4 maggio 2020

Tra volume e intensità: modulazione e controllo dei carichi di allenamento

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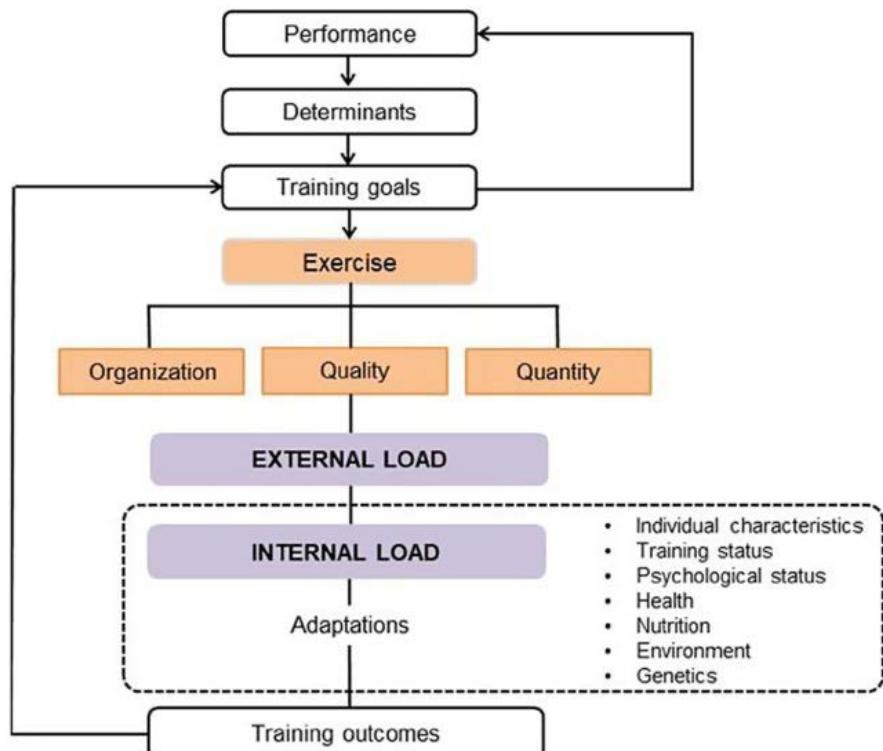
Luca Filipas   coachfilipas

Carico esterno e carico interno

Impellizzeri et al., 2019

Carico esterno
- Velocità / Passo

Carico interno
- Frequenza cardiaca
- Percezione dello sforzo (RPE)

Monitoraggio dei carichi di allenamento

A lungo termine	A breve termine
Analisi del mesociclo/macrociclo	Analisi del singolo allenamento/microciclo

- Fondamentale per avere un controllo sulla programmazione a lungo termine.

- Importante per verificare il livello di forma raggiunto in relazione al momento della programmazione.

- Fondamentale per avere un controllo sulla qualità dei singoli allenamenti.

- Importante per aggiustare eventuali errori di scelta nell'intensità degli allenamenti e nella divisione in zone di allenamento.

L'approccio multiplo è fondamentale

We should keep in mind that no accurate quantitative means exists with which to prescribe the pattern, duration, and intensity of training required to produce specific physiological adaptations, and that **individual athletes adapt differently to identical training stimuli**.

Nevertheless, **no single physiological marker has been identified that can accurately quantify the fitness and fatigue responses to training or predict competition performance**. This implies that sport scientists probably need to direct their efforts toward the measurement of markers that reflect an athlete's global capacity to respond or adapt to training.

Variable	Units/descriptors
Frequency	Sessions per day, week, month
Time	Seconds, minutes, hours
Intensity	Absolute, relative
Type	Modality, environment
Maximal effort	Maximum mean power, jump height
Repeat efforts	Number of efforts, quality of efforts
Training volume	Time, intensity
Perception of effort	RPE
Perception of fatigue and recovery	Questionnaires; REST-Q, VAS
Illness	Incidence, duration
Injury	Type, duration
Biochemistry and hormone analysis	Baseline, response to exercise
Technique	Movement deviations
Body composition	Total body weight, fat mass, fat-free mass
Sleep	Quality, quantity, routine
Psychology	Stress, anxiety, motivation
Sensations	Hopeful, neutral, hopeless

*Mujika, 2017*

Halson, 2014
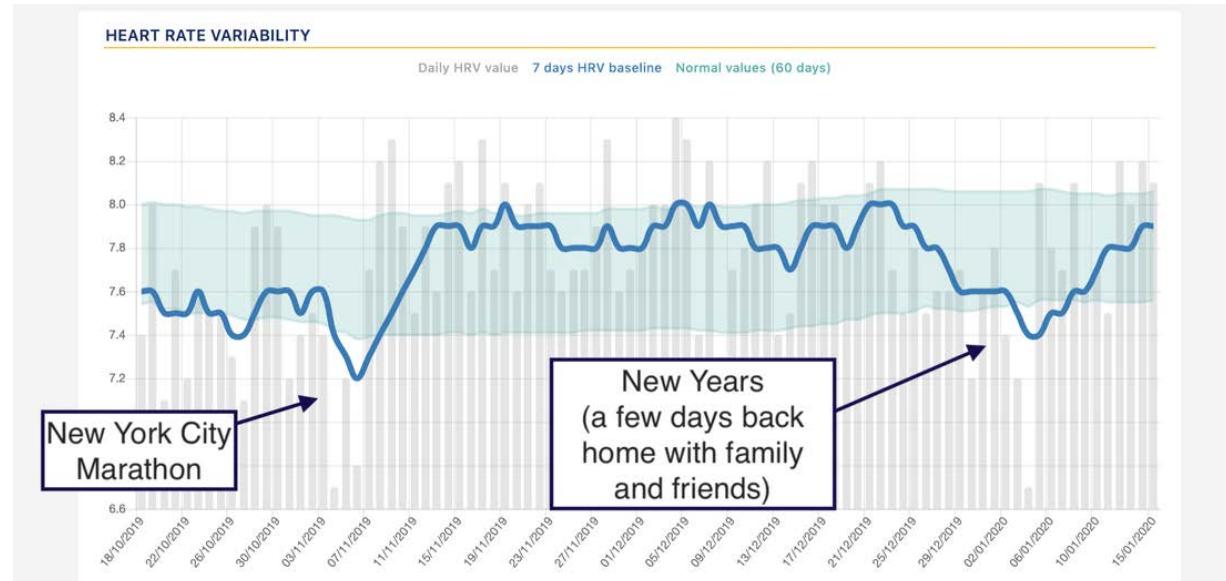
L'approccio multiplo è fondamentale

