Sport SINGAPORE

Practical Approach to Assessing, Prescribing and Monitoring Aerobic Fitness and Training in Intermittent Sports

SINGAPORE SPORTS INSTITUTE

Joel Pang & Abdul Rashid Aziz
Sports Physiology Team

7th November 2018

LIVE BETTER THROUGH SPORT

By end of the session, you will be able to:

- Conduct the Yo-Yo Intermittent Recovery Test Level 1 (or YYIRT-L1) to determine the aerobic fitness of your athlete
- Conduct the YYIRT-L1 Submaximal run to monitor the aerobic fitness of your player
- Interpret the results of your players' YYIRT-L1 and Submaximal Run tests result
- Determine your players' maximal aerobic speed and subsequently prescribe and execute aerobic interval training according to the player's individual capability and/or capacity
- Able to determine and monitor the players' training load across the training period

Aerobic endurance training improves soccer performance

JAN HELGERUD, LARS CHRISTIAN ENGEN, ULRIK WISLØFF, and JAN HOFF

Norwegian University of Science and Technology, Department of Sport Sciences, N-7491 Trondheim, NORWAY

ABSTRACT

HELGERUD, J., L. C. ENGEN, U. WISLØFF, and J. HOFF. Aerobic endurance training improves soccer performance. *Med. Sci. Sports Exerc.*, Vol. 33, No. 11, 2001, pp. 1925–1931. **Purpose:** The aim of the present study was to study the effects of aerobic training on performance during soccer match and soccer specific tests. **Methods:** Nineteen male elite junior soccer players, age 18.1 ± 0.8 yr,

- To examine the effects of aerobic training on performance during soccer match and soccer specific tests
- Nineteen male elite junior soccer players, age 18.1 ± 0.8 yr, randomly assigned to the training group (N = 9) and the control group (N = 10) participated in the study.

were found in maximal vertical jumping height, strength, speed, kicking velocity, kicking precision, or quality of passes after the training period. The control group showed no changes in any of the tested parameters. **Conclusion:** Enhanced aerobic endurance in soccer players improved soccer performance by increasing the distance covered, enhancing work intensity, and increasing the number of sprints and involvements with the ball during a match. **Key Words:** $\dot{V}O_{2max}$, LACTATE THRESHOLD, RUNNING ECONOMY, SKILL

- Measured n the laboratory, before and after training period:
  - VO_{2max}; Lactate threshold; Running economy
  - Vertical jump
  - Upper body strength = 1RM of bench press
  - Lower body strength = 1RM squat
  - Speed = at 10 m & 40 m time
  - Kicking velocity
- Measured in during actual matches via video:
  - Kick accuracy; Quality of passes
  - Distance covered during match
  - Number of high-intensity sprints
  - Work or game intensity via HR measurement
- TRG and CON groups trained 4 x 1.5 h sessions of regular soccer training and played one match per week for 8 weeks
- TRG had additional 2 sessions per week of aerobic endurance-type of training of 35-45 min each session. These two sessions consisted of high-intensity aerobic interval training - 4 runs x 4-min at intensity equivalent to 90-95% of the individual's HR_{max}; in-between repeats a recovery jog for 3 min. CON group practiced individual ball-skills and technical skills during these 2 sessions

