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Learning from different training methods across the world

Arturo Casado, PhD

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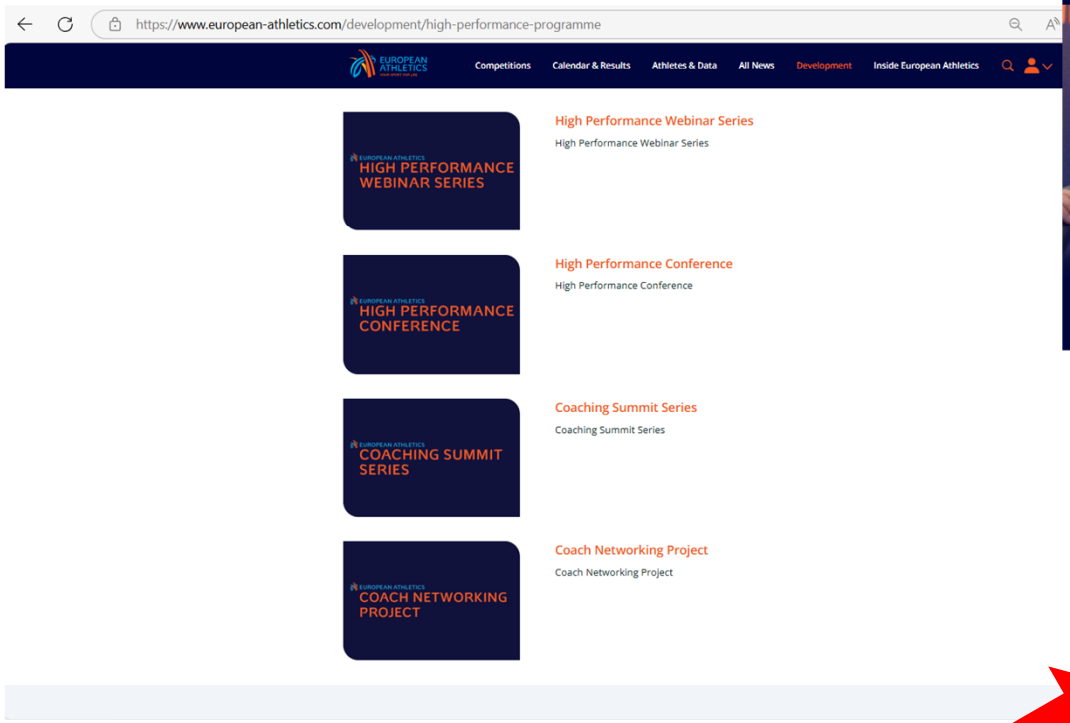
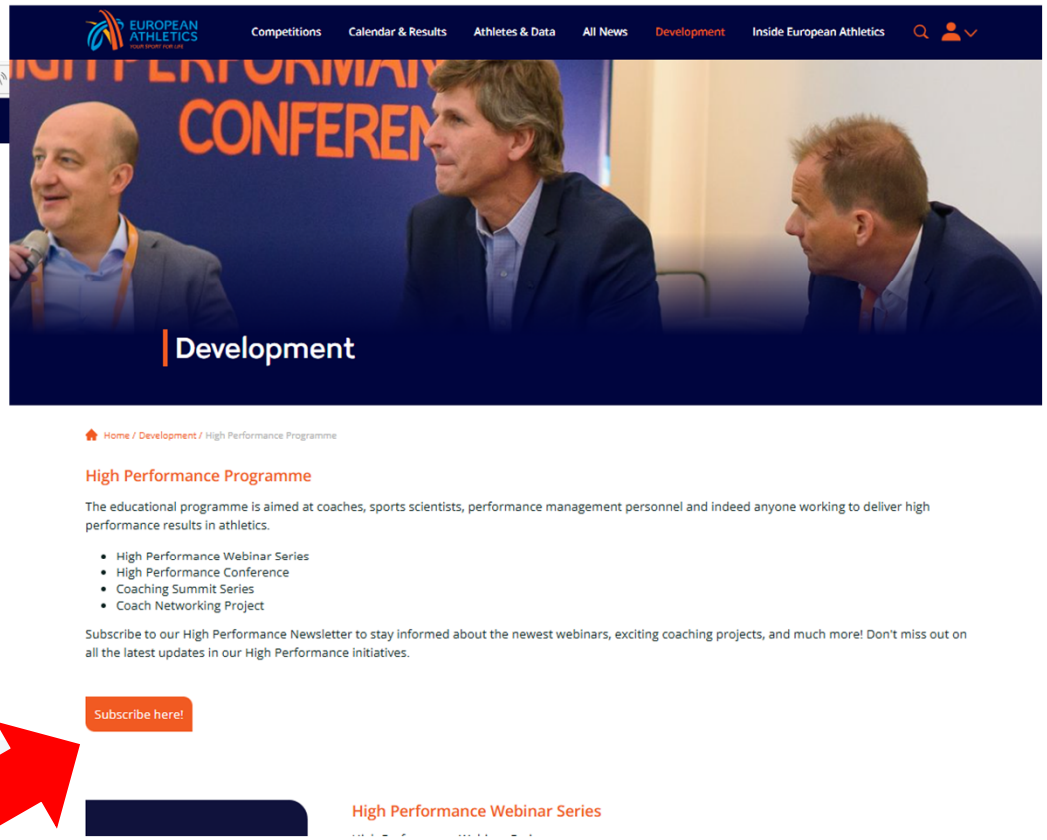
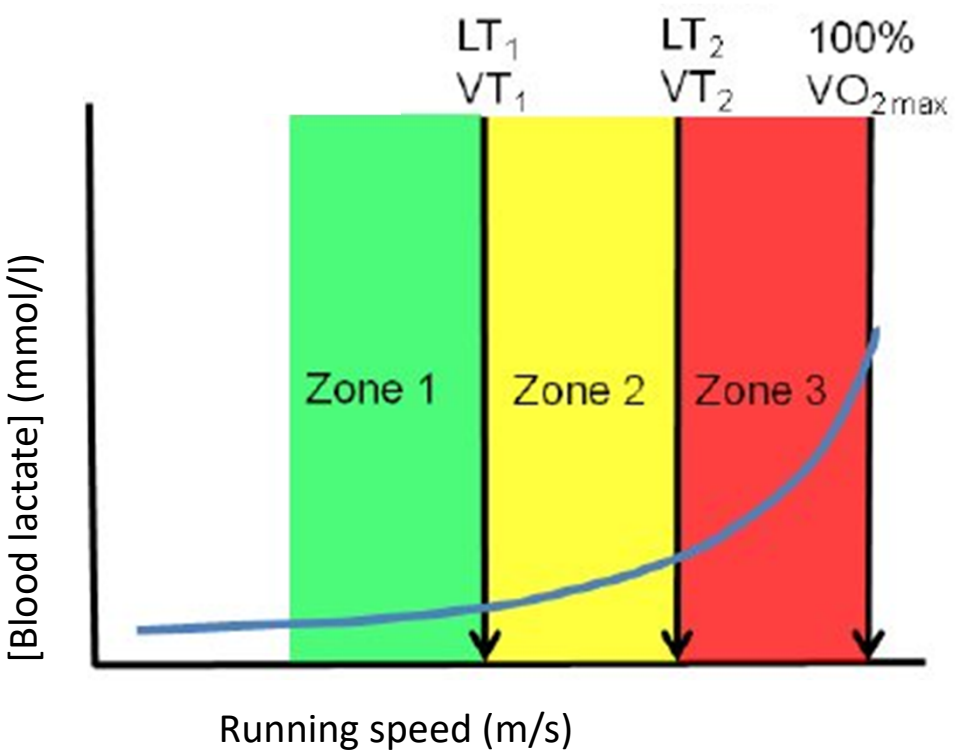
European Athletics website