Monitoraggio dell'allenamento
- Tracciato di FC
- Tracciato di intensità esterna (velocità, potenza, passo)
- Tracciato di cadenza
- Tracciato altimetrico
- Percezione dello sforzo
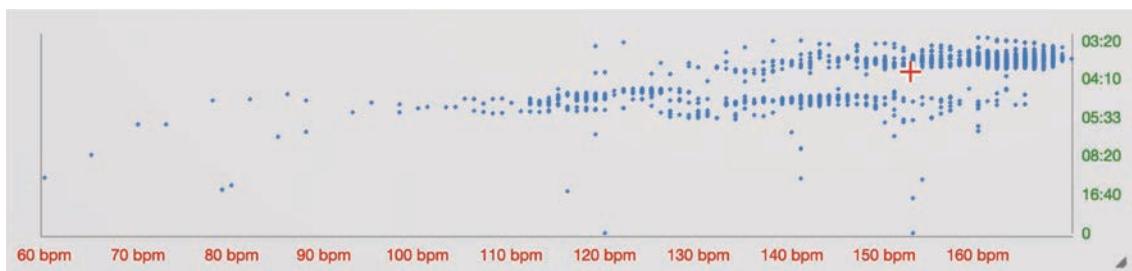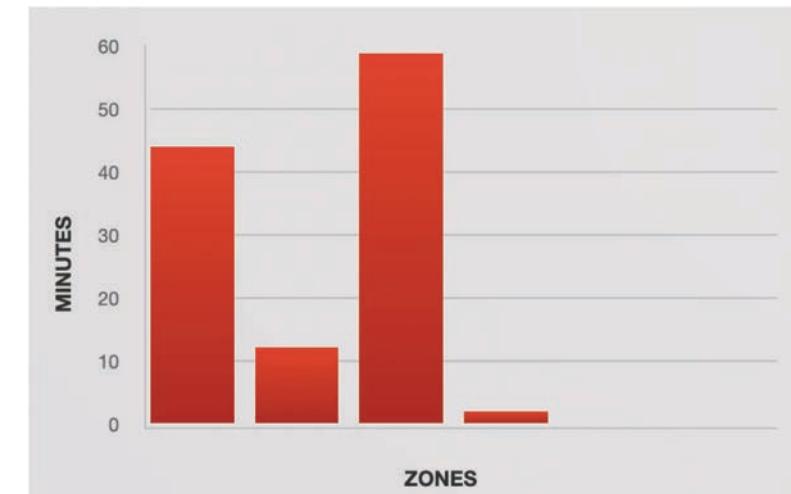
Monitoraggio di stress e recupero
- HRV
- Questionario del sonno
- Questionario psicologico
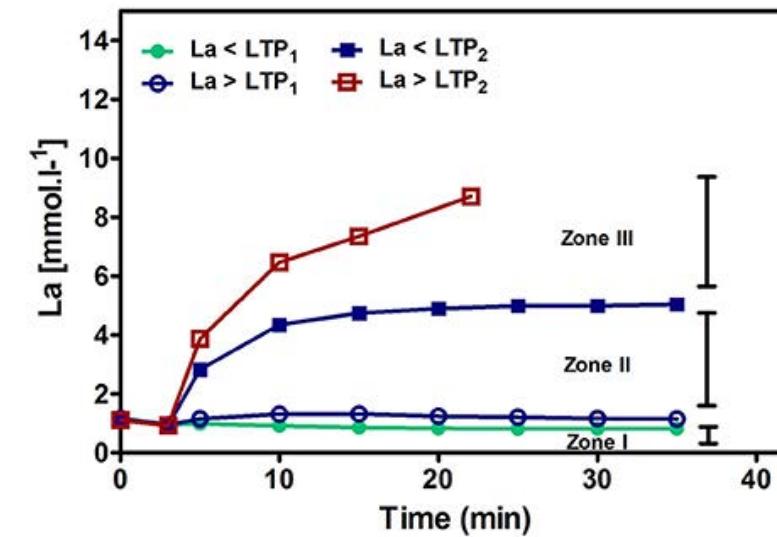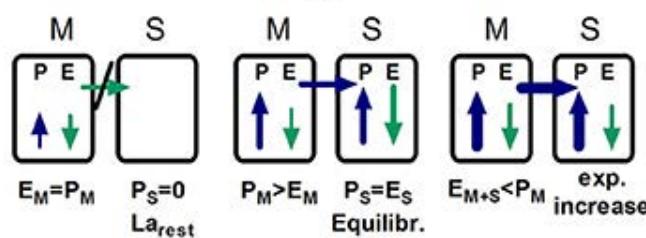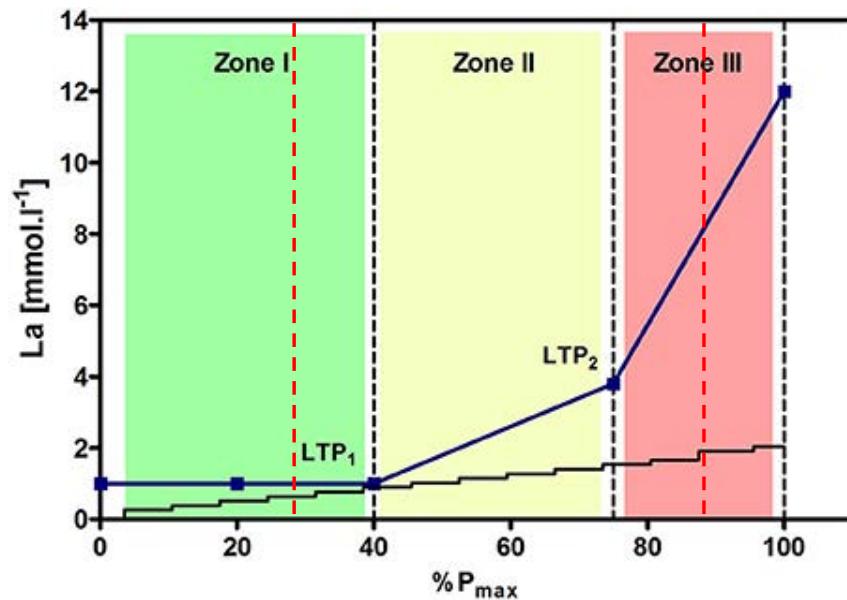
Monitoraggio dei carichi a breve termine

