EFFECTS OF ACUTE HYPOXIA AT REST EXPOURE ON TIME TRIAL PERFORMANCE OF NATIONAL CATEGORY CYCLIST

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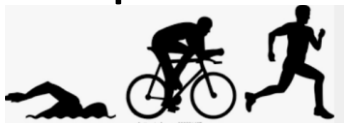
INTRODUCTION

ALTITUDE TRAINING/EXPOSURE HAS BEEN STUDIED SINCE FINAL OF 90´S → ENHANCE PERFORMANCE

- LHTL (Levine & Stray-Gundersen, 1997): Live High-Train Low (exposure to hypoxia and training in normoxia) → Enhance performance in endurance sports.

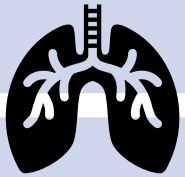


- Improvements in cycling performance→ LHTL (Garvican et al., 2012; Hahn & Gore, 2001; Hamlin et al., 2010; Mattila & Rusko, 1996; McLean et al., 2014).
- LHTL → Haematological adaptations during rest exposure & peripherical adaptations.
- LHTL → Training intensity not modified during sea level train.

LIMITATIONS: logistical, economical, personal requirements→ LHTL: Live High (normobaric hypoxia)-Train Low.

INTRODUCTION

- Normobaric hypoxia exposure allows to ACUTE exposure to hypoxia
- (Constantini et al., 2021)→ have studied influence of FiO_2=0.16→ TimeTrial (TT) 10 km.
- (11 ± 3%) decrease mean power output.
- Cardiorespiratory responses



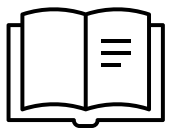
Normobaric acute hypoxia exposure

↓

Allows to research

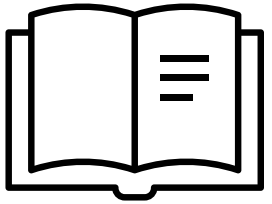
↓

Methodological applications of altitude training /hypoxia exposure.



ACUTE EXPOSURE TO HYPOXIA & SUBSEQUENT TT PERFORMANCE UNDER NORMOXIC CONDITIONS
Remains unknown

OBJECTIVES



To analyze the effects of **30-minutes at rest of normobaric hypoxia exposure**

Immediately All effort exercise **(20 min)** under normoxic conditions:

Physiological performance variables:

Gas exchange, power, perceived of effort

Economy and Gross efficiency

METHODOLOGY

- PARTICIPANTS: national class (McKay et al., 2022)
  - 7 MALE
  - 2 FEMALE

- 6 years cycling experience
- No exposure to hypoxia 6 months prior to study

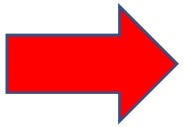
- HYPOXIA/NORMOXIA EXPOSURE PROTOCOL
  - HYPOXIA EXPOSURE: 30´AT REST FiO_2= 0.09
  - NORMOXIA/PLACEBO: 30´AT REST FiO_2= 0.21

- SIMULATED TIME TRIAL IN CYCLE ERGOMETER
  - WARM UP 5´
  - 20´SELF PACED EFFORT
  - SPEED/CADENCE/POWER: BLINDED TO PARTICIPANTS
  - ONLY ELAPSED TIME AVAIBLE (Borszcz et al., 2018)

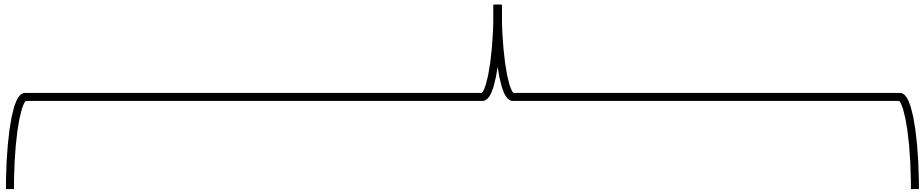
- All out effort during 20 minutes
- No fixed distance
- Time fixed

VARIABLES

- **Gas exchange variables: VO_2 (VO_2 L/min & VO_2r, mL/kg/min)**
- **Power (Watts)**
- **Rate of perceived exertion (RPE): CR10 (Borg & Löllgen, 1998)**



Economy and Gross efficiency values



Economy: average power produced (W) /mean value VO_2 during the TT (L/min).

