports Exerc. 2007;39(3):548-55.

Exercise modes of 3MT

Burnley et al. 2006; Vanhatlo et al., 2007

Cheng CF, et al. Eur J Appl Physiol. 2012;112(4):1251-60.

Figure 1. Illustration of the biomechanical movements used during upper body ski ergometry testing sessions.

Fukuda DH, et al. Physiol Meas. 2014;35(1):31-43.

Flueck JL, et al. Int J Sports Med. 2015;36(10):809-13.

Exercise modes of 3MT

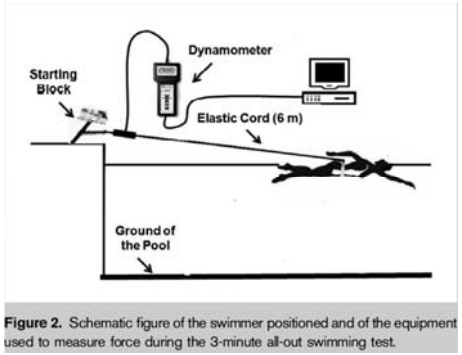


Figure 2. Schematic figure of the swimmer positioned and of the equipment used to measure force during the 3-minute all-out swimming test.

Kalva-Filho CA, et al. J Strength Cond Res. 2015;29(1):238-45.

- 50 m swimming pool
- Time every 25 m
- Critical Speed (CS)
  - Avg. speed at final 30-s

Tsai MC, & Thomas SG. Int J Sports Physiol Perform. 2017;12(1):27-35.

Exercise modes of 3MT

- **Outdoor 400 m track**
  - **GPS wrist watch (Forerunner Model 305, Garmin, Taiwan)**

    Pettitt RW, et al. Int J Sports Med. 2012;33(6):426-31.
  - **Accelerometer (RS800CX, Polar Electro Inc., NY, USA)**
  - **Avg. speed at final 20-s**

    Broxterman RM, et al. Respir Physiol Neurobiol. 2013;185(2):380-5.

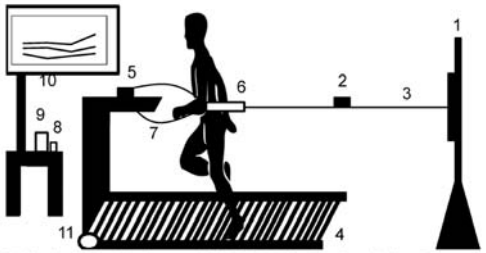


Fig 1. Schematic figure of the system developed on a non-motorized treadmill (NMT) for 3-min all-out (3MT) total power and critical power (CP) determination. 1. Height adjustment bar; 2. load cell; 3. steel cable with elastic cords (CP) or just steel cable (3MT); 4. NMT; 5 exhaustion apparatus; 6. belt attached to the steel cable and participant; 7. exhaustion apparatus security belt; 8. data acquisition module (DAC system); 9. signal amplifier; 10. computer; 11. hall effect sensor located on the treadmill's front cylinder to determine the velocity that results from the connection with the DAC system.

Gama MCT, et al. PLoS One. 2018;13(2):e0192552.

3MT for Rowing

- **18 rowers**
- **3-min unload**
- **3-min all-out with maximal damper setting (10 was used)**

Unload **3MT**

Cheng CF, et al. Eur J Appl Physiol. 2012;112(4):1251-60.