Lap	Start	End	Duration	Moving Duration	Kilometers	rTSS	IF	NGP	Avg Pace	Max Pace	Avg Heart Rate	Max Heart Rate	Cad	Elev Gain
Lap #11	0:20:37	0:39:26	0:18:49	0:18:36	5.00	31	0.97	03:46	03:46	03:43	155	166	90	23
Lap #12	0:39:28	0:44:14	0:04:46	0:04:46	1.00	5	0.76	04:47	04:47	04:46	141	165	81	0
Lap #13	0:44:14	1:03:04	0:18:50	0:18:38	5.00	31	0.97	03:46	03:46	03:44	162	168	90	33
Lap #14	1:03:04	1:07:51	0:04:47	0:04:47	1.00	5	0.76	04:48	04:48	04:47	144	165	82	1
Lap #15	1:07:52	1:27:03	0:19:11	0:18:26	5.00	32	0.98	03:44	03:44	03:41	164	170	91	21
Lap #16	1:27:02	1:31:44	0:04:42	0:04:42	1.00	5	0.77	04:43	04:43	04:42	146	167	81	2
Lap #17	1:31:45	1:51:38	0:19:53	0:18:22	5.00	32	0.99	03:41	03:41	03:40	162	169	90	28

Modello a 5 zone
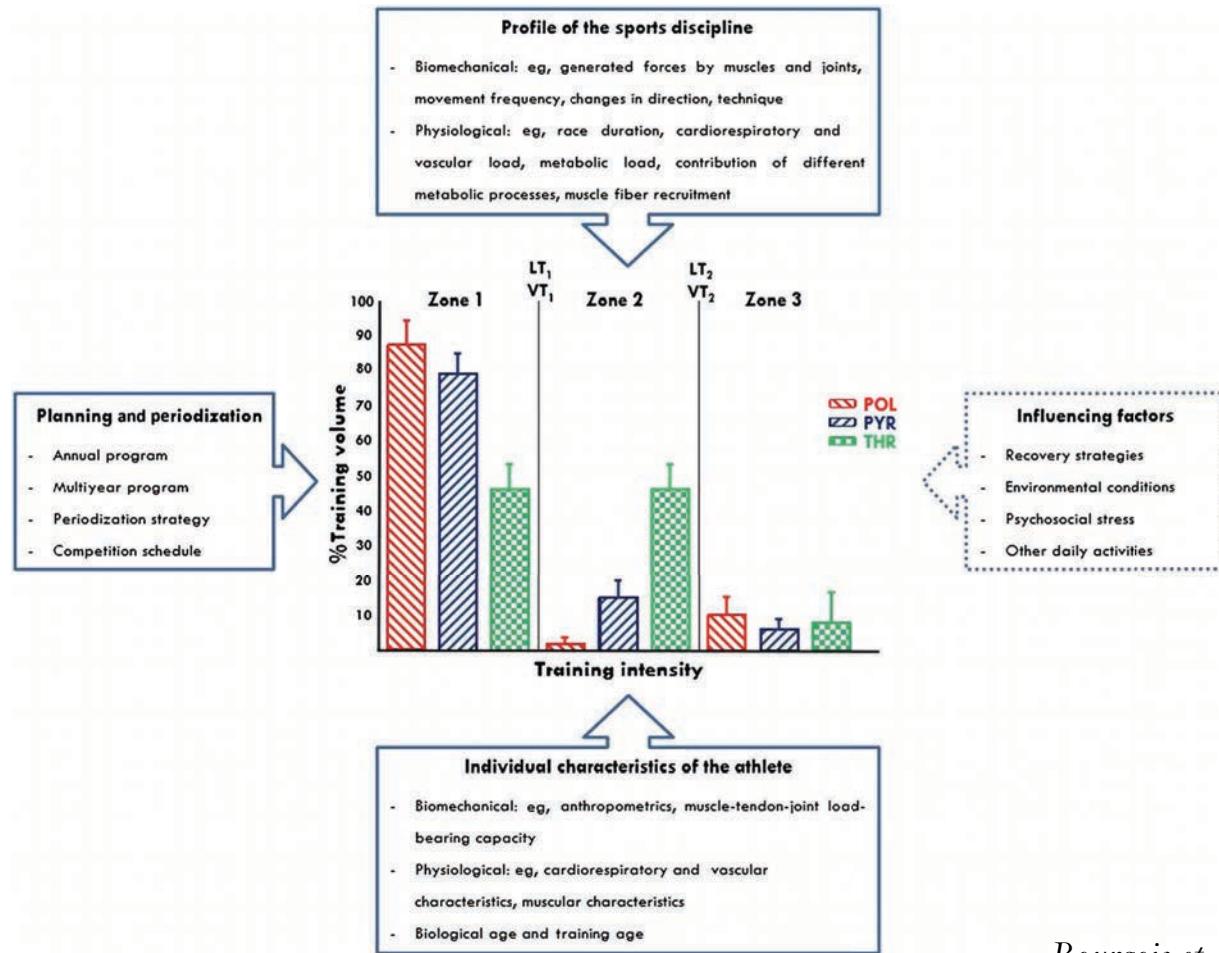
Hofmann & Tschakert, 2017

Intensity zone	Lactate[a] (mmol/L)	Heart rate (% max)	3-zone model	Binary model
5	6.0–10.0	92–97	Zone 3	high-intensity training
4	4.0–6.0	87–92	Zone 3	high-intensity training
3	2.5–4.0	82–87	Zone 2	high-intensity training
2	1.5–2.5	72–82	Zone 1	low-intensity training
1	0.8–1.5	55–72	Zone 1	low-intensity training

Sylta et al., 2014

Fattori che influenzano la distribuzione delle intensità

Bourgois et al., 2019

Fattori che influenzano la distribuzione delle intensità

La distribuzione delle intensità è decisamente più importante del calcolo dei carichi di allenamento complessivi.

TRIMP (Lucia) = 500

- Week 1
  5 x 100' Z1
- Week 2
  5 x 10' Z1 + 45' Z2
- Week 3
  5 x 10' Z1 + 30' Z3
- Week 4
  3 x 100' Z1
  1 x 10' Z1 + 45' Z2
  1 x 10' Z1 + 30' Z3
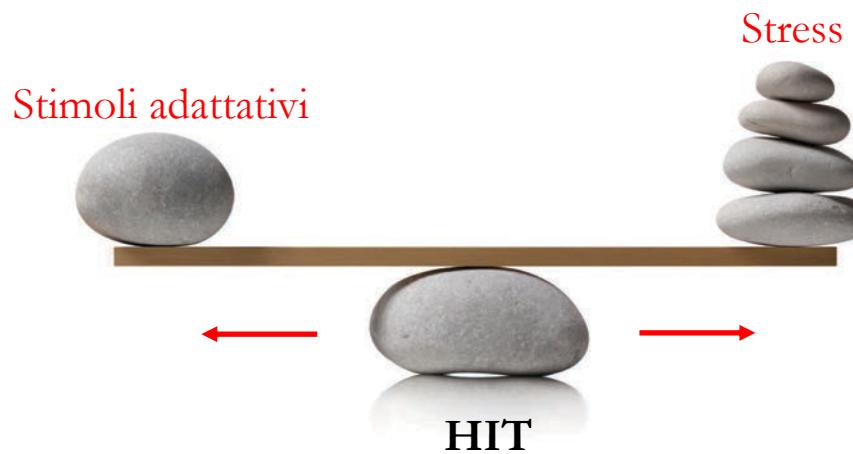
Session-RPE (Foster) = 1500