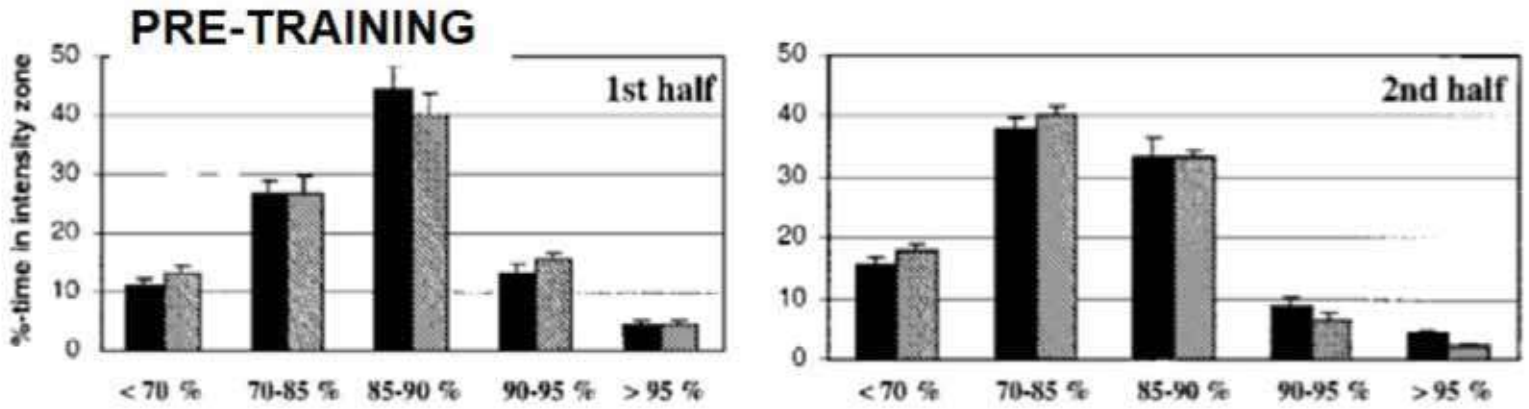
2. Results from physiological tests (± SD).

	TG (N = 9)		CG (N = 10)	
	Pretraining	Posttraining	Pretraining	Posttraining
$\dot{V}O_{2max}$				
L·min^{-1}	4.25 (1.9)	4.59 (1.4)*	4.06 (0.95)	4.11 (0.99)
mL·kg^{-1}·min^{-1}	58.1 (4.5)	64.3 (3.9)*	58.4 (4.3)	59.5 (4.4)
mL·kg$^{-0.75}$·min^{-1}	169.9 (9.6)	188.3 (10.6)*	169.2 (9.7)	170.3 (9.8)
LT				
L·min^{-1}	3.5 (0.4)	3.96 (0.3)*	3.5 (0.4)	3.46 (0.4)
mL·kg^{-1}·min^{-1}	47.8 (5.3)	55.4 (4.1)*	49.5 (3.3)	50.0 (4.1)
mL·kg$^{-0.75}$·min^{-1}	139.9 (15.5)	162.3 (12.2)*	143.7 (15.2)	143.2 (10.9)
% $\dot{V}O_{2max}$	82.4 (3.1)	86.3 (2.1)	86.2 (3.7)	84.2 (2.8)
% f_{cmax}	87.4 (2.3)	87.6 (2.4)	89.2 (3.1)	88.7 (4.2)
v_{LT} (km·h^{-1})	11.1 (0.7)	13.5 (0.4)*	11.7 (0.4)	11.5 (0.2)
Running economy				
mL·kg$^{-0.75}$·m^{-1}	0.75 (0.05)	0.70 (0.04)*	0.75 (0.04)	0.74 (0.04)
f_{cmax} (beats·min^{-1})	202 (5.5)	203 (5.7)	202 (6.3)	202 (6.3)
$[la^-]_b$ (mmol·L^{-1})	8.1 (1.5)	8.5 (1.9)	7.8 (1.4)	7.9 (1.5)
R	1.17 (0.1)	1.18 (0.1)	1.18 (0.1)	1.18 (0.1)