3MT for Rowing

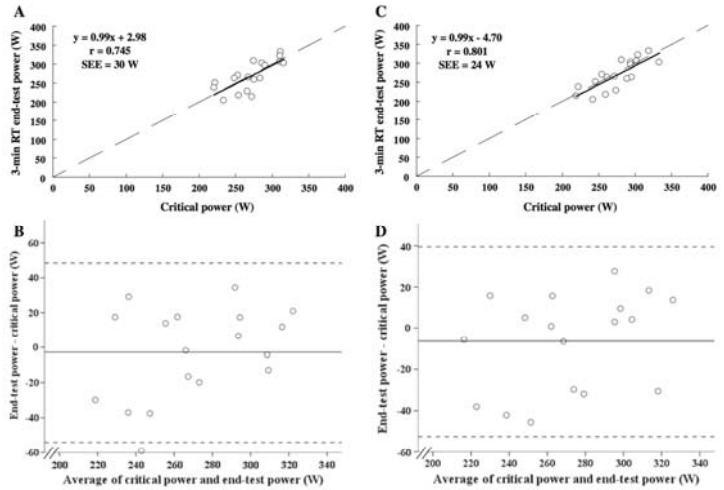


Fig. 4 Correlation and Bland-Altman analyses for differences in end-test power (EP) and critical power (CP) estimates between the 3-min RT and the work – time model (**a**, **b**), and the 3-min RT and the power – [1/time] model (**c**, **d**). In **a** and **c**, the *solid line* is the best-fit linear regression, and the *dashed line* is the line of identity. In panels **b** and **d**, the *solid line* represents the mean difference between the EP and CP estimates, and the *dashed line* represents the 95% limits of agreement

Cheng CF, et al. Eur J Appl Physiol. 2012;112(4):1251-60.

3MT for Running

- **12 male sprinters**
- **GXT in Lab (22.0˚C ± 0.5˚C)**
- **Outdoor track (34.5˚C ± 0.8˚C)**

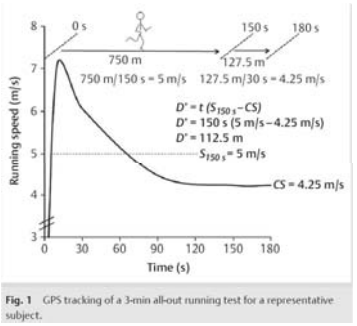


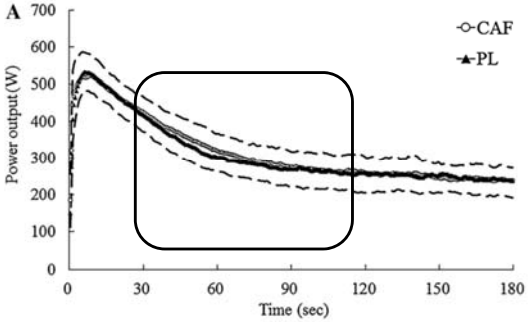
Fig. 1 GPS tracking of a 3-min all-out running test for a representative subject.

(Pettitt RW, et al., 2012)

Kuo YH, et al. Res Sports Med. 2017;25(4):470-9.

Caffeine and 3MT

- 15 basketball players
- Caffeine (6 mg/kg)
- Placebo



Cheng CF, et al. Eur J Appl Physiol. 2016;116(9):1693-702.

Visits for 3MT

Authors (year)	Subjects	Device	Visits	Resistance set
Burnley et al. (2006)	recreationally active	cycling ergometer	2	GET + 50% ($\dot{V}O_2$max − GET)
Vanhatalo et al. (2007)	cyclists, runners, active	cycling ergometer	2	GET + 50% ($\dot{V}O_2$max − GET)
Bergstrom et al. (2012)	moderately trained	cycling ergometer	1	3.5%BM 4.5%BM
Clark et al. (2013)	various fitness levels	cycling ergometer	1	3% BM = recreationally active 4% BM = anaerobic and aerobic athletes 5% BM = endurance athletes
Cheng et al. (2012)	trained rowers	rowing ergometer	1	damper setting of 10
Fukuda et al. (2014)	recreationally active	ski ergometer	1	damper setting of 4
Flueck et al. (2015)	recreationally active	arm crank ergometer	1	torque factor of 0.2
Tsai et al. (2017)	trained swimmers/triathletes	swimming pool	1	No
Kalva-Filho et al. (2015)	swimmers	swimming pool	1	No (tethered swimming)
Pettitt et al. (2012)	distance runners	outdoor track	1	No
Broxterman et al. (2013)	healthy adults	outdoor track	1	No
Gama et al. (2018)	physically active	non-motorized treadmill	1	No (tethered running)

APP?

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TABLE 5. Classification of exercise intensity: relative and absolute exercise intensity for cardiorespiratory endurance and resistance exercise.

