Changes in Heart Rate, and Blood Lactate with different increment on Treadmill Interval Training

不同斜度的跑步機間歇訓練如何影響心率和乳酸的改變

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HIT

- Maximal Oxygen Uptake, orVO_{2max} does not improved by increment in submaximal training volume -- Daniel et al (1978); Costill et al, (1988).
- Improvement on the endurance performance and associated physiological variables can be achieved only through HIT.

What is HIT?

- ***Interval training*** involved repeated short to long bout of rather ***high*** intensity exercise (equal or superior to maximal lactate-state velocity) interspersed with recovery periods (light exercises or passive rest).

Billat, 2000

- It permits the athlete to train at high intensity for greater amount of time than would possible in a single exercise session at a continuous high intensity.

VO_{2max}

- As exercise increase in intensity, the motor regions in the brain recruit more muscle fibers and hence more myofibrils to produce ever more powerful muscle contractions.
- This demands increased rates of energy requirement, and this, in turn, a greater oxygen supply.
- Trained individuals are primary limited by the heart's ability to pump blood (Q, 心輸出量) in a given exercise intensity (Wagner, 2000; Richardson, 2000).

Lactate Threshold

- Define as: the intensity of work or VO_2 where the blood lactate concentration gradually starts to increase during exercise.
- Blood lactate level represents a balance between lactate production and removal, and there are individual patterns in these kinetics (intra-individual).
- However, LT concept is appealing because it may be more sensitive to training-induced adaptations than VO_{2max} alone.

Work Economy

- Refer to as the ratio between work output and oxygen cost.
- Both Physiological and Biomechanical factors will have some effects on this.
- Also is improved from increased maximal strength and rate of force development.

Adaptations to endurance training

- Central and peripheral adaptations in oxygen transport and utilization are training-modality dependant.

Central effect

- Cardiac output (心輸出量)=HR * SV
- In most findings, Heart Rate (HR, 心率)and Stroke Volume (SV, 心搏量) plateau or increases only modestly when the work rates increase until about 50% VO_{2max} in well-trained athletes.
- Ekblom & Hermansen (1968) and Gledhill et al (1994) have shown that SV continues to increase beyond that rate though.
- For well-trained athletes, Zhou et al (2001) and Helgerud et al (2007) found out that their SV increased continuously with increased workload up to $VO_{2max.}$

Peripheral effect

- Improve ability to extract oxygen from the arterial blood.
- Improve muscle capillarity
- Increase surface availability for blood-tissue exchange

Hepple et al, 2000

Superior effect of HIT over Continuous Training (CT)

- HIT improve both central and peripheral components of VO_{2max}.
- CT is associated with greater oxygen extraction- better oxidative capacity.

(Daussin et al, 2007)

Intensity

- Intensity often regarded as the most important training variable that can be manipulated in term of eliciting the training-induced enhancement of VO_{2max}.
- For elite athletes, training at at or near VO_{2max} is the most effective training intensity to enhance maximal oxygen uptake.
- HIT have been found to be more effective than CT for increasing the time training under this recommended intensity ($\geq$95% VO_{2max}).

(Midgley & Naughton, 2006)