- Week 1
  5 x 100' Z1 – RPE(3)
- Week 2
  5 x 10' Z1 + 40' Z2 – RPE(6)
- Week 3
  5 x 10' Z1 + 3x6' Z3 – RPE(8)
- Week 4
  3 x 100' Z1 – RPE(3)
  1 x 10' Z1 + 40' Z2 – RPE(6)
  1 x 10' Z1 + 3x6' Z3 – RPE(8)

Volume e intensità di allenamento

- Esiste una soglia individuale di carico di allenamento (concetto di "effetto tetto biologico") dove i meccanismi di controllo regolatorio e i marker biologici di adattamento sono massimizzati.
- È fondamentale prescrivere la minima dose di allenamento ad alta intensità che permetta di massimizzare questi meccanismi.

Bourgois et al., 2019
Bishop et al., 2014

Stimoli adattativi

Stress

HIT
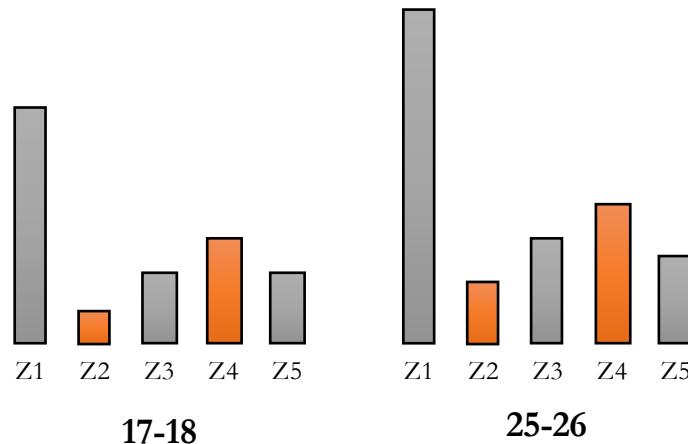
- Danni cellulari muscolari, tendinei e ossei
- Stress sistema nervoso autonomo (> FC fatica)
- Squilibri ormonali
- Immunosoppressione
- Fatica psicologica (saturazione di endorfine?)

Progressione dei volumi di lavoro nelle diverse zone

Età	Volume allenamento settimanale (h)
16	8-12
17-18	12-14
19	15-17
20	18-20
22	20-22
25-26	23-25

Erik Røste

| Z1 | Z2 | Z3 | Z4 | Z5 |

17-18

| Z1 | Z2 | Z3 | Z4 | Z5 |

25-26
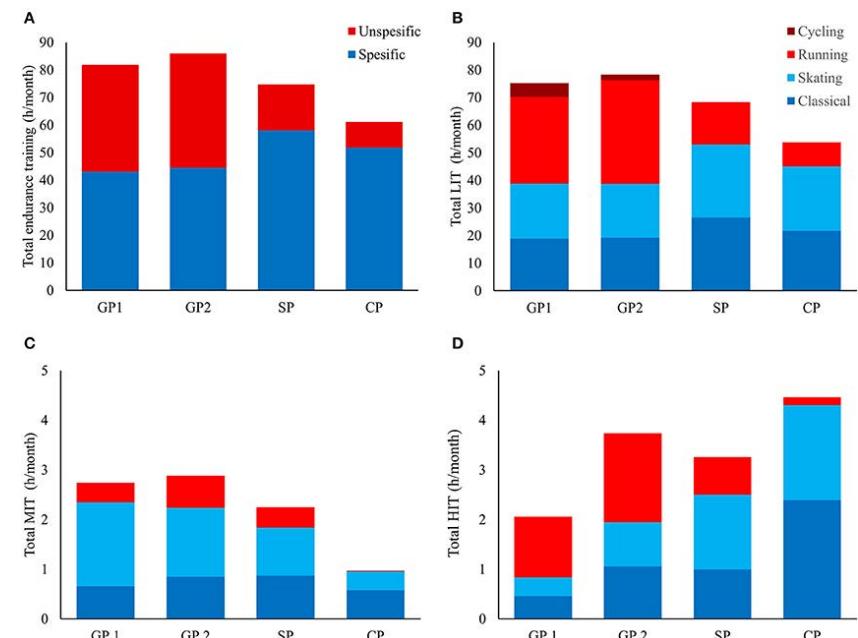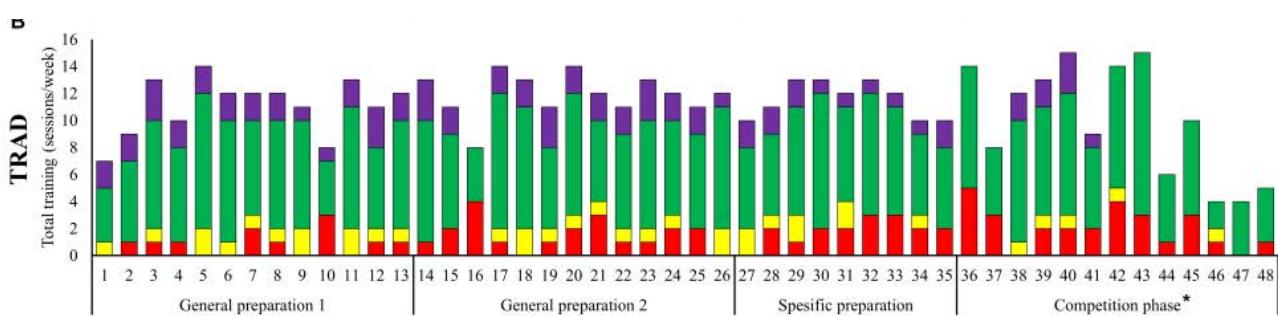
Volume e intensità nei diversi periodi della stagione