	Cardiorespiratory Endurance Exercise										Resistance Exercise
	Relative Intensity				Intensity ($\%\dot{V}O_{2max}$) Relative to Maximal Exercise Capacity in METs			Absolute Intensity	Absolute Intensity (MET) by Age			Relative Intensity
Intensity	%HRR or $\%\dot{V}O_2R$	$\%HR_{max}$	$\%\dot{V}O_{2max}$	Perceived Exertion (Rating on 6–20 RPE Scale)	20 METs $\%\dot{V}O_{2max}$	10 METs $\%\dot{V}O_{2max}$	5 METs $\%\dot{V}O_{2max}$	METs	Young (20–39 yr)	Middle-aged (40–64 yr)	Older (≥65 yr)	% 1RM
Very light	<30	<57	<37	<Very light (RPE < 9)	<34	<37	<44	<2	<2.4	<2.0	<1.6	<30
Light	30–39	57–63	37–45	Very light–fairly light (RPE 9–11)	34–42	37–45	44–51	2.0–2.9	2.4–4.7	2.0–3.9	1.6–3.1	30–49
Moderate	40–59	64–76	46–63	Fairly light to somewhat hard (RPE 12–13)	43–61	46–63	52–67	3.0 to 5.9	4.8–7.1	4.0–5.9	3.2–4.7	50–69
Vigorous	60–89	77–95	64–90	Somewhat hard to very hard (RPE 14–17)	62–90	64–90	68–91	6.0–8.7	7.2–10.1	6.0–8.4	4.8–6.7	70–84
Near-maximal to maximal	≥90	≥96	≥91	≥Very hard (RPE ≥ 18)	≥91	≥91	≥92	≥8.8	≥10.2	≥8.5	≥6.8	≥85

Table adapted from the American College of Sports Medicine (14), Howley (173), Swain and Franklin (344), Swain and Leutholtz (346), Swain et al. (347), and the US Department of Health and Human Services (370).
HR_{max}, maximal HR; $\%HR_{max}$, percent of maximal HR; HRR, HR reserve; VO_{2max}, maximal oxygen uptake; $\%VO_{2max}$, percent of maximal oxygen uptake; VO_2R, oxygen uptake reserve; RPE, ratings of perceived exertion (48).

運動自覺強度（RPE）

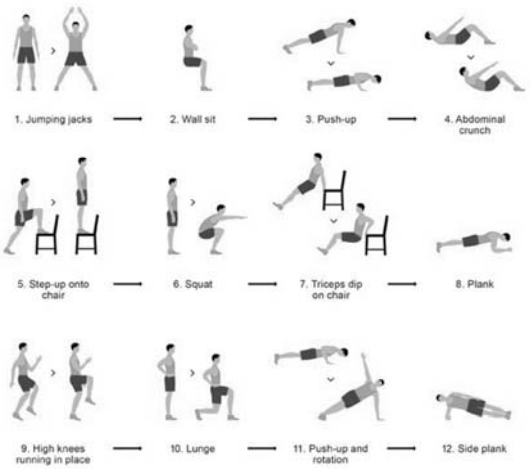
表 7-3　Borg 自覺運動強度量表

15 分量表	10 分量表
6　一點都不辛苦	0　完全不覺得
7　非常輕鬆	0.3
8	0.5
9　很輕鬆	1　很弱
10	1.5
11　輕鬆	2　弱
12	2.5
13　有點辛苦	3　中等
14	4
15　辛苦	5　強
16	6
17　很辛苦	7　很強
18	8
19　非常辛苦	9
20　最大努力	10　非常強

運動自覺強度：Talk test

Borg scale descriptor	Borg scale	Speaking and thinking scale	Duration*
No exertion at all	6		
Extremely light	7	Can sing in full stanzas	All day
	8		
Very light	9	Can sing a few lines	All day with breaks
	10		5-10 hr
Light	11	Can talk in full sentences	4-5 hr
	12		2.5-4 hr
Somewhat hard	13	Can talk—a few sentences at a time	1.5-2.5 hr
	14	Can talk—a few words at a time	50-90 min
Hard (heavy)	15		25-50 min
	16	Can't talk, but can think clearly	15-25 min
Very hard	17	Need to focus to maintain intensity	7-15 min
	18	Struggle to maintain intensity	3-7 min
Extremely hard	19	"Brain dead"—really hurting	30 sec-3 min
Maximal exertion	20	"End is imminent"	<30 sec