Training Program

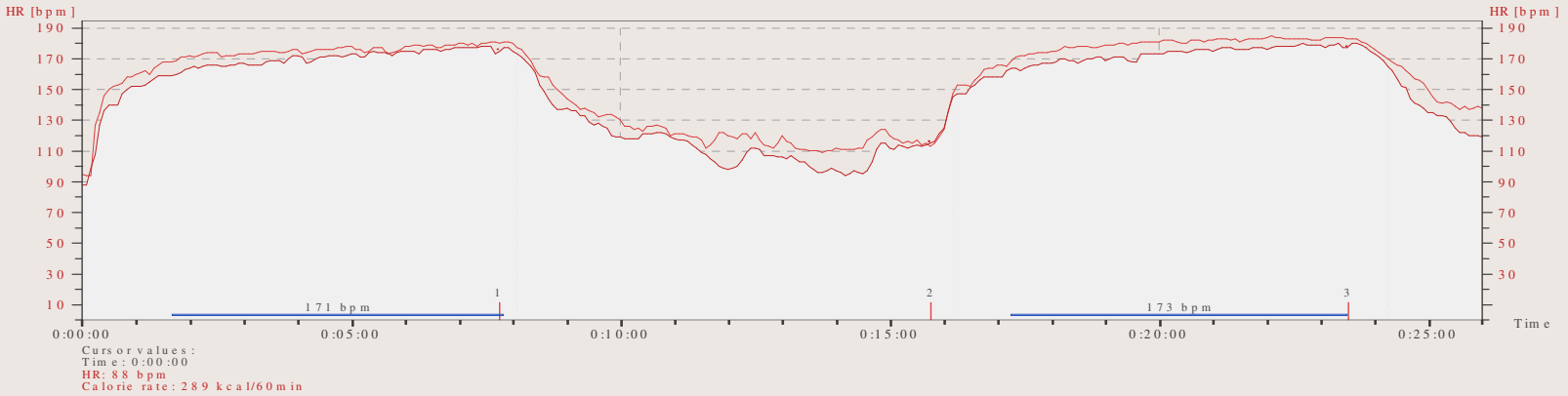
Program 1: 15/15 interval run

- 15 seconds run : 15 seconds active rest
- Frequency – 3 times a week for 8 weeks
- Intensity – 95%HRmax : 70%HRmax
- Target system – cardiopulmonary, metabolic
- ↑ VO_{2max}; ↑stroke volume; MHR ↔

Example 1

- 2 – 3 sets x (16 reps x 15 seconds run, 15 seconds active rest), 8 minutes rest between sets
- Intensity – ~120%MAS : 50%MAS
- Gradient – 3%
- 8 sessions within 1months
- Frequency – 2 to 3 times a week

Example 1 (cont')



No	Exercise	Date	Cursor HR	Heart rate	Duration	Note
1.	BasicUse	15/6/2009	95	177 / 185	0:37:30.7	
2.	BasicUse	29/7/2009	88	172 / 180	0:46:31.6	
3.						
4.						
5.						

	Pre Exercise response		Post Exercise response	
Speed (km/hr)	16.5/8.5	16.5/8.5	17/8.5	17/8.5
HR max.	181	185	178	180
HR avg.	176	180	171	173
B.Lact.	7.69	9.26	9.16	9.62

Program 2: 4 minutes interval run

- 4 minutes run : 3 minutes active rest
- Frequency – 3 times a week for 8 weeks
- Intensity – 95%HRmax : 70%HRmax
- Target system: cardiopulmonary, metabolic
- ↑ VO_{2max}; ↑ stroke volume; MHR ↔

Example 2

- 6 sets x 4 minutes run, 3minutes rest between sets
- Intensity – 95%HRmax
- Gradient – varied

Example 2 (cont')

Person	Anson Kwong	Date	30/1/2008	Heart rate average	160 bpm		
Exercise	BasicUse	Time	11:05:06	Heart rate max	174 bpm		
Sport	Running	Duration	0:46:58.7				
Note				Selection	0:00:50 - 0:00:00 (0:18:00.0)		

Speed (km/hr)	14.4	14.4	14.4	14.4	14.4	14.4
HR max. (bpm)	156	161	165	169	171	174
HR avg. (bpm)	148	157	160	164	167	170
Blood lactate(mM)	5.35	6.09	6.89	6.89	7.54	8.24

Program 3: 2 minutes interval run

- 2 minutes run : 1 minute rest
- Frequency – 6 days a week for 6 weeks
- Intensity – 100%MAS
- Target system: cardiopulmonary, metabolic
- ↑MAS; ↑ability of lactate removal

Physiological nature of Squash

- Repeated, short, high-intensity, intermittent bouts
- Game duration: 5 – 15 minutes
- Rallies: 5 – 20 seconds
- Rest between points: 7 – 8 seconds
- BL during game around 6 – 9mM/L

Typical program for Squash player

- Aerobic training for 4 – 6 weeks such as 10 minutes interval
- 4 minutes interval run with different gradient for 4 – 6 weeks
- Short sprint interval for 4 – 6 weeks, such as 5 seconds, 15 seconds with gradient or sprint on ground

Badminton training

- Traditional interval training of Hong Kong Team
- 1 minutes interval
- Work : Rest = 1: 1
- Intensity: High