DETERMINANTS OF ENDURANCE PERFORMANCE AND THREE-PHASE MODEL OF PHYSIOLOGICAL INTENSITY ADAPTED FROM SKINNER & MCLELAN (1980)

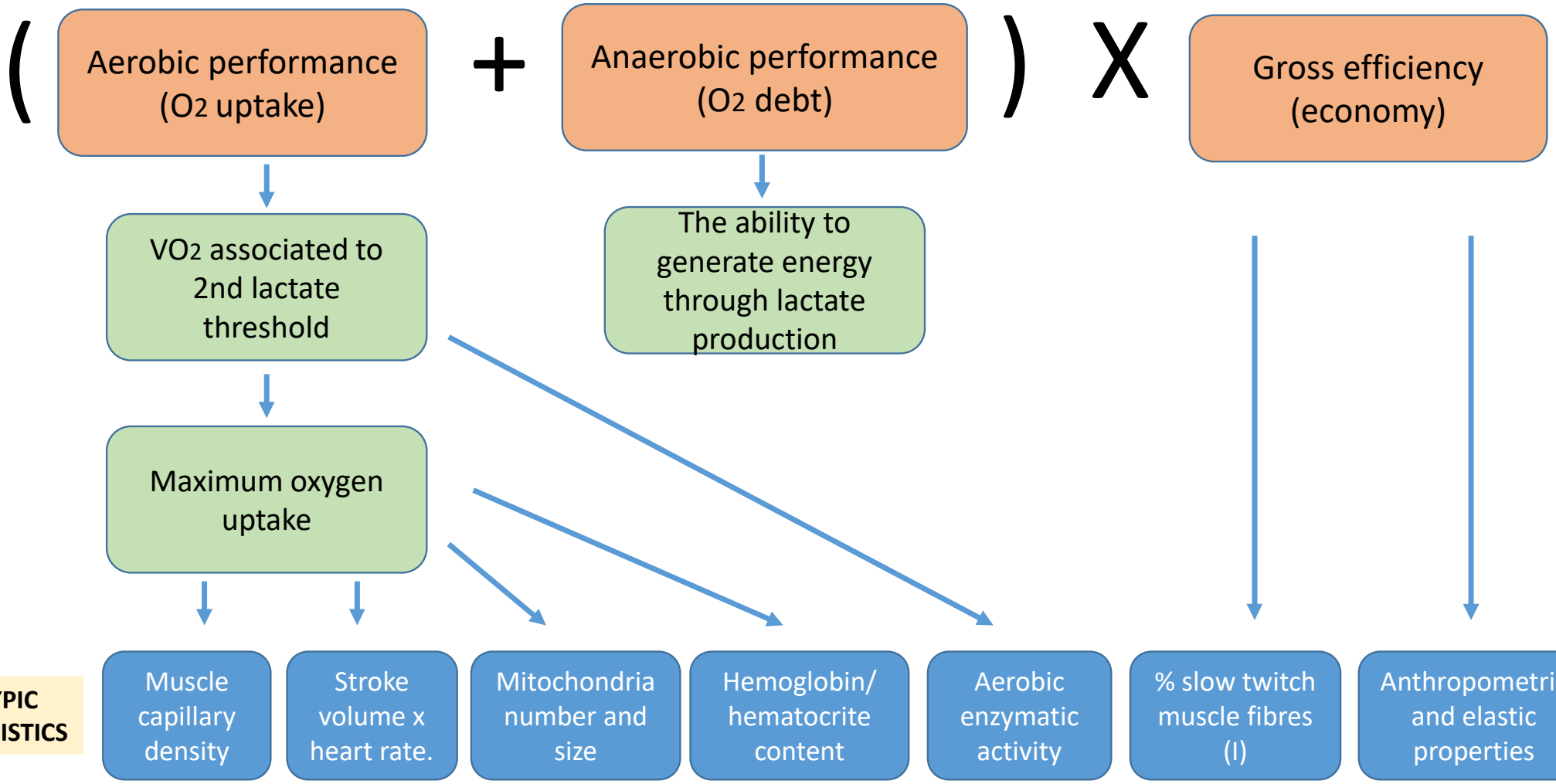


Adapted from Seiler y Tonnessen (2009)

1st threshold: VT1/ LT1
2nd threshold: VT2/ LT2
$VO_{2max.}$ and MAS
Glycolitic capacity
Glycolitic power
Sprint

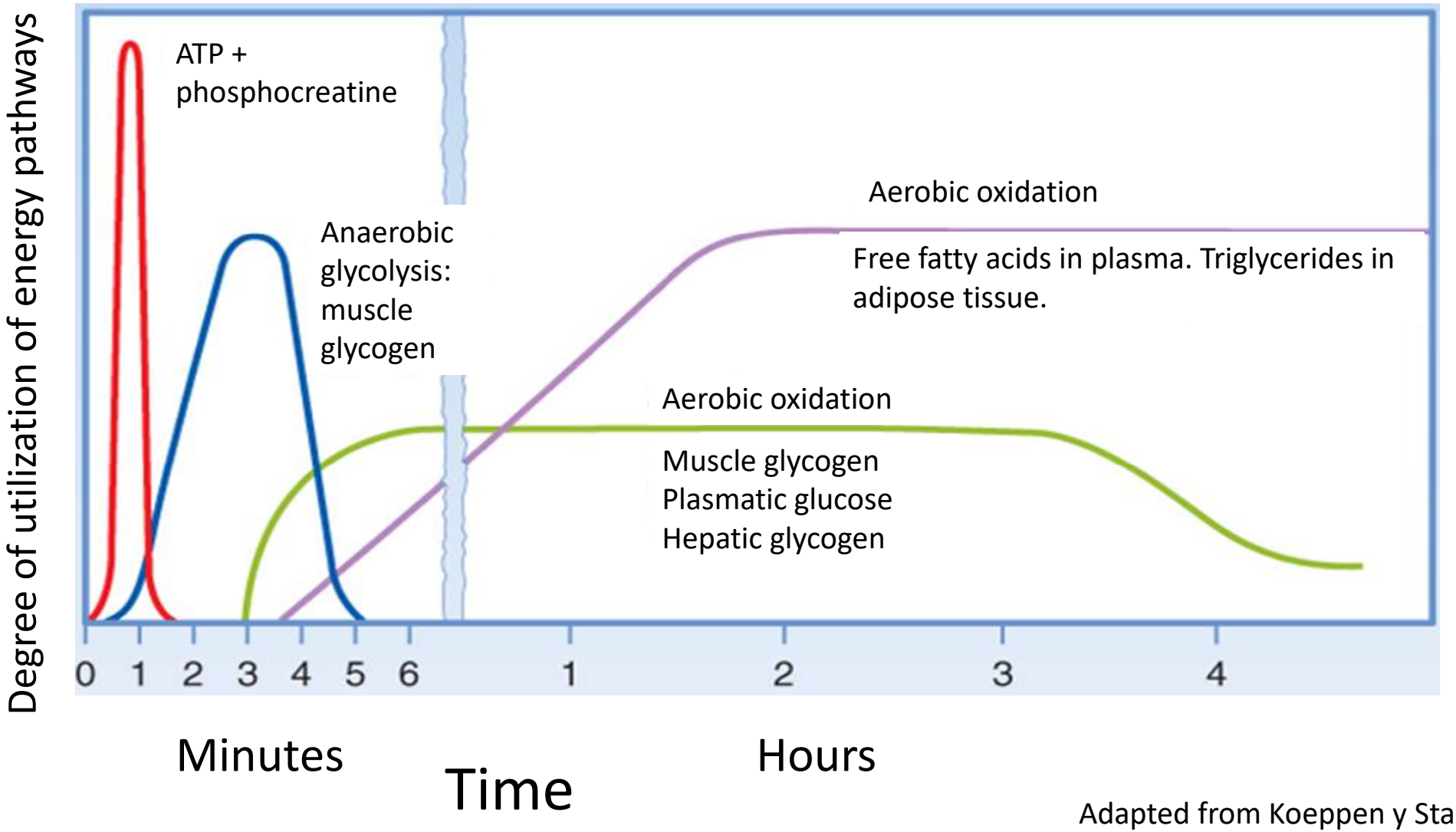
These **zones** are used to **quantify** the training **volume** performed at **different intensities**.

