

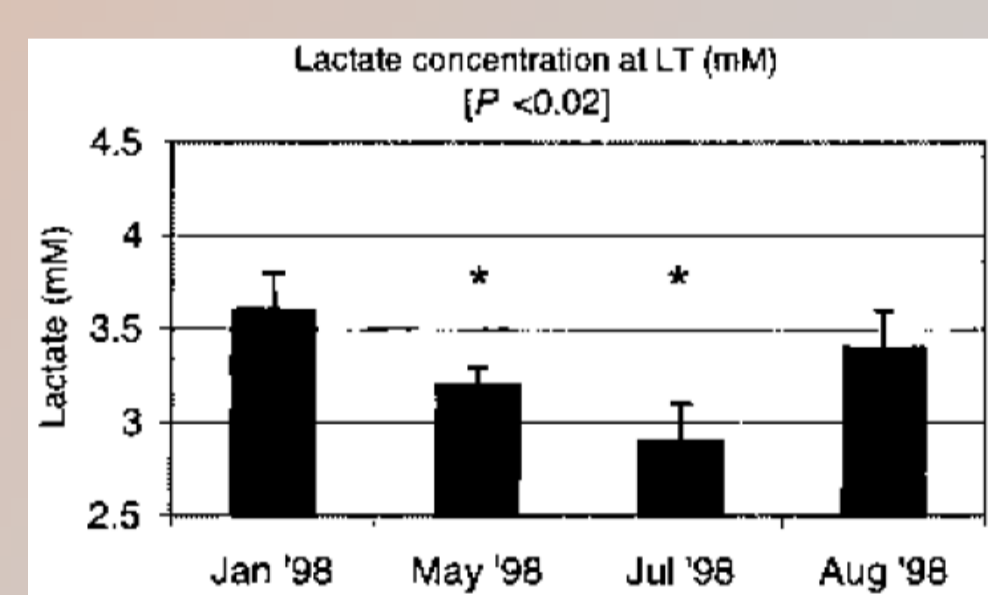


MONITORING THE ELITE SWIMMER'S PERFORMANCE AND ENERGETICAL PROFILE THROUGHOUT A TRAINING SEASON

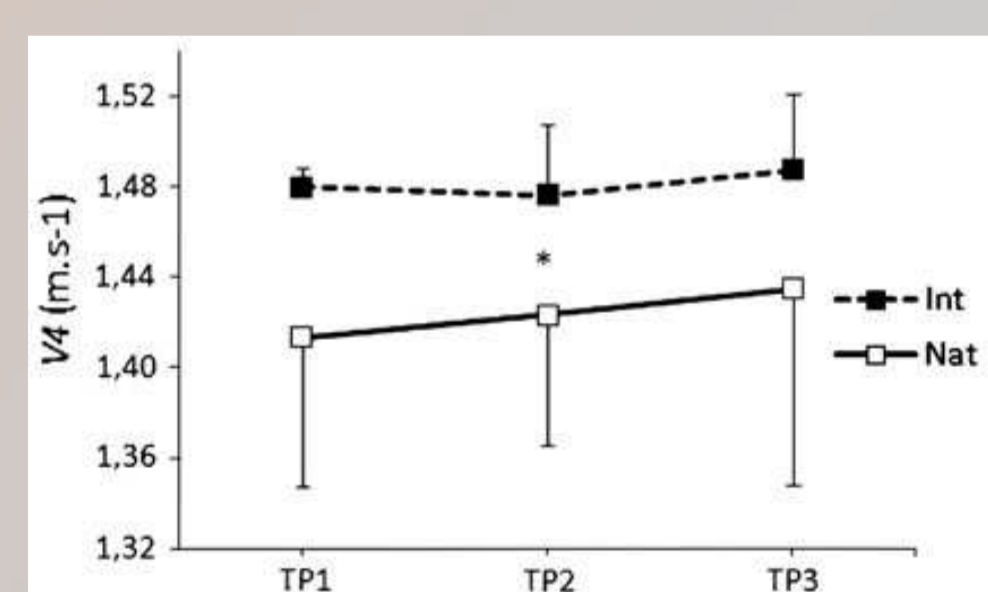
INTRODUCTION

SCIENTIFIC PROBLEM: The evaluation of seasonal performance and energetical adaptations are probably the most critical element of testing for the coach and athlete. The ability to monitor changes within a season provides fundamental information on the response of swimmers to their training periodization. Since performance depends from energetical profile, there are several factors that can provide an important feedback on training progress and in competition conditions. Adaptations to swim training are determined by the form of the training stimulus. The training volume, intensity and frequency are in constant change as the as the competitive season goes by.