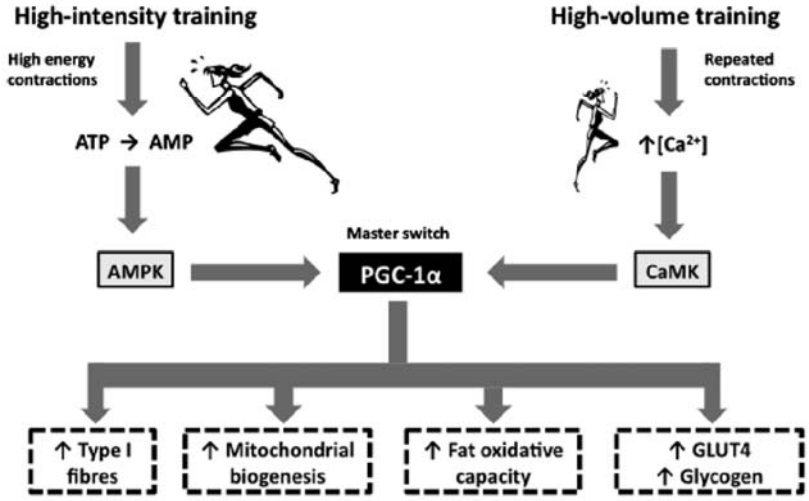
高強度間歇訓練（HIIT）



- 7-min workout
- Tabata

Brent, K. & Chris, K. (2013). *ACSM's Health & Fitness Journal, 17*(3), 8-13.

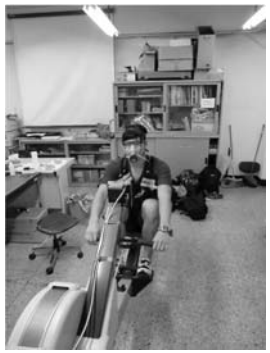
HIIT and Adaptations



Laursen PB. (2010). Scand J Med Sci Sports, 20, Suppl 2:1-10.

HIIT & Rowing

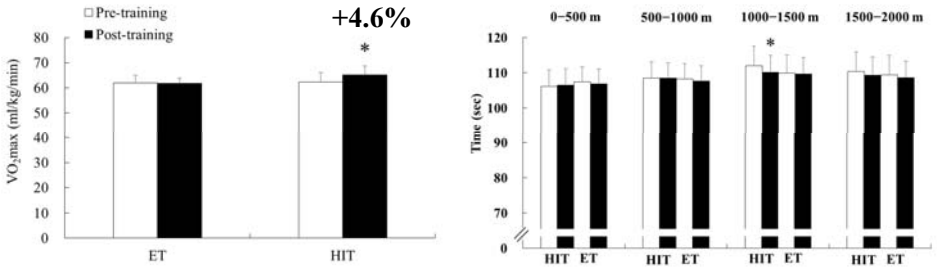
- Rowers
- SIT (n = 8)
- ET (n =8)



Parameter	HIT	ET
Intensity	30-s Wingate-based rowing sprint	60%$\dot{V}O_2$max (~VT)
Work duration	Week 1: 8 sets Week 2: 10 sets Week 3: 12 sets Week 4: 12 sets	60 min
Rest duration	4 min	NA
Sessions/week	3	3
Total exercise time	63 min	720 min
Total exercise time including rest	519 min	720 min

Cheng, C. F., et al. (2014). 19th Annual Congress of the European College of Sport Science, VU University Amsterdam, Amsterdam, Netherlands.

HIIT & Rowing



Physiological Adaptations to Sprint Interval Training with Matched Exercise Volume

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1. HIIT10s: Each session consisted of 48 × 10-s cycling sprints at the power output corresponding to 85% $\dot{V}O_{2max}$ separated by 20 s of active recovery, which yielded a work-to-rest ratio of 1:2.
2. HIIT60s: Each session comprised 8 × 60-s cycling intervals at the power output corresponding to 85% $\dot{V}O_{2max}$ separated by 120 s of active recovery, which also yielded a work-to-rest ratio of 1:2.
3. CON: The participants maintained their daily physical activity and habitual diet but did not perform any HIIT.