DISTANCE RUNNING PERFORMANCE (AVERAGE SPEED OR POWER)



Adapted from Joyner & Coyle (2008)

ENERGY PATHWAYS



Adapted from Koeppen y Stanton (2008)

OXIDATIVE AND NON-OXIDATIVE GLYCOLYTIC PROCESSES OF ENERGY PRODUCTION DURING EXERCISE

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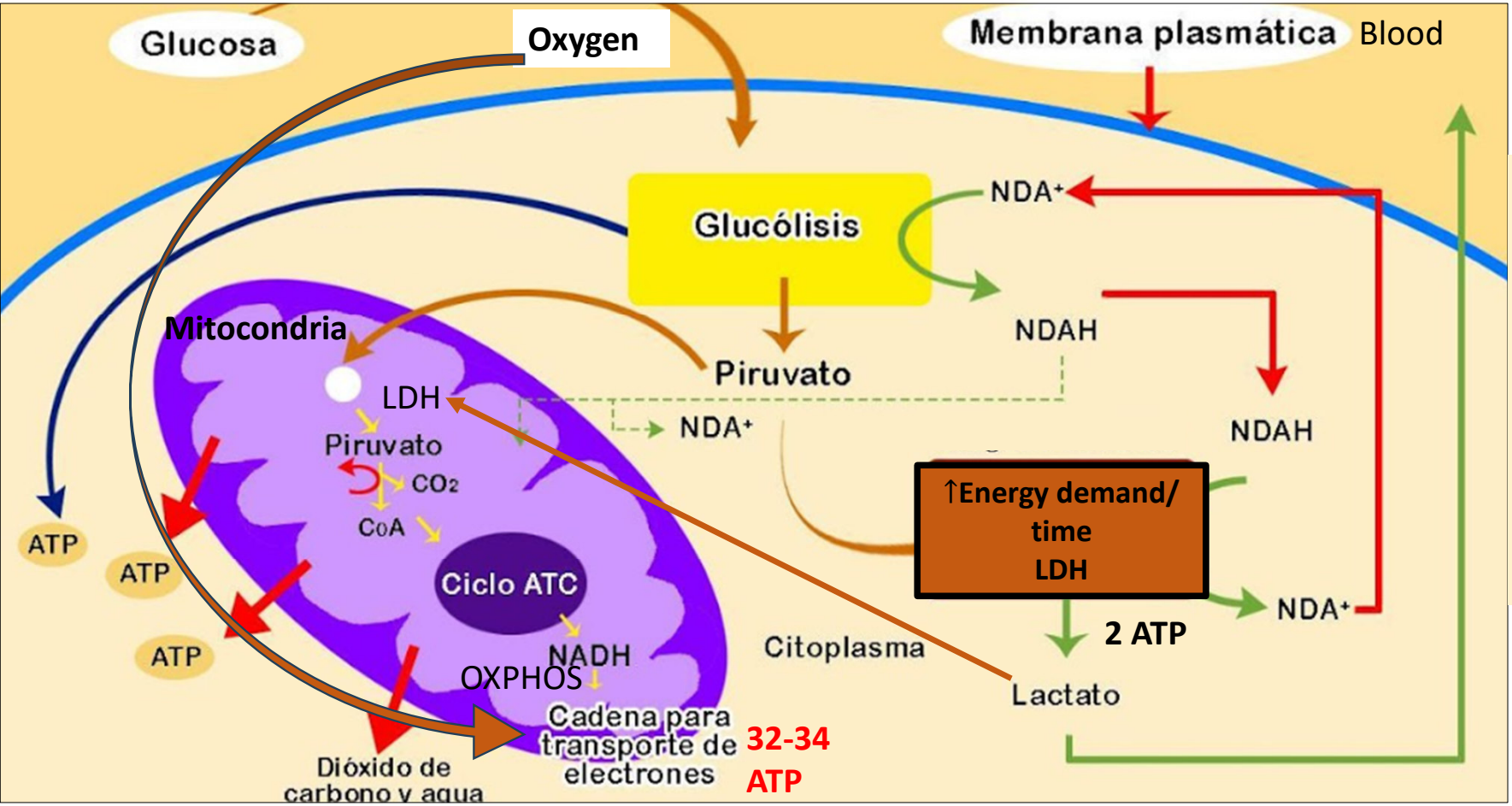
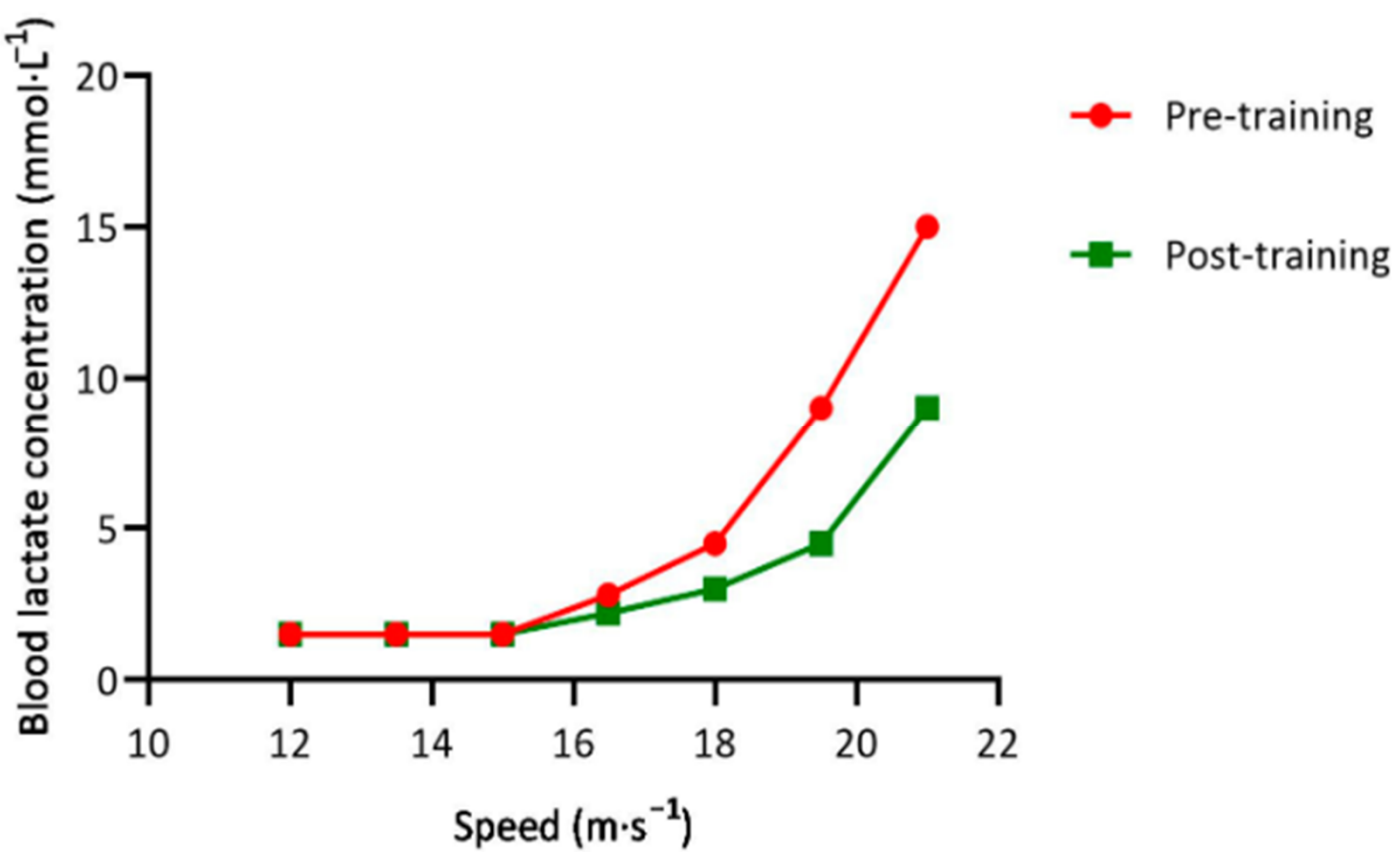