EARLIER FINDINGS: Few longitudinal studies were conducted regarding the adaptations on national and/or international level swimmers throughout a conventional training periodization. Training induced slight increases in swimming speed at sub-maximal blood lactate concentrations over the season, whereas the performance remained unchanged during such period (Pyne et al., 2001; Costa et al., 2011).



(adapted from Pyne et al., 2001)



(adapted from Costa et al., 2011)

PURPOSE OF THE STUDY: The present study aimed to add new evidences about the variations on performance and other energetical variables deemed important throughout one training season.

HYPOTHESIS: It was hypothesized a high stability for performance and those energetical variables during such period.

METHODS

SUBJECTS: Nine elite male swimmers (21±3.30 years of age; 1.80±0.06 m of body height; 74.49±6.74 kg of body mass) volunteered to serve as subjects.

STUDY DESIGN: Swimmers completed a full training preparation (figure 1) during the 2010-2011 season. They were evaluated in three different time periods: December (TP₁); March (TP₂) and July (TP₃). At the end of each time period an incremental set of 7x200-m Front Crawl in a long course pool, was applied to collect blood samples and oxygen uptake data for further energetical analysis. Measurements were made of velocity at the 4-mmol of lactate levels (V₄, m.s⁻¹), peak of lactate concentration (La_{peak}, mmol.L⁻¹), maximal oxygen consumption (VO_{2max}, ml.kg⁻¹.min⁻¹), total energy expenditure (E_{tot}, kJ), energy cost (C, J.kg⁻¹.m⁻¹) and propelling efficiency (np, %). Performance was assessed based on 200 m freestyle race times during official long course competitions.

DATA COLLECTION: The V₄ was obtained by linear interpolation considering the lactate values measured immediately before and after of the 4 mmol.L⁻¹ reference. The La_{peak} was the highest blood lactate concentration after exercise. The VO_{2max} was estimated using the backward extrapolation of the O₂ recovery curve (Laffite et al., 2004). The E_{tot} was calculated in the last 200 m trial based on its metabolic elements in terms of aerobic (Aer) and anaerobic (AnS) contributions:

$$E_{tot} = Aer + AnS$$

The C was calculated as the ratio between E_{tot} and the average velocity. The np was obtained according with the equation (Zamparo et al., 2005):

$$\eta_p = \left(\frac{v \cdot 0.9}{2\pi \cdot SF \cdot l} \right) \cdot \frac{2}{\pi}$$

STATISTICAL PROCEDURES: Data variation was analyzed with the Friedman test, as well as, the Wilcoxon signed-rank test. Stability was computed based on the Spearman correlation coefficient and considered to be: (i) high if $r \geq 0.60$; (ii) moderate if $0.30 \leq r < 0.60$ and; (iii) low if $r < 0.30$ (Malina, 2001). The level of significance was determined when $P \leq 0.05$.