Gross Efficiency (GE): average power produced (W)/ energy expenditure during the TT.

Energy Expenditure (J/s) = [3.869 x VO_2) + (1.195 x VCO_2)] x (4.186/60) x 1000

(Brouwer, 1957)

STATISTIC ANALYSIS

Mean ± standart desviation (SD)

T-Student

Effect size (ES) (Cohen, 1988)

ES: High (≥ 0.8), moderate (0.8-0.5), small (0.5-0.2), and trivial (< 0.2) (McDonald, 2014)

Statistical significance $p < 0.05$

RESULTS

Table 1. Results of gas exchange variables, before and after normoxia/hypoxia exposure.

	Pre	Post	ES (Dif %)	p
HIPOXIA				
VO_2 (L/min)	0,3 ± 0,0	0,3 ± 0,0	-0,09 (0,00)	NS
VO_2 r (mL/kg/min)	5,4 ± 1,1	5,5 ± 0,6	-0,05 (1,85)	NS
EqO_2	33,6 ± 3,7	32,8 ± 4,4	0,49 (-2,38)	NS
$EqCO_2$	38,3 ± 3,8	42,4 ± 4,7***	-1,58 (10,7)	0,001
$PetO_2$ (mmHg)	96,5 ± 3,6	92,4 ± 4,8*	0,95 (-4,25)	0,021
$PetCO_2$ (mmHg)	35,1 ± 3,4	32,6 ± 3,8*	0,84 (-7,12)	0,035
NORMOXIA				
VO_2 (L/min)	0,3 ± 0,0	0,3 ± 0,0#	-0,12 (0,00)	NS
VO_2 r (mL/kg/min)	4,8 ± 0,4	4,9 ± 0,6#	-0,14 (2,08)	NS
EqO_2	37,0 ± 4,0	34,5 ± 5,4	0,54 (-6,76)	NS
$EqCO_2$	38,9 ± 4,9	41,0 ± 5,0	-0,52 (5,40)	NS
$PetO_2$ (mmHg)	99,4 ± 3,5	95,3 ± 4,6**	1,23 (-4,12)	0,006
$PetCO_2$ (mmHg)	34,4 ± 3,2	32,8 ± 2,2	0,61 (-4,65)	NS

***$EqCO_2$**:mean values of respiratory equivalent of carbon dioxide. **EqO_2**: mean values of respiratory oxygen equivalent. **ES**: effect size. **Dif %:** difference between post and pre values expressed as a percentage. **$PetCO_2$**: mean end-expired carbon dioxide pressure values. **$PetO_2$**: mean end-expired oxygen pressure values. **Post**: time after exposure to hypoxia. **Pre**: time before exposure to hypoxia or normoxia. **VO_2 r**: mean values of oxygen consumption normalized to body mass. **VO_2**: average values of oxygen consumption. **NS**: not significant.*

** $p < 0.05$, ** $p < 0.01$, *** ≤ 0.001 significant differences with respect to pre-exposure values. # $p < 0.05$ significant differences between hypoxia and normoxia exposure.*

RESULTS

Table 2. Results of gas exchange variables, mechanical performance variables and perceived effort after normoxia/hypoxia exposure.