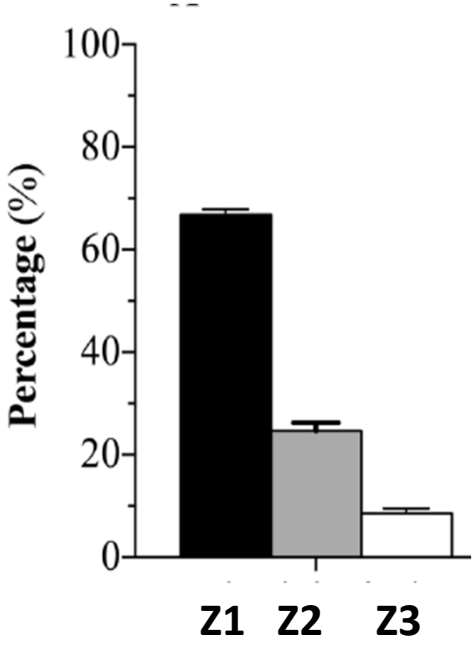
- **Maximum Lactate Steady State.**

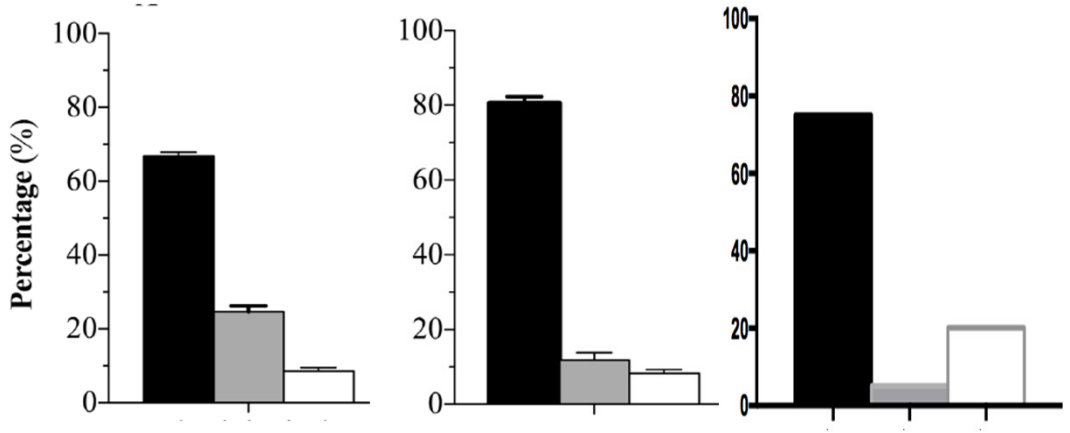
- **MLSS Training**:
  —↓ Glycogenolysis
  —↑ Pyruvate and/ or lactate oxidation.
  —**sLT2** improvement.
  (Sjodin et al., 1982)

DISPLACEMENT OF THE LACTATE-SPEED CURVE TO THE RIGHT



TID ≠ PERIODIZATION





Volume **150 km/w Sept-Jan** **130 km/w Feb-May** **100 km/w Jun-Aug**

TID: the **proportion** of **volume** in each intensity **zone** over a given period of time

Periodization: variation in **volume** and **TID** between the different cycles/periods of the sports season.

TRAINING INTENSITY DISTRIBUTION

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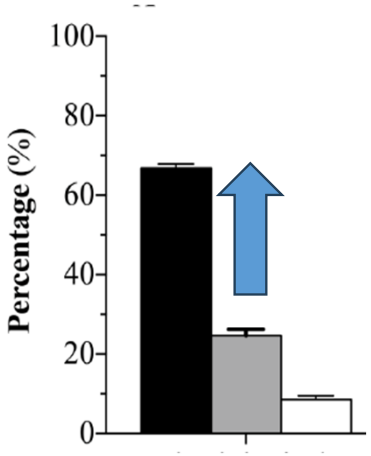
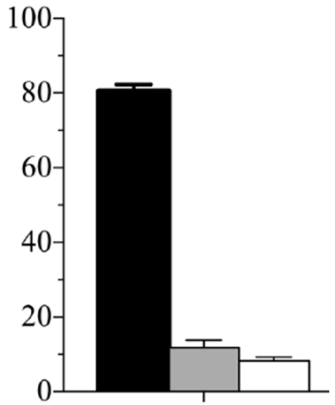


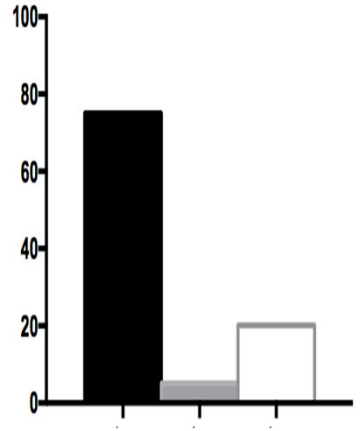
THRESHOLD

More than 25% of overall training volume is conducted in zone 2



PYRAMIDAL

70-80% of overall training volume is conducted in zone z1. The majority of the rest of the volume is conducted in z2 rather than z3.



POLARIZED

70-80% of overall training volume is conducted in zone z1. The majority of the rest of the volume is conducted in z3 rather than z2.

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The Effect of Periodisation and Training Intensity Distribution on Middle- and Long-Distance Running Performance: A Systematic Review.

Kenneally M[1], Casado A[2], Santos-Concejero J[1]. **(2017)**

REVIEWS

Training-intensity Distribution on Middle- and Long-distance Runners: A Systematic Review **(2021)**

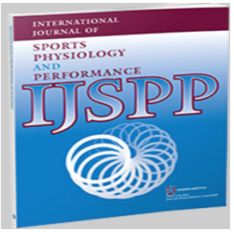
Yuri Campos, Arturo Casado, João Guilherme Vieira, Miller Guimarães, Leandro Sant'Ana, Luis Leitão, Sandro Fernandes da Silva, Paulo Henrique Silva Marques de Azevedo, Jeferson Vianna, Raúl Domínguez

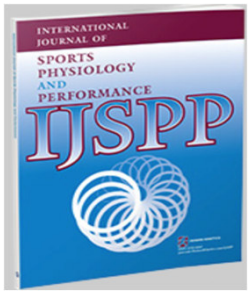
The use of **pyramidal** or **polarized** TID models is recommended for the **optimal performance** improvement in middle and long-distance runners.