RESULTS

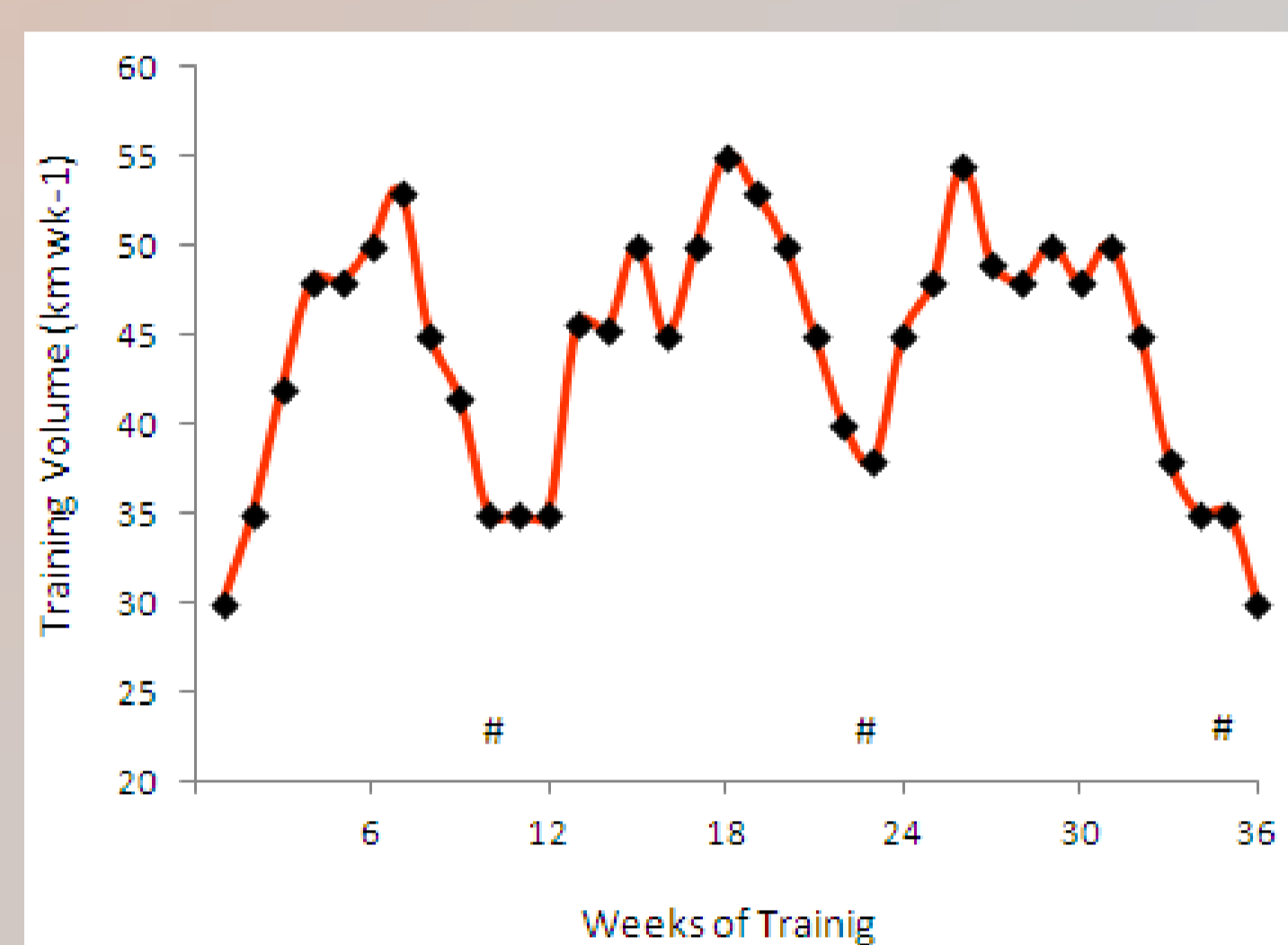


Figure 1. Total weekly volume throughout the season. # indicates testing occasions