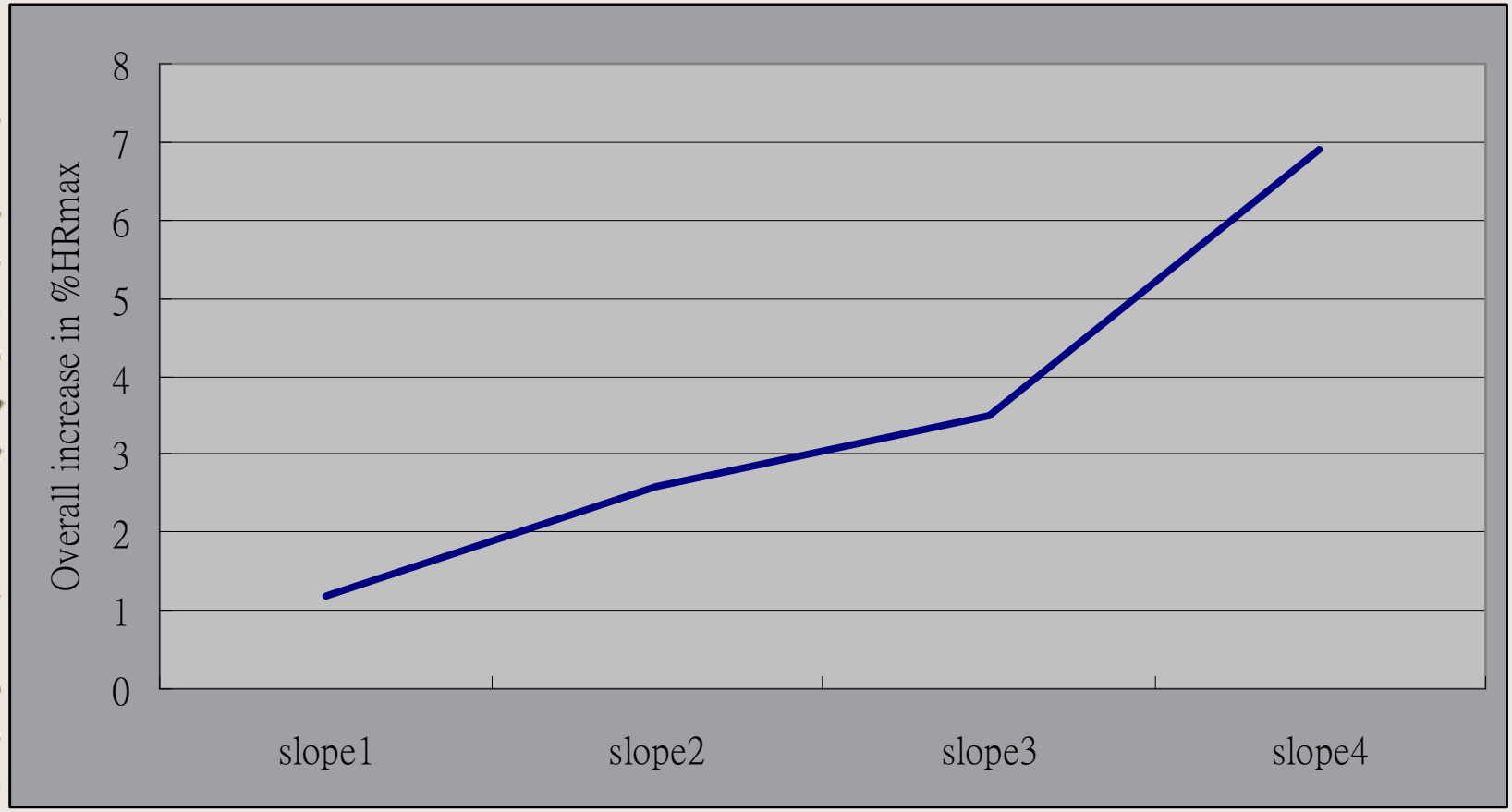
Badminton (cont')

- 12 sets x 1 minutes sprint, with 1 minutes passive rest between sets
- Speed: 100%MAS (of Vam Eval test)
- Gradient: 0 – 4%