Training Periodization, Methods, Intensity Distribution, and Volume in Highly Trained and Elite Distance Runners: A Systematic Review **(2022)**

in International Journal of Sports Physiology and Performance

Arturo Casado[1], Fernando González-Mohíno[*2,3], José María González-Ravé[2], and Carl Foster[4]





Periodisation & Training Intensity Distribution

IN MIDDLE- AND LONG-DISTANCE RUNNING PERFORMANCE

Reference: by Kenneally, Casado & Santos-Concejero IJSPP 2017

Designed by ©YLMSportScience

16 scientific articles were analyzed to determine the effect of training intensity distribution on middle- and long-distance running performance

3 training intensity distribution were compared

Current evidence describes pyramidal and polarised training as more effective than threshold training

BUT

A number of world class Kenyan athletes repeatedly showed the use of high volumes of training in the threshold zone during the specific preparatory phase leading to their marathon race

So in the specific example, marathon pace lies in the threshold zone, so a relatively large volume of training is performed in this physiological zone as the date of a specific race approaches

The volume of training performed around race pace seems to be dictated by the distance of the impending race, with shorter races, requiring faster paces, seeing less volume, and longer races requiring increasing volumes in around race pace

Similarly, a training session at a given percentage of race pace for a longer event is naturally going to be slower, in absolute terms, than a session at the same percentage of race pace for a middle distance event. Therefore these 2 sessions may fall into completely different physiological zones yet may serve the same purpose from a session intention perspective

Despite the apparent contradictory evidence on training intensity distribution and periodisation, an approach based on race pace may be suggested and may allow for different training intensity distribution types to be compatible

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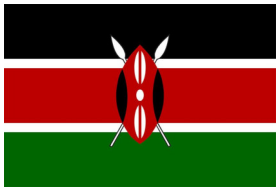


TRAINING OF KENYAN RUNNERS

Original Research — The Journal of Strength and Conditioning Research™

World-Class Long-Distance Running Performances Are Best Predicted by Volume of Easy Runs and Deliberate Practice of Short-Interval and Tempo Runs **(2021)**

Arturo Casado,[1] Brian Hanley,[2] Jordan Santos-Concejero,[3] and Luis M. Ruiz-Pérez[4]

Correlations between training **volume** (km) in different **training activities** and **performance** in **85** world-class, elite and highly trained distance runners.

Running training	After 7 years
Total volume	0,75
Easy runs	**0,68**
Tempo runs	**0,58**
Long-interval training	0,22
Short-interval training	**0,56**
Competitions/ TT	0,03

HOW THE BEST RUNNERS IN THE WORLD TRAIN?

Reference: Casado et al. JSCR 2019

Designed by @YLMSportScience

85 elite athletes - ranging from a 26:44 10k road racer to a 2:03:23 marathon runner -reported

Their best times in different running events

&

Their amounts of tempo runs*, short- & long-interval sessions and easy runs

WHAT THEY FOUND

It was observed significant correlations with some of the reported parameters

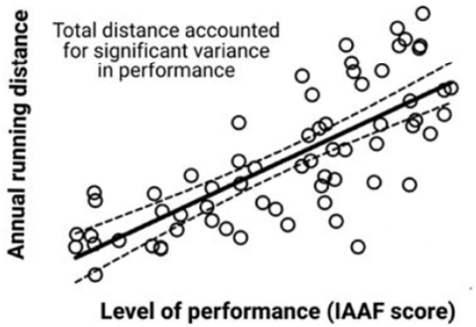
Total distance
0.75 correlation**

Easy runs
0.68

Short-intervals
0.53

Tempo runs
0.50

Long-intervals were not strongly correlated (0.22)



* Runs between 45 and 70 min in duration or running intervals from 1,000 to 5,000 m and from 82 to 92% of HRmax

**Correlations were interpreted as small (0.10–0.29), moderate (0.30–0.49), large (0.50–0.69), or very large (≥0.70)

the Journal of Strength and Conditioning Research™

THE OFFICIAL RESEARCH JOURNAL OF THE NATIONAL STRENGTH AND CONDITIONING ASSOCIATION

NSCA National Strength and Conditioning Association

PRACTICAL APPLICATIONS

There is a fundamental need for athletes to run over considerable distances (>100 km per week) to compete with world-class athletes and even with those who are below this highest standard

It is not possible to always train at high intensities, so the large associations found between easy runs and performance scores are welcome in terms of managing training intensity in long-distance running regimens, notwithstanding their central role in developing cardiovascular fitness

Tempo runs contribute to performance by being both an important source of accumulated distance run and in terms of their role in physiological improvements and specificity to racing

Similarly, short-interval training seemed to be a key component of a varied training schedule, although long intervals seem to be less important

TRAINING OF KENYAN RUNNERS

Deliberate practice in training differentiates the best Kenyan and Spanish long-distance runners

Arturo Casado, Brian Hanley & Luis Miguel Ruiz-Pérez

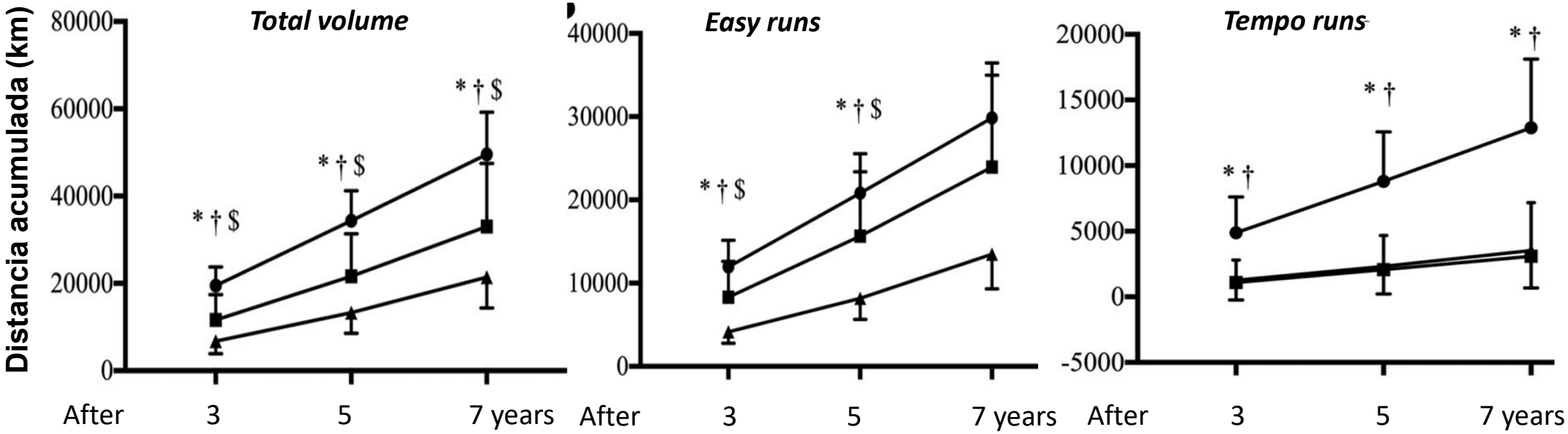
European Journal of Sport Science
The Official Journal of the European College of Sport Science

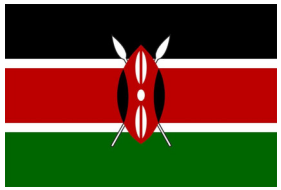
Kenyans accumulated more **volume** than Spaniards in a large portion of training activities.
However, the greatest differences were observed in **tempo runs**.