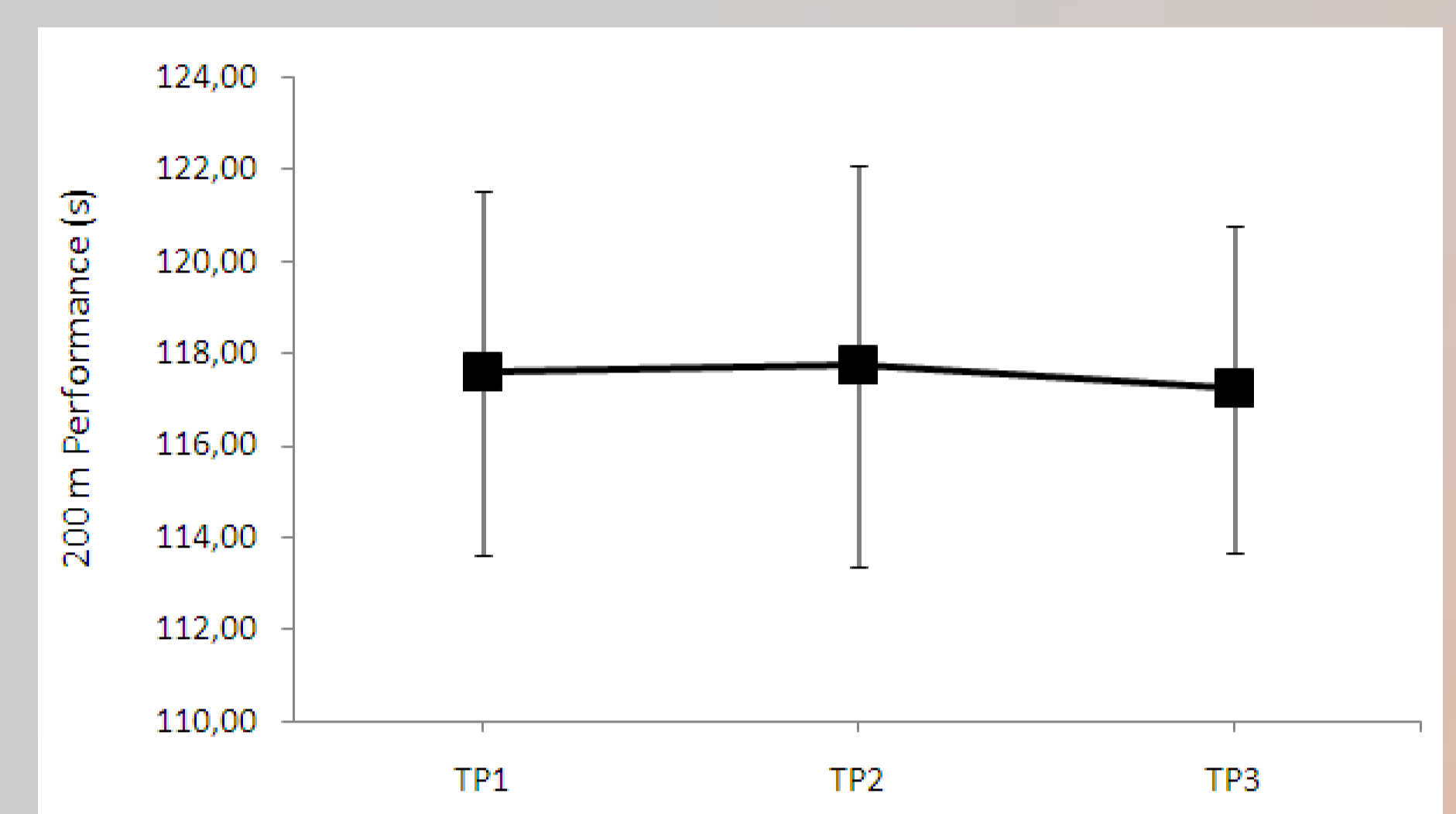


Figure 2. Variation of the 200 m freestyle performance throughout the training season.