|	GP1	GP2				SP	CP			
		Overall	Pre altitude	During altitude	After altitude		Overall	Pre-peaking Phase 1	Pre-peaking Phase 2	Peaking phase
TOTAL TRAINING										
Hours	20.9 ± 1.3	21.7 ± 0.6	19.9 ± 1.0	27.6 ± 1.6	18.3 ± 1.5	18.4 ± 0.5	14.7 ± 0.8	15.8 ± 2.2	19.7 ± 2.7	16.2 ± 0.5
Sessions	10.8 ± 0.3	11.1 ± 0.2	10.9 ± 0.4	11.9 ± 0.6	10.3 ± 0.9	11.7 ± 0.5	10.5 ± 0.6	10.8 ± 1.0	11.3 ± 1.5	11.9 ± 0.3
TRAINING FORMS										
Endurance (h)	18.3 ± 0.6	19.4 ± 0.6	16.9 ± 0.4	26.1 ± 1.0	16.2 ± 1.7	16.9 ± 0.4	14.0 ± 0.7	15.2 ± 2.0	17.6 ± 2.1	15.3 ± 0.7
Strength (h)	2.2 ± 0.6	1.9 ± 0.7	2.6 ± 0.6	1.4 ± 0.8	1.8 ± 0.7	1.2 ± 0.3	0.6 ± 0.2	0.5 ± 0.0	1.9 ± 0.9	0.6 ± 0.5
Speed (h)	0.4 ± 0.1	0.4 ± 0.1	0.4 ± 0.2	0.2 ± 0.1	0.3 ± 0.2	0.2 ± 0.0	0.1 ± 0.0	0.1 ± 0.1	0.2 ± 0.1	0.3 ± 0.1
EXERCISE MODE										
Specific (h)	9.8 ± 0.5	10.0 ± 0.5	7.1 ± 2.3	19.2 ± 4.8	9.2 ± 1.1	13.3 ± 1.2	12.0 ± 0.5	13.8 ± 2.0	15.3 ± 2.1	13.6 ± 0.7
Unspecific (h)	8.8 ± 0.6	9.7 ± 0.4	10.2 ± 2.9	7.1 ± 2.9	7.3 ± 0.9	3.8 ± 0.9	2.1 ± 0.3	1.5 ± 0.6	2.5 ± 0.6	2.0 ± 0.2
SPE/UNSPE (%)	53/47	51/49	41/59	73/27	56/44	78/22	85/15	90/10	86/14	87/13
INTENSITY DISTRIBUTION										
LIT (h)	17.2 ± 0.5	17.9 ± 0.6	15.4 ± 0.5	24.7 ± 1.1	14.8 ± 1.8	15.7 ± 0.4	12.7 ± 0.7	14.0 ± 2.1	16.2 ± 0.9	14.0 ± 1.6
MIT (h)	0.6 ± 0.2	0.7 ± 0.1	0.4 ± 0.4	1.2 ± 0.3	0.7 ± 0.2	0.5 ± 0.1	0.2 ± 0.0	0.3 ± 0.1	0.4 ± 0.3	0.3 ± 0.2
HIT (h)	0.5 ± 0.1	0.8 ± 0.1	1.1 ± 0.2	0.2 ± 0.1	0.7 ± 0.2	0.7 ± 0.1	1.1 ± 0.1	0.9 ± 0.2	1.0 ± 0.1	1.0 ± 0.1
LIT/MIT/HIT (%)	94/3/3	92/4/4	91/2/7	94/5/1	92/4/4	93/3/4	91/1/8	92/2/6	92/2/6	91/2/7
INTENSITY DISTRIBUTION										
LIT (sessions)	7.1 ± 0.3	6.9 ± 0.3	6.1 ± 1.2	8.6 ± 0.8	6.6 ± 0.8	7.8 ± 0.5	7.3 ± 0.5	7.1 ± 0.9	7.1 ± 1.0	8.3 ± 0.5
MIT (sessions)	0.8 ± 0.2	0.9 ± 0.1	0.7 ± 0.8	1.6 ± 0.3	0.9 ± 0.3	0.8 ± 0.2	0.5 ± 0.1	0.8 ± 0.5	0.5 ± 0.4	0.6 ± 0.3
HIT (sessions)	0.9 ± 0.2	1.6 ± 0.1	2.2 ± 0.3	0.3 ± 0.3	1.3 ± 0.3	1.9 ± 0.3	2.1 ± 0.2	2.3 ± 0.3	2.0 ± 0.2	2.3 ± 0.3
LIT/MIT/HIT (%)	80/9/11	74/9/17	68/8/24	82/16/2	76/10/14	74/8/18	74/5/21	71/7/22	74/5/21	74/6/20
CATEGORIZATION OF LIT										
<50 min (sessions)	0.2 ± 0.2	0.1 ± 0.1	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	1.9 ± 0.7	2.8 ± 0.5	2.1 ± 0.5	1.1 ± 0.8	3.0 ± 0.4
50–90 min (sessions)	1.0 ± 0.2	1.1 ± 0.3	1.1 ± 1.0	0.5 ± 0.4	1.5 ± 1.1	1.7 ± 0.6	1.3 ± 0.4	1.4 ± 0.8	1.3 ± 0.5	2.4 ± 1.7
90–150 min (sessions)	4.4 ± 0.5	4.0 ± 0.4	4.7 ± 0.8	3.9 ± 0.6	4.8 ± 1.0	3.2 ± 0.2	2.4 ± 0.4	3.0 ± 0.7	3.1 ± 0.8	2.4 ± 0.9
≥ 150 min (sessions)	1.6 ± 0.5	1.8 ± 0.1	0.5 ± 0.4	4.5 ± 0.7	0.5 ± 0.4	1.0 ± 0.4	0.7 ± 0.2	0.9 ± 0.8	1.8 ± 0.3	1.0 ± 0.7
AVG. SESSION DURATION										
LIT (h)	2.0 ± 0.1	2.1 ± 0.1	1.8 ± 0.1	2.6 ± 0.1	1.8 ± 0.1	1.5 ± 0.1	1.3 ± 0.1	1.4 ± 0.1	1.7 ± 0.1	1.3 ± 0.2
MIT (h)	0.8 ± 0.1	0.8 ± 0.1	0.7 ± 0.1	0.8 ± 0.1	0.7 ± 0.0	0.7 ± 0.1	0.5 ± 0.1	0.2 ± 0.1	0.4 ± 0.3	0.3 ± 0.2
HIT (h)	0.5 ± 0.0	0.5 ± 0.0	0.5 ± 0.1	0.7 ± 0.1	0.5 ± 0.0	0.4 ± 0.0	0.5 ± 0.1	0.4 ± 0.1	0.5 ± 0.1	0.5 ± 0.0
COMPETITIONS										
Hours	0.1 ± 0.1	0.1 ± 0.1	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.4 ± 0.1	0.7 ± 0.1	0.6 ± 0.3	0.5 ± 0.3	0.3 ± 0.1
Number	0.2 ± 0.1	0.3 ± 0.2	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	1.1 ± 0.2	1.5 ± 0.1	1.6 ± 0.5	1.0 ± 0.6	0.9 ± 0.3
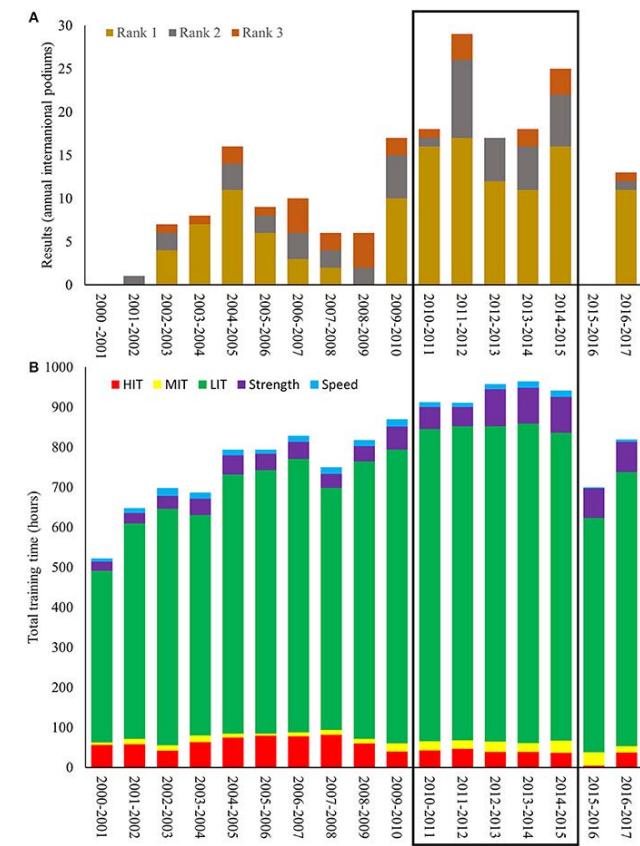
Solli et al., 2017

