

Research question

Are recreational athletes working too hard?: A cross-sectional study investigating the association between the volume of training in zone 1 and the ability to oxidise fat at a higher relative intensity.

Introduction

In recent years, there has been increased interest in fat metabolism in the field of both sports sciences and medicine (Özgünen *et al.*, 2019).

Lima-Silva *et al.* (2011) explain during exercise the main substrates for energy production are fat and carbohydrate (CHO) with CHO oxidation (CHO_{ox}) increasing linearly alongside exercise intensity, while fat oxidation (FAT_{ox}) increases progressively from rest to approximately 60% of maximal oxygen uptake (VO₂max) and then decreases gradually due to glycolysis and the associated glycolytic flux (Achten and Jeukendrup, 2003). The point at which this transition occurs is known as the cross over concept and demonstrates the effect of exercise intensity on the balance of CHO and fat oxidation (Purdom *et al.*, 2018; San-Milla'n and Brooks, 2018). Furthermore Lima-Silva *et al.* (2010) reveal the highest value of fat oxidation (g/min) has been defined as the maximal fat oxidation (MFO) and the exercise intensity at which this point occurs is known as (Fatmax).

A recent study by San-Milla'n and Brooks (2018) reveal that elite endurance athletes possess greater (FAT_{ox}), possibly due to their large volume of endurance training enhancing mitochondrial function and lactate clearance capacity. This makes Fatmax an important threshold for exercise prescription as it represents an intensity for maximal fat burning potential (Purdom *et al.*, 2018). Moreover, Achten and Jeukendrup (2003) suggest it allows the athlete to rely more on their intramuscular triglycerides, thus saving glycogen stores for later in competition.

In order to achieve these physiological adaptations coaches and athletes attempt to find the optimal combination of intensity, duration and frequency of training (Muñoz and Varela-Sanz, 2018). The manipulation of these variables at distinct stages of the season is referred to as training periodisation and to better understand, prescribe and monitor, different training zones have been created based on physiological factors such as lactate thresholds, ventilatory thresholds and percentage of heart rate (HR) (Filipas *et al.*, 2022).

In addition, the amount of time the athlete spends in each zone during training is a concept known as training intensity distribution (TID) (Filipas *et al.*, 2022), with successful endurance athletes adopting TID models including polarised (POL) and pyramidal (PYR) where up to 80% of their training is completed in zone 1 (Z1) with the remaining 20% being split into zones 2 (Z2) and 3 (Z3)

(Kenneally, Casado and Santos-Concejero, 2018). These models have been consistently shown to be more effective than accumulating a high amount of training in Z2, the so called lactate threshold model (LTM) (Muñoz and Varela-Sanz, 2018).

With this said, It is often suggested that recreational athletes complete their easy aerobic training too hard, whilst not working hard enough for the prescribed high intensity sessions (Muñoz and Varela-Sanz, 2018; Seiler and Kjerland, 2006). Although training at the highest intensity that can be maintained for extended periods seems reasonable, repeatedly doing so may firstly, generate excessive sympathetic stress, thus increasing the risk of over training, and secondly still not provide an optimal stimulus to create further adaptation (Seiler and Kjerland, 2006).

In light of this, the study hypothesises that the subjects completing the largest percentage of their training in Z1 will also possess a greater MFO with Fatmax occurring at higher relative workloads, an ability that San-Milla'n and Brooks (2018) suggest is a characteristic of elite endurance athletes.

Aims

The study aims to provide evidence of the relationship between the percentage of training time completed in Z1 and the ability to oxidise fat at a higher relative percentage of oxygen consumption (VO₂), heart rate (HR) and power output (PO).

The first objective of the proposed study is to evaluate the subjects current training to determine TID and percentage of time completed in Z1. This will be achieved using the ventilatory threshold approach to define three intensity zones as used in several additional studies over recent years (Seiler and Kjerland, 2006; Muñoz and Varela-Sanz, 2018). Additionally, Filipas *et al.* (2022) reveal Z1 as below the first ventilatory threshold; Z2 between the first and the second ventilatory threshold; and Z3 as above the second ventilatory threshold.

This is an essential part of the research process as it not only provides relevant information but also allows the researcher to eliminate any participants who have not met the inclusion criteria.

The second objective will be to determine the subjects physiological and performance parameters including MFO, Fatmax, ventilatory thresholds (VT's), VO₂max and peak power output (PPO). With this, the researcher now has the primary data needed to obtain a conclusive investigation that will go some way towards answering the research question.