VARIABLE	After normoxia exposure	After hypoxia exposure	ES		p
VO_2 (L/min)	3.6 ± 0.3	3.6 ± 0.4	0.10	trivial	0.770
VO_2r (ml/kg/min)	57.6 ± 4.2	56.8 ± 4.9	0.13		0.707
POWER (W)	273.2 ± 31.8	277.8 ± 33.3	-0.21		0.540
POWERr (W/kg)	4.2 ± 0.4	4.3 ± 0.3	-0.21	small	0.545
$CR10^{WUP}$	3.1 ± 1.5	2.7 ± 0.9	0.21		0.535
$CR10^{TT10}$	7.0 ± 0.9	7.3 ± 0.6	-0.25		0.464
$CR10^{TT20}$	9.0 ± 1.0	9.1 ± 0.8	-0.17	trivial	0.608
$CR10^{TTmean}$	6.3 ± 1.0	6.4 ± 0.6	-0.03		0.923

VO_2: average values of oxygen consumption during the time trial. WUP: values in the warm-up prior to the time trial. ***VO_2r****: average values of oxygen consumption relative to body mass during the time trial.* ***POWER****: average power of the time trial.* ***POWERr****: average relative power of the time trial.* ***$CR10^{WUP}$****: values of rate of perceived exertion during warm up of TT.* ***$CR10^{TT10}$****: values of rate of perceived during min 0 and min 10 of TT.* ***$CR10^{TT20}$****: values of rate of perceived during min 10 and min 20 of TT.* ***$CR10^{TTmean}$****: average values of $CR10^{TT10}$ and $CR10^{TT20}$.* ***ES****: effect size.*

ECONOMY & GROSS EFFICIENCY: energy expenditure

ECONOMY VALUES			
NORMOXIA	**HYPOXIA**	**p**	**ES**
4.4 ± 0.2 W/L/min	4.5 ± 0.2 W/L/min	0.214	0.45 small

GE VALUES			
NORMOXIA	**HYPOXIA**	**p**	**ES**
7.5 ± 1.0 %	7.4 ± 1.0 %	0.689	-0.14 trivial

ENERGY EXPENDITURE			
NORMOXIA	**HYPOXIA**	**p**	**ES**
3613.8 ± 181.6 J/s	3750.3 ± 338.1 J/s	0.205	0.41 small

DISCUSSION

NO CHANGES

- Gas Exchange variables
- Performance variables: Power
- RPE
- Economy, GE, energy expenditure

EXERCISE UNDER ACUTE HIPOXIA EXPOSURE

PERFORMANCE LOSSES

MEAN POWER LOSS
TT 10 KM: FiO_2: 0.16
11 ± 3% less
(Constantini et al., 2021)

MEAN POWER LOSS
TT 30 KM: FiO_2: 0.16
9.6 % less
(Płoszczyca et al., 2021)

ECONOMY
VO_2 affected under HPX exercise
(Wehrlin & Hallén, 2006)

GROSS EFICIENCY:
(Noordhof et al., 2013)
Sea level *vs* Altitude (1500 m.a.s.l) :
21.4 ± 0.8 % *vs* 20.7 ± 1.1*%,
*GE at GXT; RER ≤1.0, max % VO_2 peak,

(Clark et al., 2007)
200 *vs* 3200 m.a.s.l
5´TT : did not change.
*Submaximal GE; mean of stages (5´) at GXT test:
17.3 ± 2.4% *vs* 16.8 ± 2.2*%

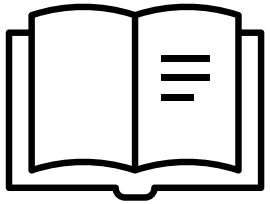
EXPLAINED MAINLY LOSS IN POWER
(van Erck et al., 2019)

- Compensatory effect of exercise→on Gas Exchange variables→ No performance changes.
(Constantini et al., 2021)

DISCUSSION

HYPOXIA EXPOSURE: 30´AT REST → EXERCISE UNDER NORMOXIA: TT 20´ NORMOXIA

NORMOXIA PERFORMANCE	=	HYPOXIA PERFORMANCE



PRACTICAL APPLICATIONS

The use of normobaric hypoxia in training may have potential for improving performance.

More studies are needed to evaluate the usefulness of acute exposure to hypoxia for the improvement of subsequent performance on a 20 min TT in cycling.

“Acute exposure to hypoxia at rest” didn´t modificate the immediately performance under normoxic conditions on TT.

Application of acute exposure “doesn´t compromise the performance in training”

THANK YOU FOR YOUR ATTENTION

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