Distribuzione delle intensità in una stagione

*Solli et al., 2019*

Solli et al., 2017

Esempio di un microciclo settimanale in atleti elite
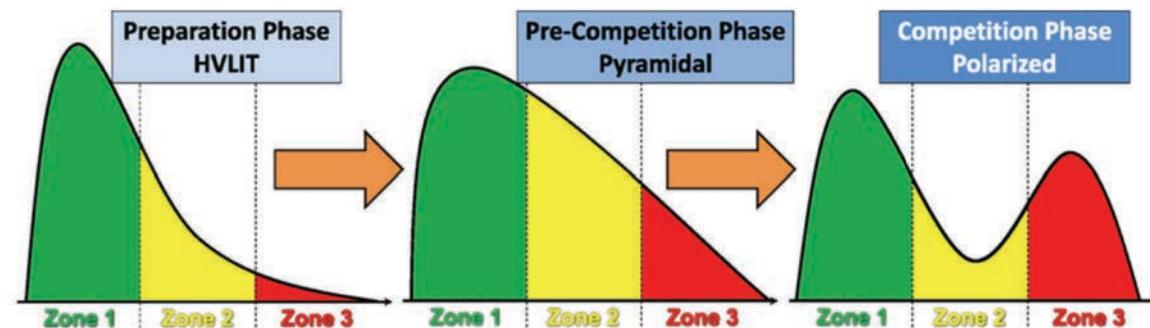
Table 2 Typical Training Weeks for a World-Class Cross-Country Skier at Low Altitude (<800 m Above Sea Level) During the Preparation and Competition Periods

Day	Preparation	Competition
Monday	AM: 7 × 5-min HIT, uphill running/walking with poles	AM: 2 h LIT, classical skiing on easy terrain
	PM: 1.5 h LIT, classical roller skiing with double poling on easy terrain	PM: Warm-up + 30 min strength training
Tuesday	AM: 1.5 h, LIT roller ski skating on easy/moderate terrain	AM: 6 × 4-min HIT, classical skiing and skating on varied terrain
	PM: 2 h LIT, running on easy/moderate terrain	PM: 0.5 h LIT, running on easy terrain
Wednesday	AM: Strength training	AM: 1.5 h LIT, ski skating on relatively flat terrain
	PM: 1.5 h LIT, roller ski skating on varied terrain, including 10 × 12-s sprints	PM: Rest
Thursday	AM: 2.5 h LIT, classical roller skiing on varied terrain	AM: Travel
	PM: Rest	PM: 1.5 h LIT, skating on moderate terrain
Friday	AM: 45 min continuous MIT/HIT, roller-ski skating on a roller-ski track	AM: 45 min LIT on the competition track followed by 3 × 6-min MIT/HIT, classical skiing
	PM: 1.5 h LIT, running on hilly terrain with a soft surface	PM: Rest
Saturday	AM: 10 × 10 maximal jumps + strength training	AM: Jog 30 min, 3–4 strides; 15-km classic competition
	PM: 1.5 h LIT, classical roller skiing on easy/moderate terrain, including 8 × 10–15-s double-poling sprints	PM: Easy skiing 45 min, stretching/massage
Sunday	AM: 3.5 h LIT, running on terrain of moderate incline with a soft surface	AM: 30-km Skiathlon competition
	PM: Rest	PM: Travel

Note: Competitions and HIT sessions routinely included approximately 30–45 min of LIT, followed by 10–15 min of MIT/HIT. Cooldown involves 15 min of LIT. Strength sessions typically consist of a 30-min warm-up (running/cycling at LIT) followed by 15–30 min of maximal movement-specific strength exercises for the upper body and thereafter 30–45 min of more general core/stabilization exercises. Abbreviations: LIT, low-intensity training, blood lactate concentration <2.5 mmol/L, heart rate <81% HRmax; MIT, moderate-intensity training, blood lactate concentration 2.5–4.0 mmol/L, heart rate 81–87% HRmax; HIT, high-intensity training, blood lactate concentration 4.0–10.0 mmol/L, heart rate >87% HRmax.