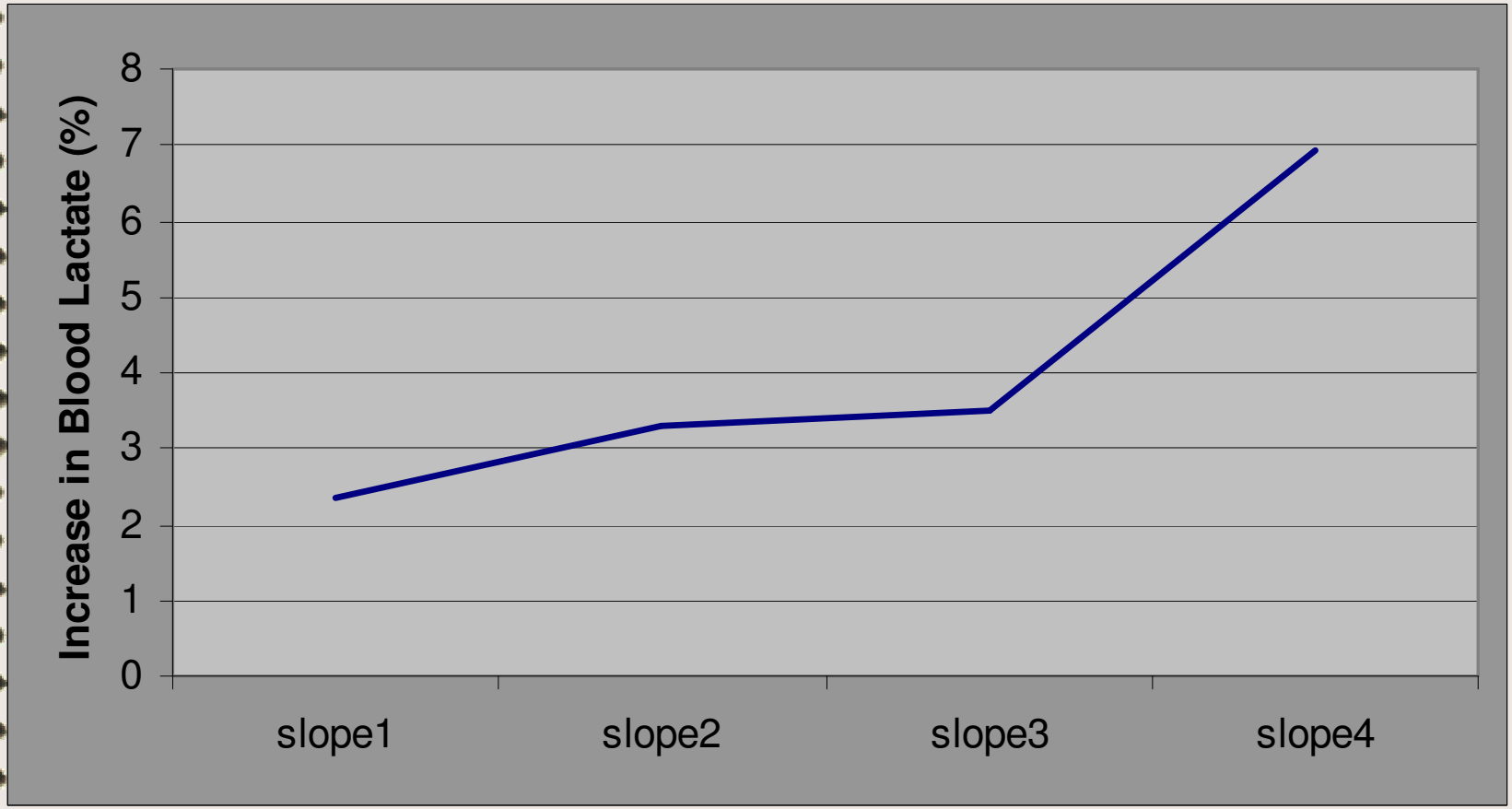
Test: VAM-EVAL track test to get subjects maximal aerobic speed (MAS)

- MAS defined as the minimum speed needed to reach Maximal Oxygen Uptake (VO_{2max}), might represent an optimal training stimulus when the goal is to run for as long as possible at VO_{2max}. Training at MAS is important because MAS is the lowest speed that elicit VO_{2max} and it may be optimal to train at VO_{2max} in order to improve it.
- The VAM-EVAL track test took place on a 400 m track with cones placed every 20 m. A pre-recorded soundtrack indicated with brief sounds the instant when the subject had to pass near a cone to maintain the imposed speed. A longer sound marked a change of stage. The first stage was set at 8 kmh^{-1} with subsequent increments of 0.5 kmh-1 per 1 min stages. The test was finished when the subject was unable to maintain the imposed running speed. The speed corresponding to the last completed stage was recorded as vVO_{2max} (kmh^{-1}).

Increase in %HR when compared to 0% gradient



Increase in %La when compared to 0% gradient



Safety Concern

- This type of training shouldn't be performed until a firm base of aerobic endurance training has been attained.
- Not to perform after strenuous training session/ when fatigue.

Program design: Acute variables

Pollock (1977) shown that the improvement in VO_{2max} is directly related to intensity, duration and frequency of training.

- Interval number per set
- Number of set
- Work-to-rest ratio
- **Intensity** (speed, gradient)

- Frequency (session/ week; number of micros)

Program design: Energy Production (NSCA)

Phosphagens (ATP & PCr)

- 5-10 seconds

Fast glycolysis /Anaerobic glycolysis

- 15-30 seconds

Fast glycolysis and Oxidative glycolysis

- 1-3 min

Oxidative

- > 3min

The End

Thank You

References

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