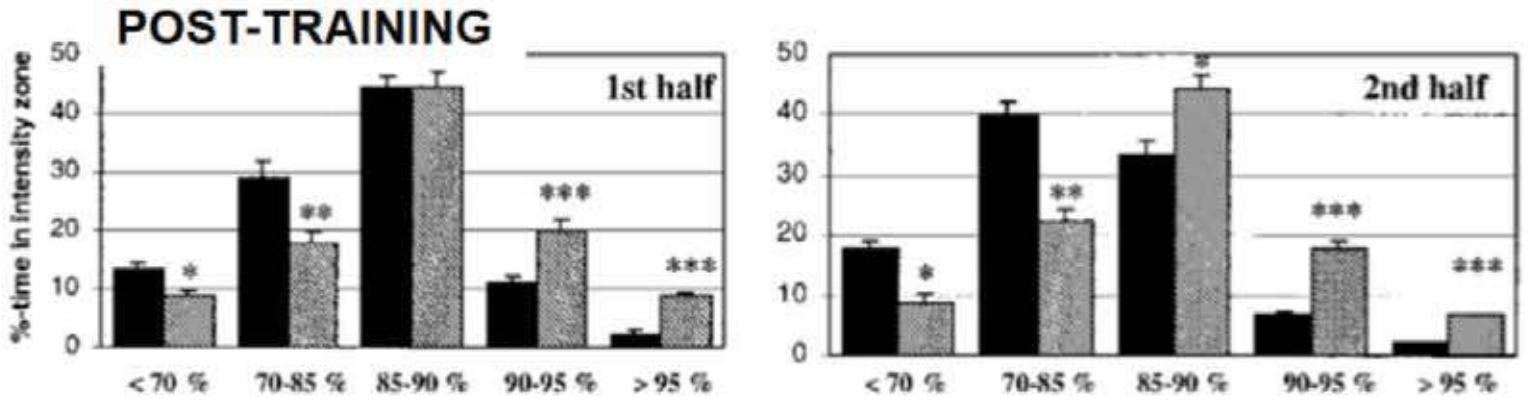
TABLE 3. Video analyses from soccer matches at pretest and posttest, as average numbers per player and match (± SD).

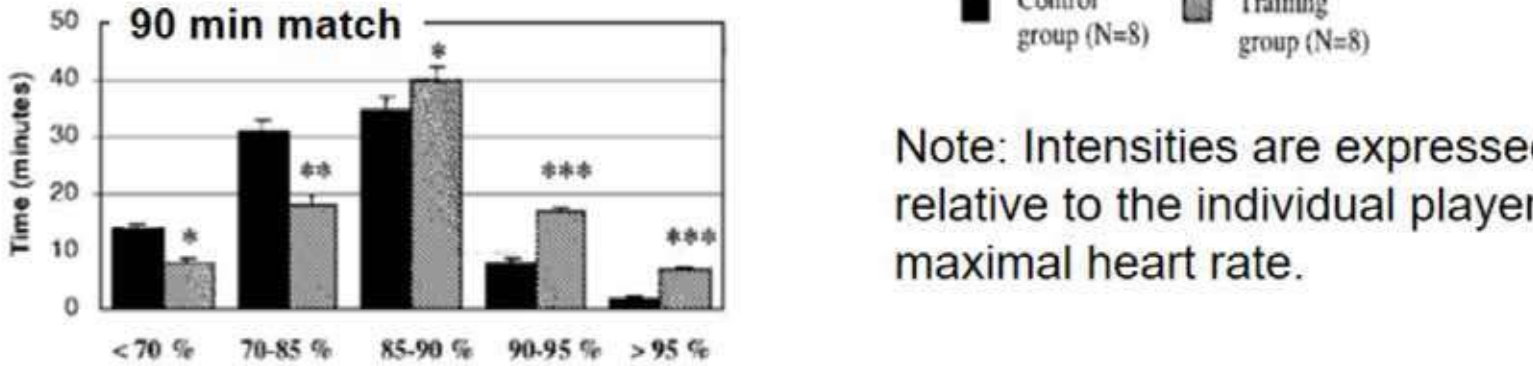
	TG (N = 9)		CG (N = 10)	
	Pretraining	Posttraining	Pretraining	Posttraining
No. of sprints	6.2 (2.2)	12.4 (4.3)**	6.4 (2.4)	7.5 (2.7)
No. of involvements with ball	47.4 (5.5)	58.8 (6.9)*	50.1 (6.1)	52.4 (6.7)
No. of passes	28.5 (3.5)	30.7 (3.9)	24.8 (3.1)	26.9 (3.9)
Successful passes	19.4 (2.1)	23.5 (2.7)	16.6 (2.0)	18.7 (2.3)
Unsuccessful passes	9.1 (1.9)	7.2 (1.4)	8.2 (1.7)	8.2 (1.8)
Distance covered (m)	8619 (1237)	10,335 (1608)**	9076 (1512)	9137 (1565)

* $P < 0.05$; ** $P < 0.01$.