Sandbakk & Holmberg, 2017

Periodizzazione degli allenamenti
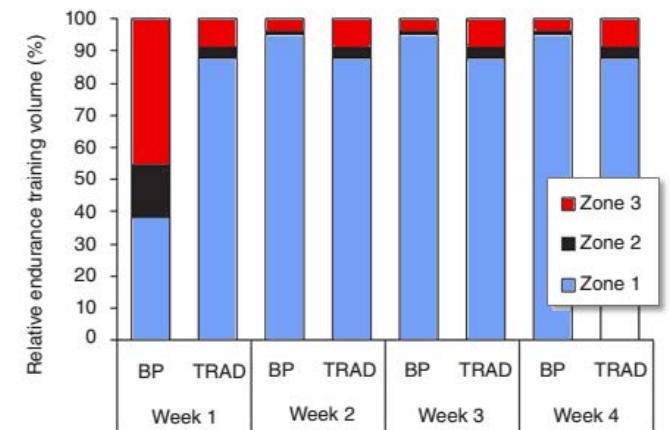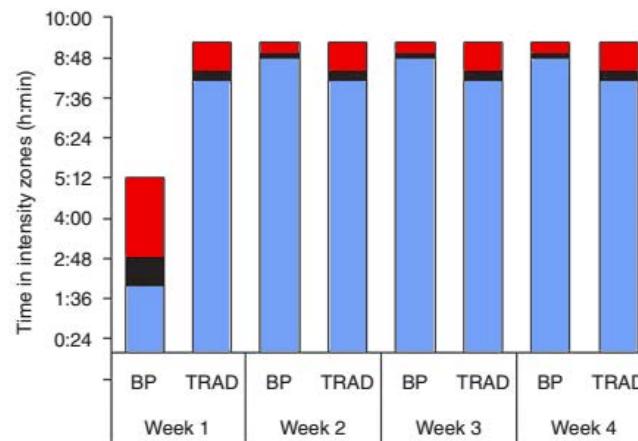
Stöggl, 2018

|	Fase preparatoria (< 8 settimane dalla gara target)	Fase pre-competitiva (2-8 settimane dalla gara target)	Fase competitiva (< 2 settimane dalla gara target)
Sci di fondo	85-89 / 6-10 / 3-7	78-82 / 12-16 / 4-8	82-86 / 2-6 / 10-14
Corsa in montagna	83-87 / 8-12 / 3-7	73-77 / 17-21 / 4-8	78-82 / 2-6 / 14-18
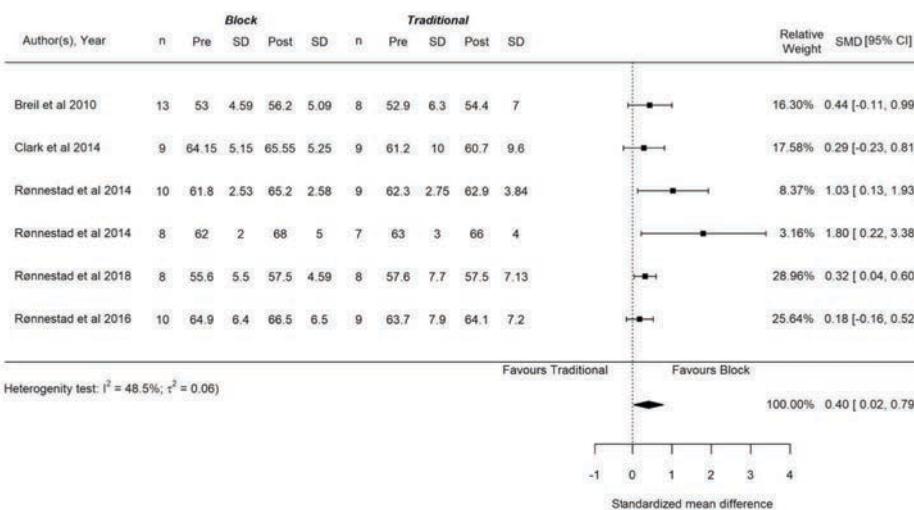
Come distribuire l'intensità durante il micro/mesociclo?

**Periodizzazione tradizionale vs Periodizzazione a blocchi**
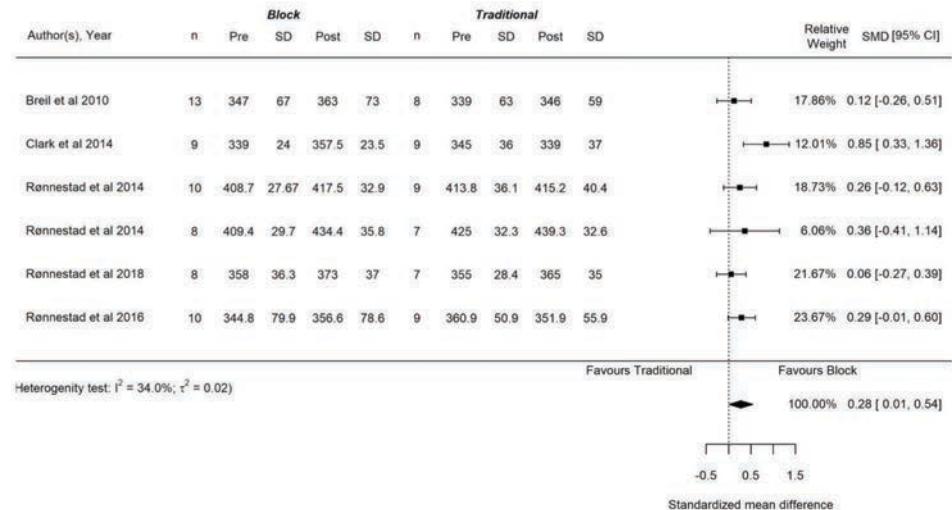
A blocchi o tradizionale?