Lee, C. L., et al. (2017). Med Sci Sports Exerc, 49(1), 86-95.

HIIT and Aerobic Capacity

TABLE 1. Aerobic parameters among HIIT60s, HIIT10s, and CON groups at pretraining and posttraining (mean ± SD).

	HIIT60s (n = 13)		HIIT10s (n = 12)		CON (n = 13)	
	Pretraining	Posttraining	Pretraining	Posttraining	Pretraining	Posttraining
$\dot{V}O_{2max}$ (L·min^{-1})	3.5 ± 0.5	4.1 ± 0.8**	3.5 ± 0.8	4.1 ± 0.8**	3.6 ± 0.7	3.7 ± 0.7
$\dot{V}O_{2max}$ (mL·kg^{-1}·min^{-1})	51.9 ± 9.2	61.4 ± 12.2*,**	52.6 ± 9.5	61.0 ± 9.6*,**	50.0 ± 6.8	52.4 ± 6.5
HR_{max} (bpm)	182 ± 11	180 ± 11	184 ± 9	183 ± 8	183 ± 11	188 ± 10
RPE (Borg's 6–20)	17 ± 1	18 ± 2	16 ± 1	17 ± 1	17 ± 1	17 ± 1
Blood lactate (mM)	9.6 ± 2.0	10.6 ± 2.0	9.0 ± 1.4	9.8 ± 1.9	9.4 ± 1.8	9.5 ± 1.8
O_2 pulse (mL per beat)	19.6 ± 2.9	23.6 ± 4.4*	19.8 ± 3.5	23.1 ± 4.7**	20.6 ± 4.1	19.8 ± 2.4
Endurance time (s)	573.2 ± 62.8	621.2 ± 46.7**	571.0 ± 79.5	624.0 ± 89.4**	579.7 ± 96.2	601.8 ± 76.2
$\dot{V}_E$ at $\dot{V}O_{2max}$ (L·min^{-1})	131.6 ± 21.4	138.7 ± 21.9	126.7 ± 27.2	137.9 ± 34.7	130.5 ± 27.7	131.6 ± 27.5
RER at $\dot{V}O_{2max}$	1.3 ± 0.1	1.3 ± 0.2	1.3 ± 0.1	1.2 ± 0.1	1.3 ± 0.2	1.3 ± 0.1
$\dot{V}O_2$ at AT (L·min^{-1})	2.2 ± 0.3	2.5 ± 0.4**	2.1 ± 0.3	2.5 ± 0.5**	2.3 ± 0.4	2.3 ± 0.3
$\dot{V}O_2$ at AT (mL·kg^{-1}·min^{-1})	31.9 ± 5.6	36.6 ± 6.3**	31.5 ± 6.1	36.6 ± 6.4**	31.7 ± 5	32.5 ± 6.6
%$\dot{V}O_{2max}$ at AT (%)	57.7 ± 5.5	64.4 ± 7.9**	58.8 ± 9.3	61.6 ± 6.3	58.6 ± 6.5	61.9 ± 12.0

*Significantly different from CON.
**Significantly different from pretraining.

Lee, C. L., et al. (2017). Med Sci Sports Exerc, 49(1), 86-95.

HIIT and Body Fat

TABLE 2. Physical characteristics, blood pressure, and body composition among HIIT60s, HIIT10s, and CON groups at pretraining and posttraining (mean ± SD).