Post-training





Control group (N=8)

Training group (N=8)

Note: Intensities are expressed relative to the individual players' maximal heart rate.

At Post-training, TRG group improved:

- VO_{2max} - 11%
- Lactate threshold - 16%
- Running economy - 6.7%
- but NO changes in Vertical Jump, Strength, Speed, Kicking Velocity & Kicking precision

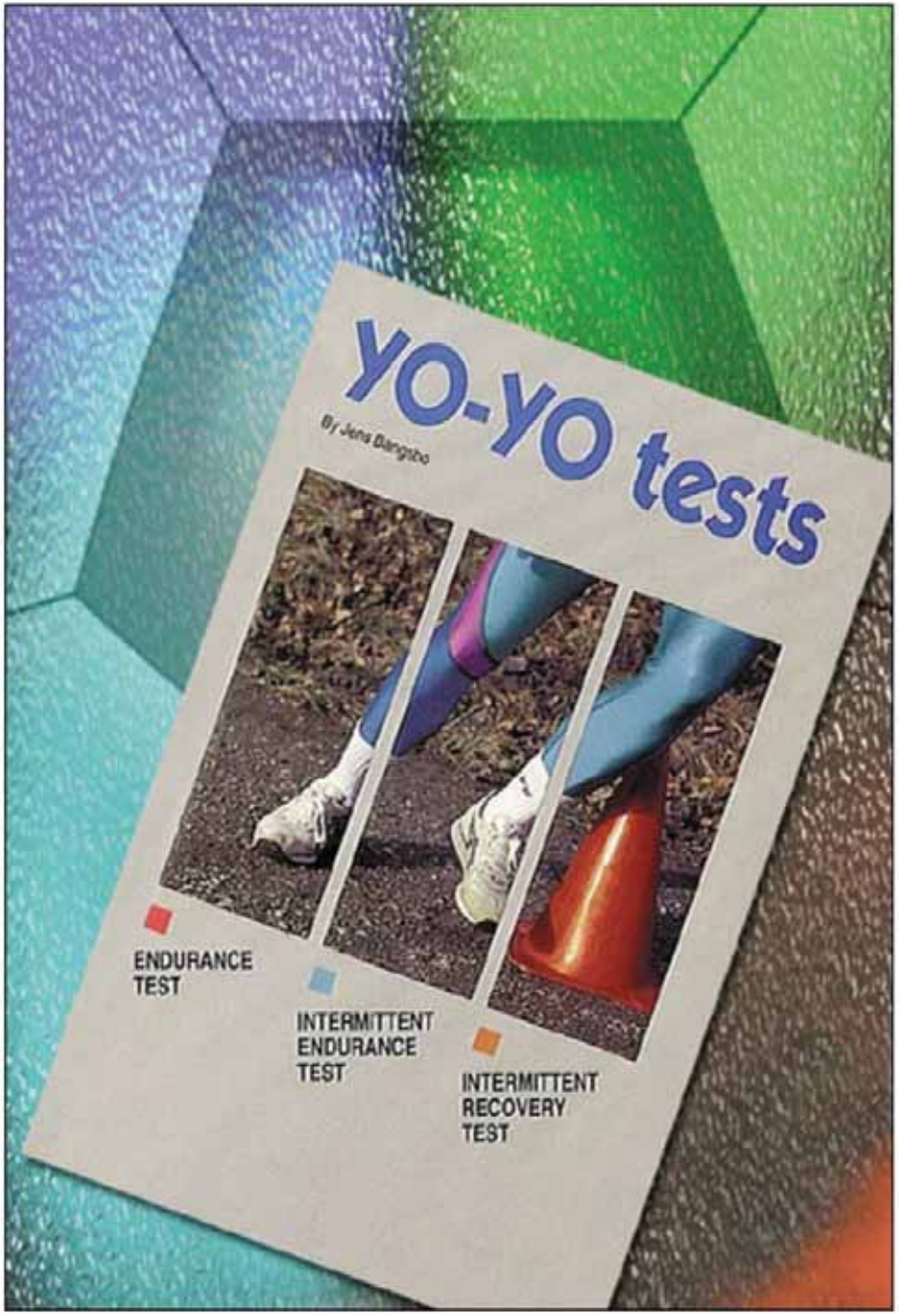
Most significant findings were that throughout the soccer match, TRG group increased:

- distance covered during a match - 20%
- number of sprints - 100%
- player involvement with ball (close contact with ball) - 24%
- work intensity via HR - 4%
- Implication:
  - higher levels of aerobic fitness (and/or improvements in aerobic fitness) resulted in ***producing*** a greater work-rate and ***maintaining*** a higher level of exercise intensity throughout match-play

Increased in aerobic fitness also means:

- Aerobically fitter players also mean:
  - Greater resistance to physical fatigue = maintenance of technical performance
  - Greater resistance to mental fatigue = maintenance of better decision-making
  - less fatigue means lower risk to injury – since more injuries were observed towards the end of each half when athletes are presumably experiencing higher levels of "fatigue".
  - increased scoring opportunities increases with match duration – and therefore more goals!

(Haugen & Seiler, 2015)



Aerobic Fitness (field-based) Testing for Intermittent Sports

- **Maximal test**
- **Submaximal test**

Created & Design by
Professor Jens Bangsbo

Professor of Exercise Physiology from the Copenhagen Muscle Research Centre at the University of Denmark

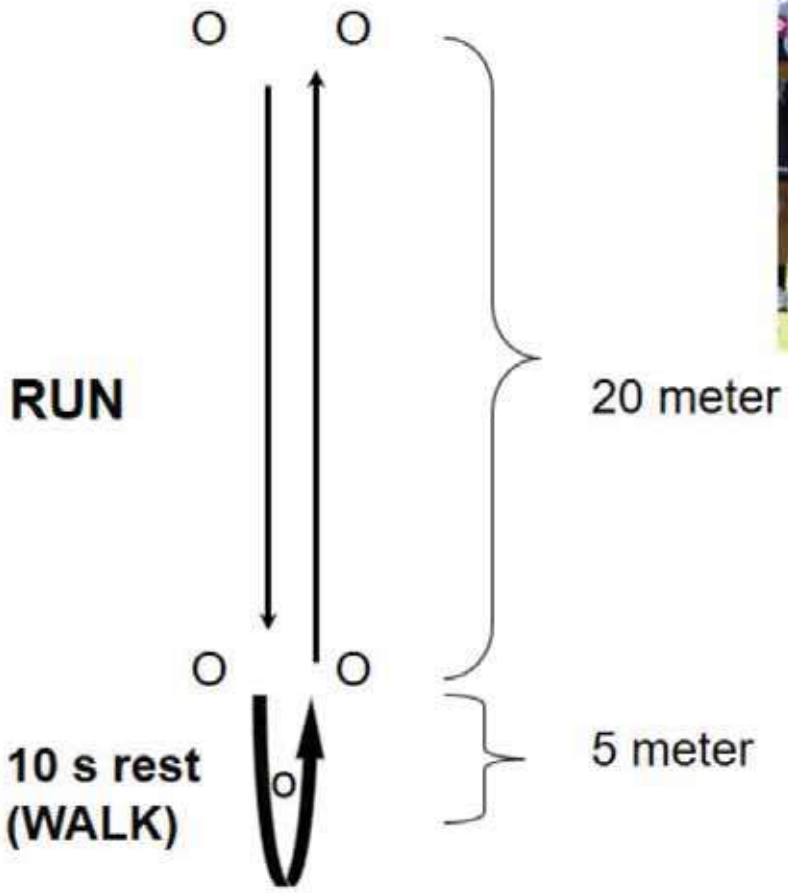
He was formerly Head Fitness Coach for Juventus and Denmark National Men Football Teams