The final objective will be to analyse and simultaneously investigate the relationships and associations of the measured variables. Subsequently, recommendations based on the strength and

weaknesses of the relationships can be made, although no cause and effect relationship can be assumed as unmeasured variables are also likely to effect the result (Smith, 2018).

Method

All lab equipment reference details are provided in **Appendix 1**.

Study design

The study will employ a cross sectional design as this will assess the association between physiological variables and performance outcomes at a specific point in time (Armstrong and Kramer, 2015). In addition, a quantitative method will be utilised to deductively access if the general theory fits a specific subject group, as Smith (2018) explains this method is best for testing pre-constructed hypotheses that provide quantitative, numerical data.

Participants

The subject group will be moderately trained male recreational cyclists and triathletes (n=15) with no underlying health concerns or injuries within the previous 12 months. This relatively homogeneous group will provide a large enough sample size to supply conclusive data to the research, whilst also controlling for the high inter-individual variability associated with MFO and Fatmax (Amaro-Gahete *et al.*, 2019).

Inclusion criteria will be at least 3 years endurance training with a current weekly training volume of between 8-15 hours per week. This will ensure that all participants are currently active whilst also controlling for TID as athletes completing a large volume of training have been shown to generally use POL or PYR models (Muñoz and Varela-Sanz, 2018).

Participants will be recruited from the South Wales area through social media outlets, invitations sent to local cycling and triathlon clubs, plus word of mouth. Once recruited, participants will be accepted following signed consent and a successful completion of the pre-participation health questionnaire (PAR-Q). Additional requirements for all participants are that they own an active membership of the training app (Training Peaks) to provide access and details of current training data, which must include HR.

In order for participants to be included in the final analyses, a minimum of 8 hours of endurance training per week over a 6-week period must be provided. In cases where these requirements are not met, participants will be considered dropouts.

Measurements

Training intensity distribution (TID)

All participants will provide current training data via Training peaks to a coaching account (no cost).

Physiological and performance

All participants will attend the laboratory in a fasted state as Rosenkilde *et al.* (2015) explain nutritional status is known to influence substrate utilisation during exercise. Upon arrival anthropometric measurements will be taken and recorded using the Tanita body composition scale (Tanita MC980 MA). This is of great importance as the weight of the athlete plays a vital role in endurance performance, thus all measurements need to be relative to body weight (Mujika and Padilla, 2001).

Following this subjects will be asked to perform a graded exercise test to exhaustion, on an electronically braked cycle ergometer (Watt bike Atom X) to determine physiological markers including MFO, Fatmax, VT1, VT2 , VO2max and PPO.

As Fatmax is expressed as a percentage of VO2max then determining both these variables is essential. In order to do this the protocol will begin with 3 minute stages which Achten and Jeukendrup (2003) suggest is important in establishing an accurate MFO, then subsequently when the respiratory exchange rate (RER) reaches 1.0, stages will be reduced in duration to 1 minute until exhaustion, thus obtaining accurate MFO/Fatmax and VO2max all in the same day (Amaro-Gahete *et al.*, 2019).

Data analysis

All data will be uploaded and logged to Microsoft Excel. Subsequently data analysis will proceed using IBM SPSS statistics, version 28.0, where bivariate two-tailed Pearson Product-Moment correlation coefficients will be used to describe the strength and direction of the measured variables. Statistical significance will be set at ($p < 0.05$) and also reported as ($p < 0.05$) if a lesser value was calculated.

Research timetable

Proposal and ethics approval	October 2022
Pilot testing	October-November
Subject recruitment	November
Data collection and analysis	December
Introduction and literature review	November-December 19 th
Physiological testing	January 9-22 nd 2023
Data analysis	January 23 rd - February 12 th
Results and discussion	February 13 th – March 5 th
Final conclusion and completion of project	April
Submission	April

References

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- Smith, M.F. (2018) *Research methods in sport*. 2nd edn. 55 City Road: SAGE .

Appendix

Appendix 1. Lab Equipment Reference Details

- Tanita Body Comp, Tanita MC980 MA, (Tanita, Amsterdam, The Netherlands),
<https://tanita.eu/>
- Wattbike Atom, Wattbike atom x, (Wattbike, Nottingham, UK), <https://www.wattbike.com>
- Heart rate chest strap, Polar H7 or H10, (Polar Electro, Warwick, UK),
<https://www.polar.com/uk-en>