	HIIT60s (n = 13)		HIIT10s (n = 12)		CON (n = 13)	
	Pretraining	Posttraining	Pretraining	Posttraining	Pretraining	Posttraining
Height (m)	1.77 ± 0.06	1.76 ± 0.05	1.77 ± 0.09	1.77 ± 0.09	1.76 ± 0.05	1.76 ± 0.05
Body mass (kg)	68.4 ± 7.2	67.5 ± 6.3	67.9 ± 11.0	68.4 ± 9.9	71.9 ± 7.2	72.1 ± 7.3
BMI (kg·m^{-2})	21.8 ± 2.0	21.7 ± 1.8	21.5 ± 2.0	21.7 ± 1.8	23.1 ± 1.8	23.3 ± 1.6
SBP (mm Hg)	125 ± 7	126 ± 9	124 ± 9	123 ± 9	123 ± 14	127 ± 12
DBP (mm Hg)	67 ± 10	66 ± 8	67 ± 6	66 ± 8	71 ± 7	68 ± 8
Skinfold (mm)						
Chest*	9.4 ± 3.9	8.5 ± 3.0	9.4 ± 3.4	8.8 ± 3.3	9.6 ± 3.9	8.4 ± 3.7
Abdominal	15.2 ± 4.9	11.4 ± 3.5**	13.3 ± 3.3	11.5 ± 2.6**	14.6 ± 6.2	13.9 ± 6.5
Thigh	13.7 ± 3.4	10.9 ± 2.9**	11.6 ± 2.9	9.3 ± 2.0**	11.4 ± 3.7	10.5 ± 3.8
Body fat (%)	10.6 ± 3.4	8.3 ± 2.3**	9.3 ± 2.6	7.9 ± 2.1**	9.8 ± 4.3	9.3 ± 4.1

BMI, body mass index.
*Main effect identified for training ($P < 0.05$).
**Significantly different from pretraining.

Lee, C. L., et al. (2017). Med Sci Sports Exerc, 49(1), 86-95.

Acute High-Intensity Interval Cycling Improves Postprandial Lipid Metabolism

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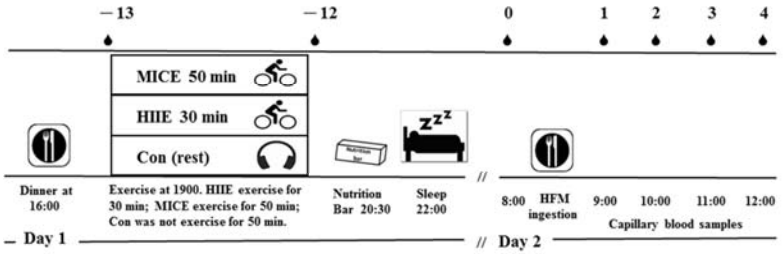
- **HIIE (10 x 60-s sprint, 85%VO2max, 120-s interval)**
- **MICE (65%VO2max, 50-min)**
- **CON**



Lee, C. L., et al. (2018). Med Sci Sports Exerc, 50(8), 1687-1696.

HIIT and Lipid Metabolism

TABLE 3. TAUC responses of serum/plasma glucose, insulin, triglyceride, and FFA.

Condition	HIIE (n = 12)	MICE (n = 12)	Con (n = 12)
Glucose (mg·dL^{-1} per 17 h)	1649 ± 142**	1432 ± 123*	1576 ± 119
Insulin (μU·mL^{-1} per 17 h)	245 ± 70**	171 ± 64*	273 ± 79
Triglyceride (mg·dL^{-1} per 17 h)	1376 ± 880	1424 ± 708	1408 ± 574
FFA (mmol·L^{-1} per 17 h)	7.5 ± 1.6	9.1 ± 2.1	8.1 ± 2.9

Values are expressed as mean ± SD.
*Significantly different from Con (P < 0.05).
**Significantly different from MICE (P < 0.05).

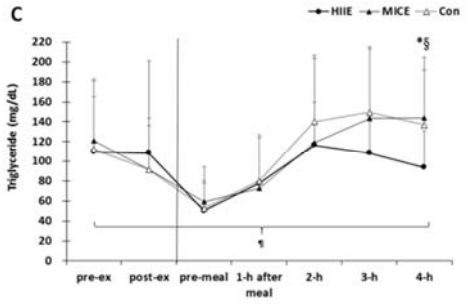
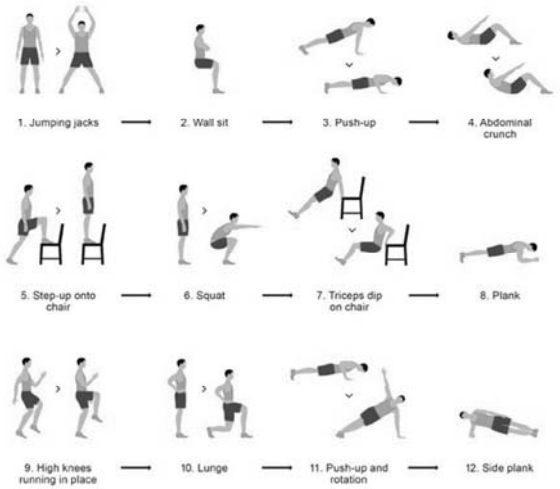


TABLE 2. Metabolic rate before breakfast and during the postprandial period.