Top Kenyans

European level Spaniards

National level Spaniards





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Deliberate practice in training differentiates the best Kenyan and Spanish long-distance runners

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CERTIFICATE OF
ACHIEVEMENT

EUROPEAN JOURNAL OF SPORT SCIENCE

2020 Best Paper Award

Eighth place

Awarded to:

Arturo Casado

for your outstanding article published in Volume 20, Issue 7, entitled:

"Deliberate practice in training differentiates the best Kenyan and Spanish long-distance runners"

Andrew M Jones
Editor-in-Chief, ECSS

Professor Jørn Wulff Helge
President, ECSS

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MELBOURNE TRACK CLUB

TRAINING OF AUSTRALIAN RUNNERS

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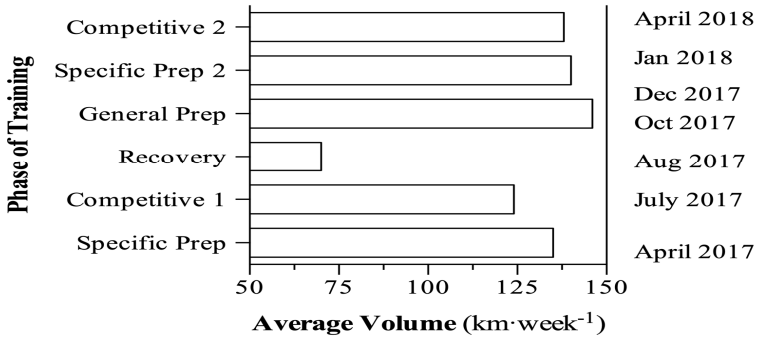
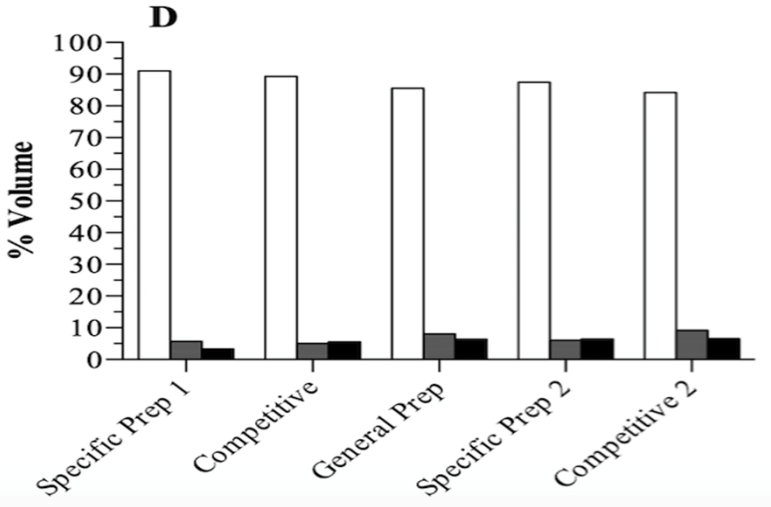
European Journal of Sport Science
The Official Journal of the European College of Sport Science

Original Article

Training intensity distribution analysis by race pace vs. physiological approach in world-class middle- and long-distance runners (2020)

Mark Kenneally, Arturo Casado, Josu Gomez-Ezeiza & Jordan Santos-Concejero





Gen Gregson (LaCaze)

Brett Robinson

MARATHON TRAINING

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Chapter

Training Volume and Intensity Distribution among Elite Middle- and Long-Distance Runners **(2021)**

By Arturo Casado, Leif Inge Tjelta

215 km week	Morning	Afternoon
Monday	60 min Z1	40 min Z1
Tuesday	40 min Z1 + **8x1000m Z3**	40 min Z1
Wednesday	60 min Z1	40 min Z1
Thursday	40 min Z1 + 20 km Fartlëk alternating **10X1km Z3 + 10x1km Z2**	30 min Z1
Friday	60 min Z1	30 min Z1
Saturday	**Hilly 7 km Z2 and Z3**	Rest
Sunday	2h 30 min: 1h 30' Z1 and **1h Z2**	Rest

Sinead Diver

TID BETWEEN LONG- VS. MIDDLE-DISTANCE EVENTS

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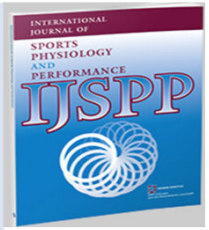
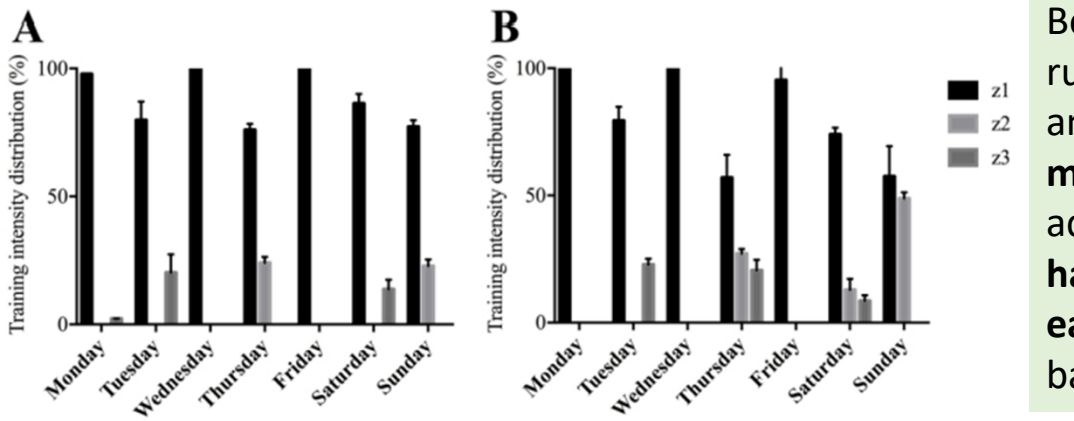
Training periodization, methods, intensity distribution and volume in highly trained and elite distance runners: a systematic review

Arturo Casado, Fernando González-Mohíno, José María González-Ravé, Carl Foster **(2022)**



Ryan Gregson



Both **1500 m** runners (A) and **marathoners** adopted a **hard day-easy day** basis.

Jack Rayner

TID BETWEEN LONG- VS. MIDDLE-DISTANCE EVENTS

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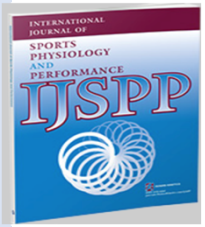
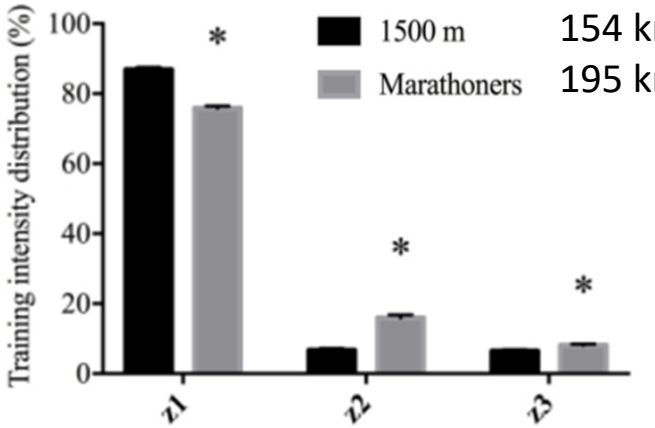


(2022)



154 km/w (pol)
195 km/w (pyr)

Differences in training **volume** and **TID** between **marathoners** and **1500m** runners.