Yo-Yo tests – many variations

- 1. Yo-Yo Endurance test, Level 1 and Level 2
  - very similar to Beep test (continuous shuttle running at progressive speeds)
- 2. Yo-Yo Intermittent Endurance test Level 1 and Level 2
  - 2 x 20 m shuttle runs with 5 second recovery between each 40 m
- 3. Yo-Yo Intermittent Recovery test Level 1 and Level 2
  - 2 x 20 m shuttle runs with 10 second recovery between each 40 m
  - L 1 - speed of runs start slow
  - L 2 - speed of runs much faster

  = Hence YYIRT- L1 test is deemed more aerobic and YYIRT-L2 test involves a greater anaerobic energy contributions

Yo-Yo intermittent recovery test Level 1 (YYIRT-L1)



Equipment & Facilities

- 30 m x 30 m area, preferably over-head covered, hard surface and non-slipped (NOT field-grass, why?)
- measuring tape, YYIRT-L1 CD and CD-player with batteries
- YYIRT-L1 score sheet for each player & pencils
- cones and sticky white tape to mark area
- court or running shoes
- HR monitors, if available

YYIRT - L1

- Simple, requires minimum equipment, facilities & expertise
- Multiple players can be tested at the same time
- Mimics movements similar to soccer of acceleration, deceleration and dynamic twist & turns actions and variable speeds
- Reliability test: consistency of results is ensured
  (assuming procedures of test are conducted properly and athlete is well-motivated to give his/her maximal effort during the test)
- Validated test – test that measures what it is supposed to be measuring
- Termination criteria: i.e. one foot must crossed/stepped over the end line in time with the beeping sound – TWICE at any time during the test
- Player's score are reported in:
  - Number of level and shuttles attained OR
  - Distance covered (in metres)
- The higher the number of shuttles attained (i.e. via player's performance *perse*) implies that the higher is the player's aerobic fitness or player's sustained ability to perform intermittent exercise

YYIRT-L1 Score sheet

L 5	1 (40)							
L 9	1 (80)							
L 11	1 (120)	2 (160)						
L 12	1 (200)	2 (240)	3 (280)					
L 13	1 (320)	2 (360)	3 (400)	4 (440)				
L 14	1 (480)	2 (520)	3 (560)	4 (600)	5 (640)	6 (680)	7 (720)	8 (760)
L 15	1 (800)	2 (840)	3 (880)	4 (920)	5 (960)	6 (1000)	7 (1040)	8 (1080)
L 16	1 (1120)	2 (1160)	3 (1200)	4 (1240)	5 (1280)	6 (1320)	7 (1360)	8 (1400)
L 17	1 (1440)	2 (1480)	3 (1520)	4 (1560)	5 (1600)	6 (1640)	7 (1680)	8 (1720)
L 18	1 (1760)	2 (1800)	3 (1840)	4 (1880)	5 (1920)	6 (1960)	7 (2000)	8 (2040)
L 19	1 (2080)	2 (2120)	3 (2160)	4 (2200)	5 (2240)	6 (2280)	7 (2320)	8 (2360)
L 20	1 (2400)	2 (2440)	3 (2480)	4 (2520)	5 (2560)	6 (2600)	7 (2640)	8 (2680)
L 21	1 (2720)	2 (2760)	3 (2800)	4 (2840)	5 (2880)	6 (2920)	7 (2960)	8 (3000)
L 22	1 (3040)	2 (3080)	3 (3120)	4 (3160)	5 (3200)	6 (3240)	7 (3280)	8 (3320)
L 23	1 (3360)	2 (3400)	3 (3440)	4 (3480)	5 (3520)	6 (3560)	7 (3600)	8 (3640)