Metabolite	HIIE (n = 12)	MICE (n = 12)	Con (n = 12)
$\dot{V}O_2$ (L·min^{-1})			
Before meal	0.27 ± 0.04	0.24 ± 0.04	0.26 ± 0.04
Postprandial 1 h	0.34 ± 0.06*	0.30 ± 0.03	0.29 ± 0.05
Postprandial 2 h	0.33 ± 0.05	0.31 ± 0.03	0.30 ± 0.03
Postprandial 3 h	0.32 ± 0.06	0.30 ± 0.03	0.29 ± 0.04
Postprandial 4 h	0.29 ± 0.05	0.29 ± 0.03	0.29 ± 0.04
$\dot{V}CO_2$ (L·min^{-1})			
Before meal	0.22 ± 0.03	0.20 ± 0.04	0.22 ± 0.04
Postprandial 1 h	0.27 ± 0.06	0.25 ± 0.03	0.24 ± 0.05
Postprandial 2 h	0.26 ± 0.05	0.25 ± 0.02	0.24 ± 0.03
Postprandial 3 h	0.24 ± 0.04	0.23 ± 0.02	0.23 ± 0.04
Postprandial 4 h	0.22 ± 0.03	0.22 ± 0.01	0.23 ± 0.04
RER			
Before meal	0.85 ± 0.05	0.84 ± 0.05	0.87 ± 0.09
Postprandial 1 h	0.78 ± 0.04*,**	0.84 ± 0.02	0.85 ± 0.07
Postprandial 2 h	0.77 ± 0.04	0.79 ± 0.02	0.81 ± 0.04
Postprandial 3 h	0.75 ± 0.04	0.78 ± 0.05	0.78 ± 0.07
Postprandial 4 h	0.76 ± 0.03	0.76 ± 0.05	0.78 ± 0.06
EE (kcal·min^{-1})			
Before meal	1.31 ± 0.21	0.19 ± 0.23	1.28 ± 0.22
Postprandial 1 h	1.64 ± 0.32	1.47 ± 0.19	0.41 ± 0.27
Postprandial 2 h	1.59 ± 0.28	1.51 ± 0.17	1.45 ± 0.19
Postprandial 3 h	1.51 ± 0.29	1.45 ± 0.16	1.42 ± 0.24
Postprandial 4 h	1.39 ± 0.26	1.42 ± 0.13	1.38 ± 0.20
CHO oxidation rate (kJ·min^{-1})			
Before meal	2.7 ± 1.1	2.4 ± 1.0	3.1 ± 1.8
Postprandial 1 h	2.0 ± 1.4	3.0 ± 0.7	3.1 ± 1.5
Postprandial 2 h	1.8 ± 1.2	1.9 ± 0.5	2.3 ± 0.9
Postprandial 3 h	1.3 ± 1.0	1.6 ± 1.0	1.6 ± 1.7
Postprandial 4 h	1.3 ± 0.6	1.2 ± 1.0	1.7 ± 1.5
Fat oxidation rate (kJ·min^{-1})			
Before meal	2.5 ± 1.5	2.4 ± 0.8	2.1 ± 1.6
Postprandial 1 h	4.6 ± 0.8*,**	2.9 ± 0.6	2.6 ± 1.3
Postprandial 2 h	4.6 ± 1.1*	4.1 ± 0.7	3.5 ± 0.9
Postprandial 3 h	5.0 ± 1.4	4.2 ± 1.3	4.1 ± 1.5
Postprandial 4 h	4.3 ± 1.2	4.5 ± 1.3	3.9 ± 1.4

Values are expressed as mean ± SD. CHO, carbohydrate.
*Significantly different from Con (P < 0.05).
**Significantly different from MICE (P < 0.05).