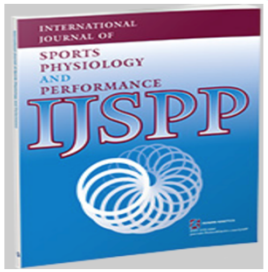
Isobel Batt Doyle

Georgia Griffith

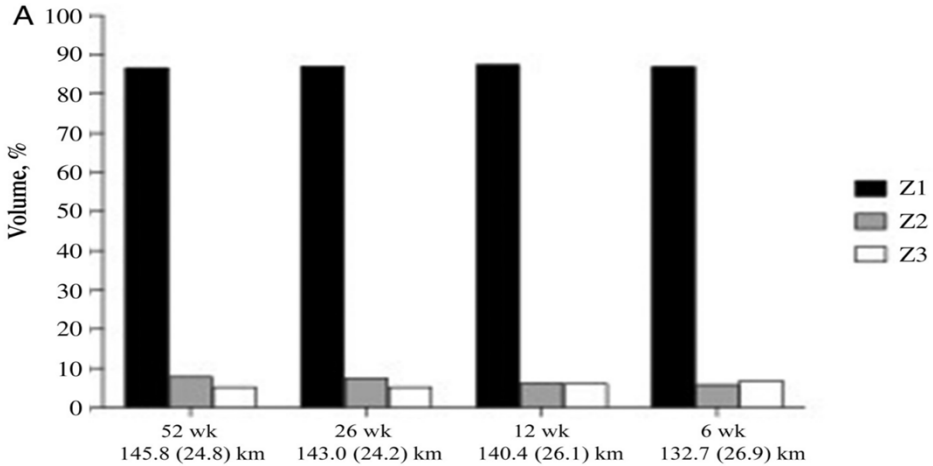
PERIODIZATION

Training Characteristics of a World Championship 5000-m Finalist and Multiple Continental Record Holder Over the Year Leading to a World Championship Final (2021)

Mark Kenneally, Arturo Casado, Josu Gomez-Ezeiza, and Jordan Santos-Concejero



Stewart McSweyn



A change from the **pyramidal** towards the **polarized** model was observed.

PERSONAL EXAMPLE

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Crossing the Golden Training Divide: The Science and Practice of Training World-Class 800- and 1500-m Runners **(2021)**

Thomas Haugen[1] · Øyvind Sandbakk[2] · Eystein Enoksen[3] · Stephen Seiler[4] · Espen Tønnessen[1]

26 years old
2009: 152 km
Coach: Arturo Martín
A hard day-easy day pattern.
81% in Z1, 7% in Z2 y 13% in Z3.

	Morning	Afternoon
Monday	14 km Z1	10 km Z1
Tuesday	14 km Z1 + **10x400m Z3**	10 km Z1
Wednesday	19 km Z1 + ST + PLY + 18X100 m hills	Rest
Thursday	7 km Z1 + **10X1000m Z3**	10 km Z1
Friday	19 km Z1 + Drills	Rest
Saturday	7 km Z1 + **2x6000m Z2**	Rest
Sunday	12 km Z1	Rest

LACTATE GUIDED THRESHOLD INTERVAL TRAINING (LGTIT)

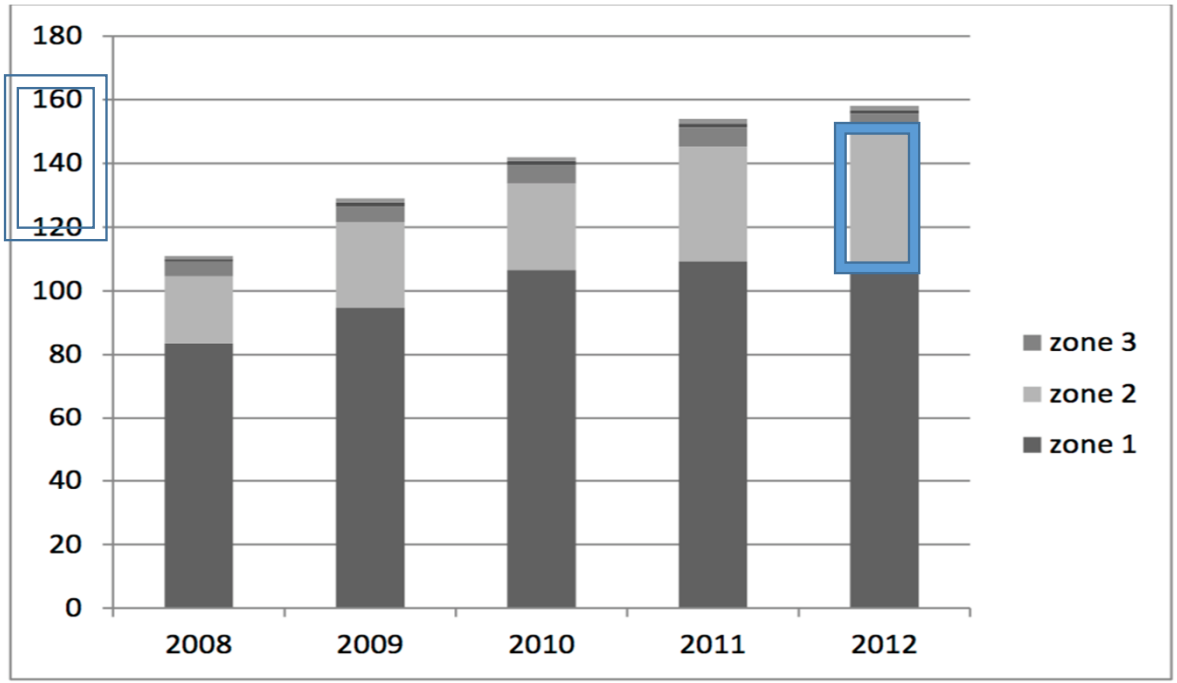
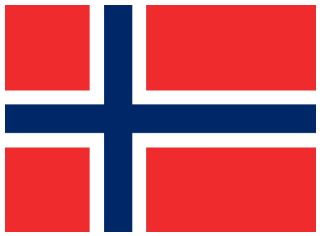


Fig 1. *Average total running volume (km· week^{-1}) and average running volume in different intensity zones during 10 weeks from January to middle of March in the years 2008-2012*

A Longitudinal Case Study of the Training of the 2012 European 1500 m Track Champion. LEIF INGE TJELTA "International Journal of Applied Sports Sciences" (2014)

- Analysis of **training characteristics** of Henrik Ingebrigtsen (2012 1500m European Champion).



INTERVAL TRAINING IN Z2 CONTROLING INTENSITY THROUGH [LaS] MEASUREMENT

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Traditionally, **interval training** in endurance sports has been conducted at **maximum intensity**.

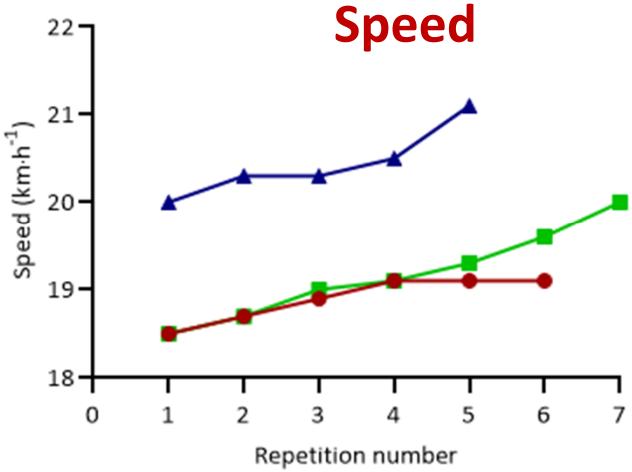
Nonetheless, following the **pyramidal** model, **Z2 interval training** can offer important benefits.