VO$_2$max

Wmax
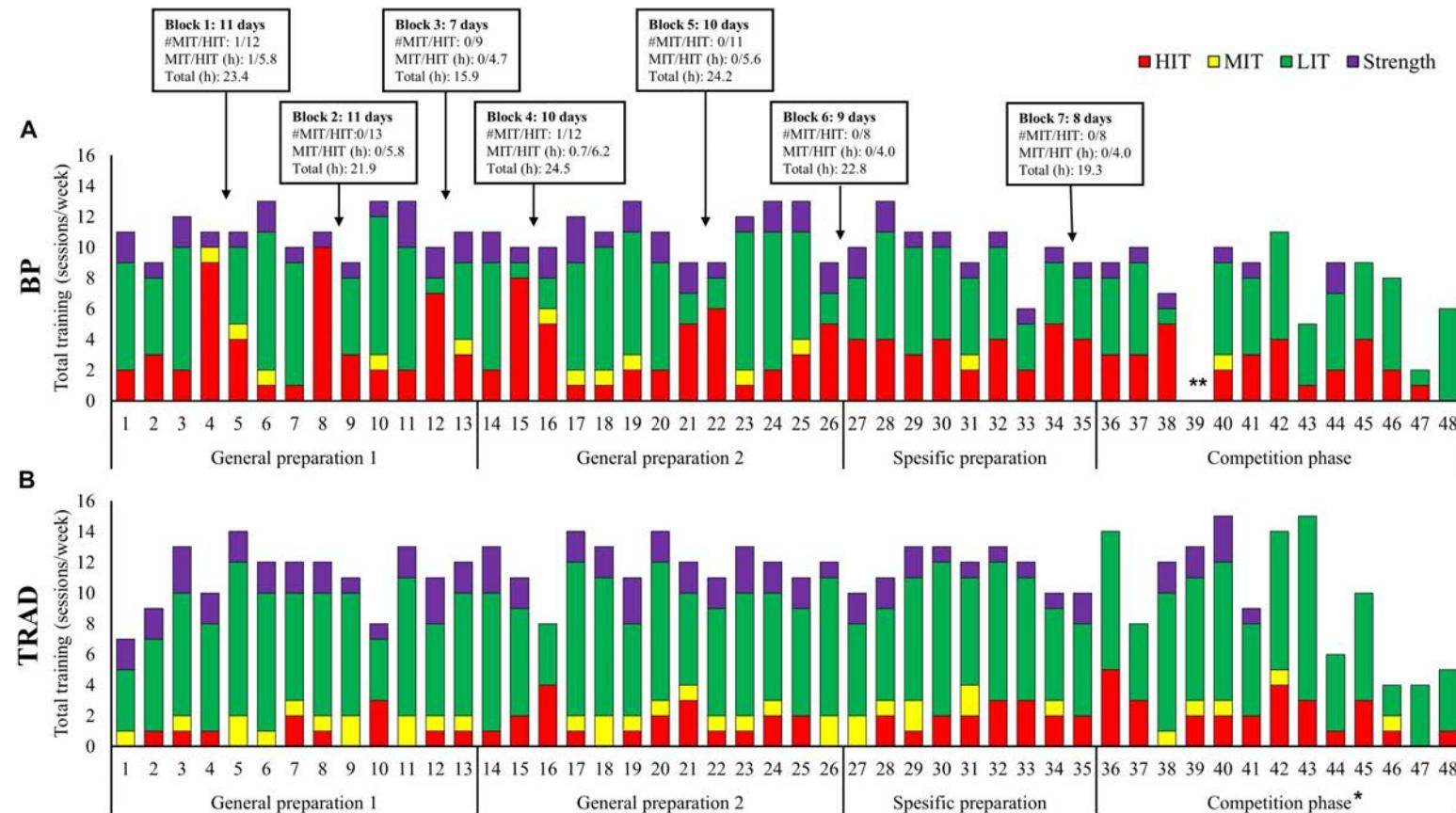
Mølmen et al., 2019

A blocchi o tradizionale?

	EVEN			BLOCK			Δ	
	Pre	Post	Δ	Pre	Post	Δ	P-value	ES
n = 20								
Skiing economy (O_2 L·min^{-1})	2.83 ± 0.57	2.78 ± 0.57*	−0.06 ± 0.10	2.77 ± 0.58	2.79 ± 0.58	0.02 ± 0.16	0.117	0.79
VO_2max(mL·kg^{-1}·min^{-1})	60.3 ± 7.2	61.2 ± 7.9	0.9 ± 2.6	61.4 ± 8.1	60.6 ± 8.2	−0.8 ± 2.4	0.071	0.67
600-m time-trial (s)^T	187 ± 23	183 ± 25*	−3 ± 5	185 ± 23	184 ± 22	−1 ± 6	0.280	0.44
Resting cortisol (μg/dL)	0.45 ± 0.21	0.54 ± 0.30	0.09 ± 0.21	0.53 ± 0.32	0.48 ± 0.19	−0.05 ± 0.30	0.208	0.59
Resting testosterone (pg/mL)^T	108 ± 75	96 ± 45	−12 ± 51	108 ± 53	86 ± 39	−20 ± 41	0.592	0.15
Resting testosterone:cortisol^T	264 ± 203	216 ± 157	−48 ± 94	257 ± 190	218 ± 170	−39 ± 139	0.817	0.18
Resting IgA (μg/mL)	36 ± 34	76 ± 83	40 ± 96	72 ± 83	45 ± 43	−26 ± 69	0.081	0.68
n = 11								
Capillary density (per mm^2)	377 ± 31	379 ± 44	3 ± 34	385 ± 42	365 ± 36	−20 ± 39	0.253	0.66
Mean fiber area (μm^2)^T	4594 ± 761	4661 ± 764	68 ± 522	4596 ± 776	4968 ± 1000	372 ± 655	0.379	0.11
Type I (%)	66.2 ± 7.5	69.1 ± 6.7	2.9 ± 6.5	67.5 ± 6.5	67.2 ± 8.3	−0.3 ± 7.4	0.203	0.50
Type IIA (%)	25.2 ± 6.4	22.7 ± 5.6	−2.5 ± 4.8	24.1 ± 5.0	21.9 ± 7.9	−2.2 ± 8.3	0.904	0.07
Type IIB (%)	7.2 ± 4.1	7.2 ± 3.8	0.0 ± 3.2	7.5 ± 4.4	9.4 ± 5.9	1.9 ± 3.9	0.177	0.60
Type IIC (%)	1.4 ± 1.9	1.0 ± 2.4	−0.4 ± 3.4	1.0 ± 2.4	1.5 ± 2.6	0.5 ± 3.9	0.680	0.27
CS activity (μmol/min/g)	23.2 ± 2.9	22.5 ± 2.9	−0.7 ± 2.5	23.6 ± 2.7	22.5 ± 1.7	−1.1 ± 2.1	0.743	0.15
HAD activity (μmol/min/g)^T	7.4 ± 1.0	7.4 ± 1.1	0.0 ± 1.1	7.6 ± 1.1	6.9 ± 0.9*	−0.7 ± 1.0	0.317	0.60
PFK activity (μmol/min/g)^T	21.7 ± 2.9	20.7 ± 2.1	−1.0 ± 2.3	20.8 ± 2.1	20.1 ± 2.4	−0.7 ± 1.9	0.753	0.14
VEGF protein content (AU)	20.0 ± 9.3	15.4 ± 10.7	−4.7 ± 15.2	16.5 ± 10.9	19.9 ± 15.5	3.5 ± 12.4	0.235	0.53
PGC-1α protein content (AU)^T	0.07 ± 0.02	0.09 ± 0.02*	0.02 ± 0.02	0.08 ± 0.01	0.11 ± 0.04*	0.03 ± 0.04	0.862	0.11

McGawley et al., 2017

A blocchi o tradizionale?

Solli et al., 2019

4 maggio 2020

Grazie per l'attenzione

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