HIIT with body weight



High-Intensity Circuit Training

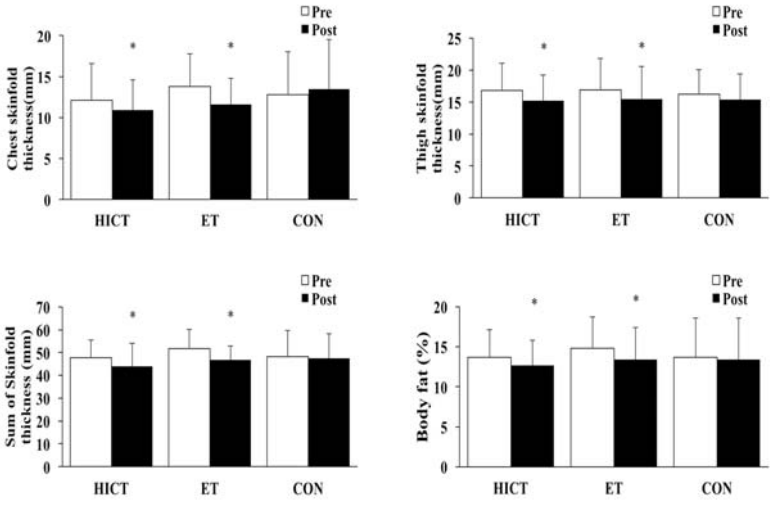
表二　不同運動方式對耐力運動表現之影響

變項	時間點 (訓練前 / 後)	HICT	ET	CON
$\dot{V}O_{2max}$ (ml·kg^{-1}·min^{-1})	前	54.1 ± 5.3	52.8 ± 5.6	54.3 ± 6.1
	後	54.0 ± 5.5	53.2 ± 5.9	52.2 ± 4.3
$v\dot{V}O_{2max}$ (km·hr^{-1})	前	15.3 ± 1.1	14.9 ± 1.4	14.8 ± 1.3
	後	15.8 ± 1.2*†	15.8 ± 1.1*†	14.3 ± 1.3†

註：$\dot{V}O_{2max}$，最大攝氧量；$v\dot{V}O_{2max}$，最大攝氧量對應跑步速度；*$p < .05$，與控制組比較；†$p < .05$，與前測值比較。

郭育瑄等（2019）。大專體育學刊，21（1），72-83。

High-Intensity Circuit Training



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高強度間歇訓練與運動員有氧能力

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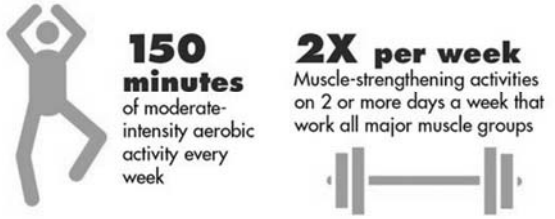
摘　要

有氧能力對於運動員的運動表現而言，是一項很重要的體能要素。傳統上，長時間慢速度 (long slow distance, LSD) 的訓練，常被教練與運動員用以促進有氧能力，例如最大攝氧量 (maximum oxygen uptake, $\dot{V}O_2max$)。不過，LSD 訓練的特徵之一：高訓練量，可能會增加過度訓練的風險。近年來，高強度間歇訓練 (high-intensity interval training, HIT) 被發展用以提升有氧能力，同時，伴隨著節省時間與低過度訓練風險的益處。本文透過資料庫搜索相關文獻，針對 HIT 對於運動員有氧能力的影響，以及 HIT 可能引起的生理機制進行探討。根據 HIT 訓練所使用的強度，HIT 的介入方式可區分爲兩類：以 90%~130% $\dot{V}O_2max$ 的強度進行衝刺，以及利用 30 秒溫蓋特進行的全力衝刺。兩種 HIT 訓練課表均能引起高乳酸環境，並大量消耗肌肉內的 ATP，進而改善肌肉內的代謝控制，加速粒線體的生物合成作用，最終有助於改善運動員的有氧能力與運動表現。

Summary

- 中等強度
- 激烈強度



- 強度？？

感謝聆聽！
敬請指教！

運動表現實驗室
Sports Performance Lab