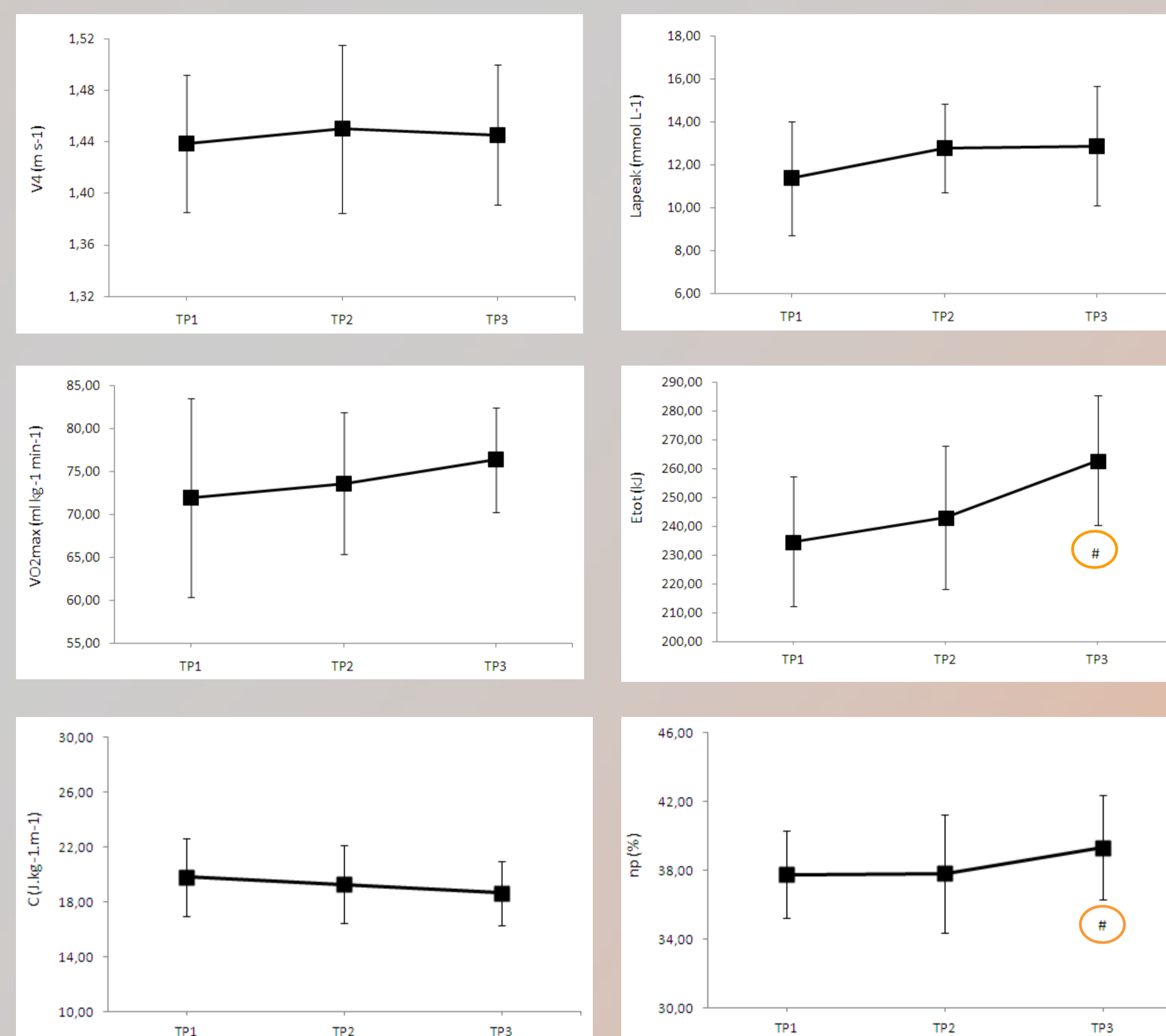


Figure 3. Variation of the energetical profile throughout the training season. # indicates significant differences.

Table 1. Spearman Correlation Coefficients of the energetical variables measured at the time periods of training.

	TP1	TP2	TP3		TP1	TP2	TP3
V ₄	1			La _{peak}	1		
TP1				TP1			
TP2	0.81**	1		TP2	0.22	1	
TP3	0.79*	0.78*	1	TP3	0.53	0.60	1
VO _{2max}				E _{tot}			
TP1	1			TP1	1		
TP2	0.88**	1		TP2	0.63	1	
TP3	0.63	0.70*	1	TP3	0.67*	0.55	1
C				np			
TP1	1			TP1	1		
TP2	0.87	1		TP2	0.40	1	
TP3	0.80	0.55	1	TP3	0.55	0.60	1

* P < 0.05

** P < 0.01

CONCLUSIONS

It can be concluded that, despite slight changes, elite swimmers demonstrate high stability in their performances and energetical profile throughout one single season. Further research should focus on analyzing individual trends in order to facilitate the adequate training prescription for new adaptations.

REFERENCES

- Costa MJ, Bragada JA, Mejias JE, Louro H, Marinho DA, Silva AJ, Barbosa TM. Tracking the performance, energetics and biomechanics of international versus national level swimmers during a competitive season. *Eur J Appl Physiol* 2011; DOI 10.1007/s00421-011-2037-6.
- Laffite LP, Vilas-Boas JP, Demarle A, Silva J, Fernandes R, Billat V. Changes in physiological and stroke parameters during a maximal 400-m free swimming test in elite swimmers. *Can J Appl Physiol* 2004; 29(Suppl.): S17-S31.
- Malina RM. Adherence to physical activity from childhood to adulthood: a perspective from tracking studies. *Quest* 2001; 53: 346-355.
- Pyne DB, Lee H, Swanwick KM. Monitoring the lactate threshold in world ranked swimmers. *Med Sci Sports Exerc* 2001; 33: 291-297.
- Zamparo P, Pendergast D, Mollendorf A, Termin B and Minetti A. An energy balance of front crawl. *Eur J Appl Physiol* 2005; 94:134-144.

ACKNOWLEDGMENTS

From Mário J. Costa to the Portuguese Science and Technology Foundation (FCT) for the PhD grant (SFRH/BD/62005/2009).