Training at **different speeds/powers** similar/ close to **competition** pace using **oxidative glycolysis** predominantly to produce energy.

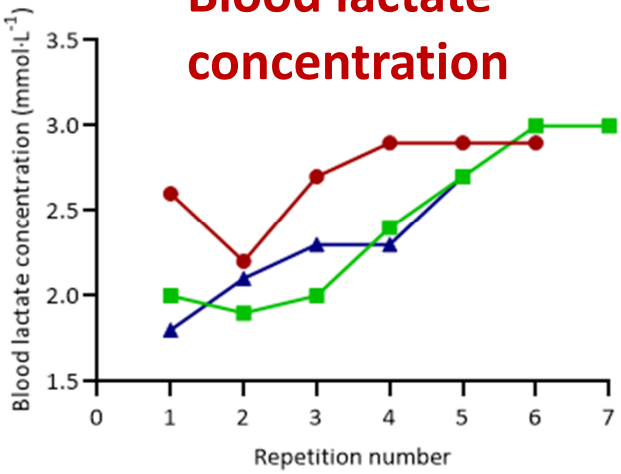
Does Lactate-Guided Threshold Interval Training within a High-Volume Low-Intensity Approach Represent the "Next Step" in the Evolution of Distance Running Training? **(2023)**

by Arturo Casado [1,*], Carl Foster [2], Marius Bakken [3] and Leif Inge Tjelta [4]

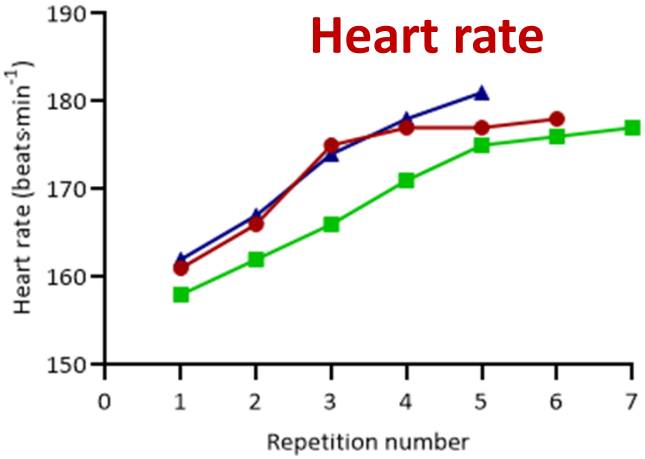
Speed

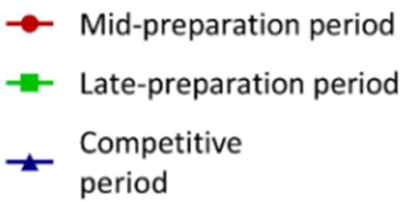


Blood lactate concentration



Heart rate





- **Speed**, **[Bla],** and **heart rate** response to 3 LGTIT sessions (**6 × 2000, 7 × 2000, and 5 × 2000 m**) rec. 1 min by Marius Bakken during the 2003-2004 season

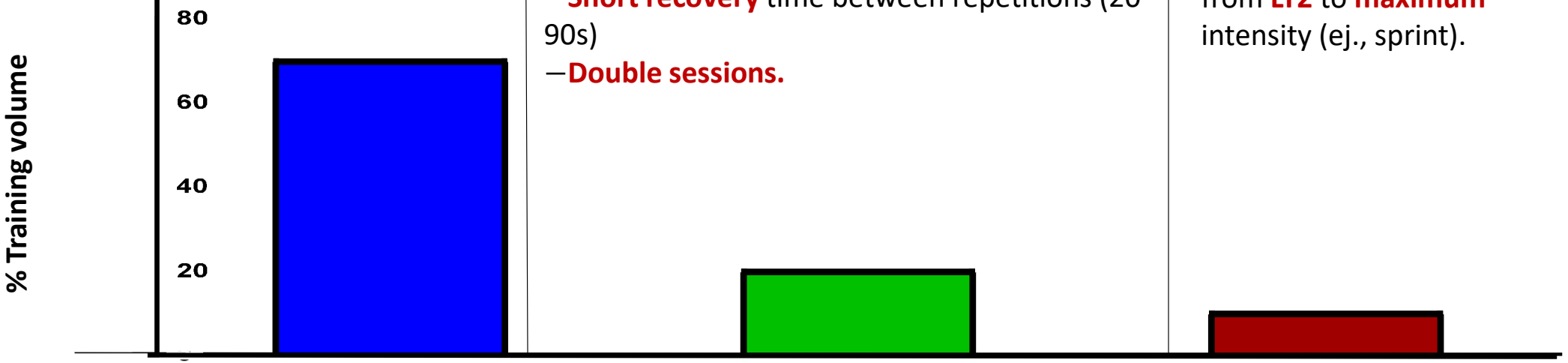
LACTATE GUIDED THRESHOLD INTERVAL TRAINING

International Journal of Environmental Research and Public Health

Does Lactate-Guided Threshold Interval Training within a High-Volume Low-Intensity Approach Represent the "Next Step" in the Evolution of Distance Running Training?

by Arturo Casado [1,*], Carl Foster [2], Marius Bakken [3] and Leif Inge Tjelta [4]

	Low intensity training (z1)	Threshold intensity (z2)	High intensity training (z3)
Physiological mechanisms	—**Mitochondrial biogenesis** and increased **capillarization** in Type I **muscle fibers.** –Greater **cardiac output**	—**Mitochondrial biogenesis y ↑máximum cardiac output** — ↑ number of recruited **motor units.** —↓ Degree of glycogenolysis while ↑ **oxidation** of **piruvate** and/or **lactate.** —Improvement in **sLT2**. —↓ **Central and peripheral fatigue.**	—↑**Muscle capillary density**, and ↑**mitocondrial respiration** in type **II** muscle fibers. —Recruitment of certain **motor units** demanded at **competitive intensity**.
Training characteristics	—**Continuous** run from 20 to 100 min.	—**Continuous/ Interval** training. —Adoption of **specific [LaS]** values —**Short recovery** time between repetitions (20-90s) —**Double sessions.**	—**Interval** training. —Training intensity ranging from **LT2** to **maximum** intensity (ej., sprint).



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Chapter

Training Volume and Intensity Distribution among Elite Middle- and Long-Distance Runners

By *Arturo Casado, Leif Inge Tjelta*

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TAKE HOME MESSAGE

- Both **polarised** and **pyramidal** TIDs are good options for elite distance runners
- A huge **aerobic base** has to be developed in all middle- and long-distance runners (particularly for distances of 1500 m and longer) during the **preparatory period** through a combination of easy runs, **tempo** runs and **interval** training sessions.
- For **longer**-distance events, the training **volume** has to be **greater** and the intensity lower.
- A **hard day-easy day** pattern is observed in all distance running events (i.e., from 1500m to marathon).

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- A **long run** each week, as well as frequent **competitions**, are observed in all events at any time during the season.
- During the **pre-competitive** and **competitive** periods, runners targeting events other than the marathon have to **decrease** the training **volume** and run at **race pace** and even faster during training (i.e., from a pyramidal towards a polarized training intensity distribution model).
- **Marathoners** should increase their total training volume and conduct greater volumes of **race pace** training during the **pre-competitive** and **competitive** periods.
- **Lactate guided threshold interval training** represents a valid approach to optimise training adaptations and performance.

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Thanks for your attention

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