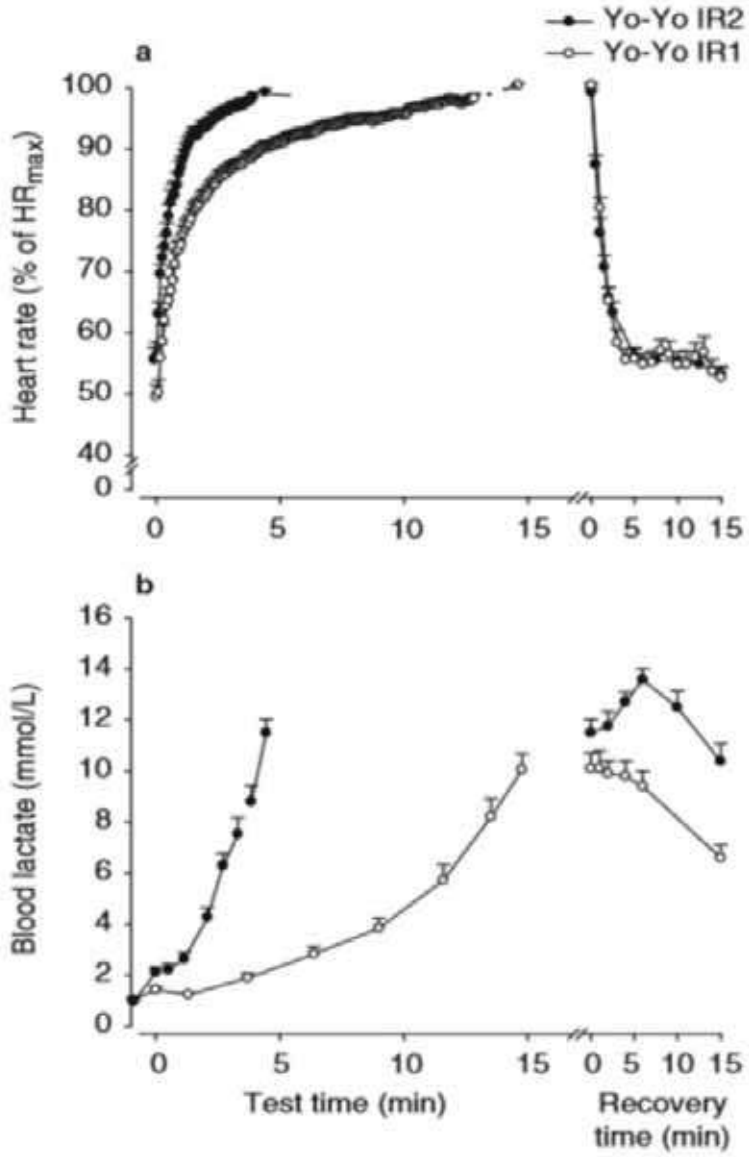


Fig. 2. Heart rate expressed as a percentage of (**a**) maximal heart rate (HR_{max}) and (**b**) blood lactate before, during and after the Yo-Yo intermittent recovery level 1 (Yo-Yo IR1) and level 2 (Yo-Yo IR2) tests. Values are mean ± standard error of the mean (reproduced from Krustrup et al.,[15,17] with permission).

- Both tests are therefore stimulating the aerobic system maximally; the major difference between the two tests is the degree of activating the anaerobic system.
- YYIRT-L1 focuses on the ability to repeatedly perform aerobic high-intensity work, the YYIRT-L2 examines the capacity to perform intense intermittent exercise with a large anaerobic component in combination with a significant aerobic contribution

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The Yo-Yo Intermittent Recovery Test

A Useful Tool for Evaluation of Physical Performance in Intermittent Sports

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The Yo-Yo Intermittent Tests: A Systematic Review and Structured Compendium of Test Results

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[1] *Institute of Sports Medicine, Molecular Genetics of Cardiovascular Disease, University Hospital Muenster, Muenster, Germany,* [2] *Institute of Biostatistics and Clinical Research, University of Muenster, Muenster, Germany*

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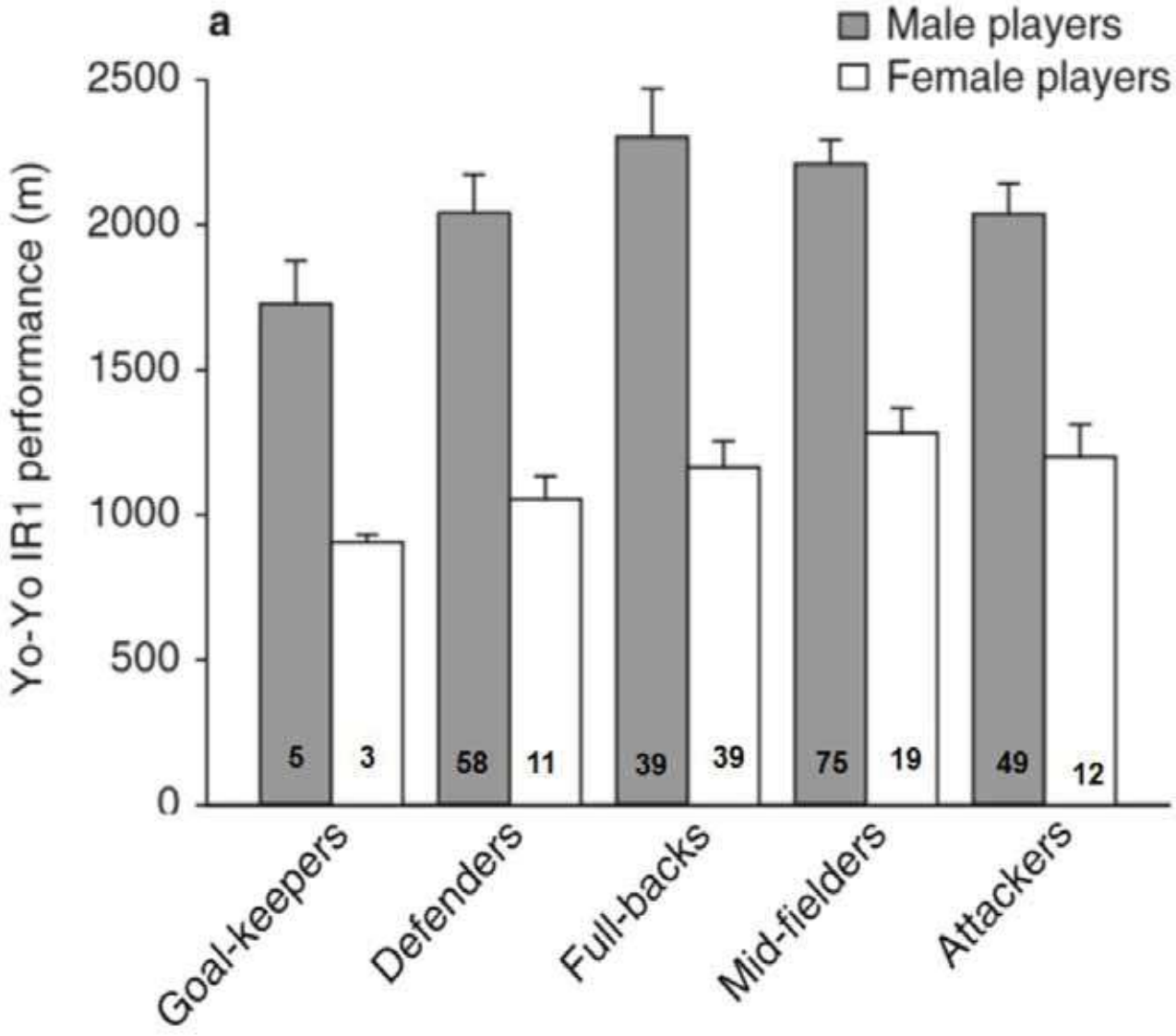
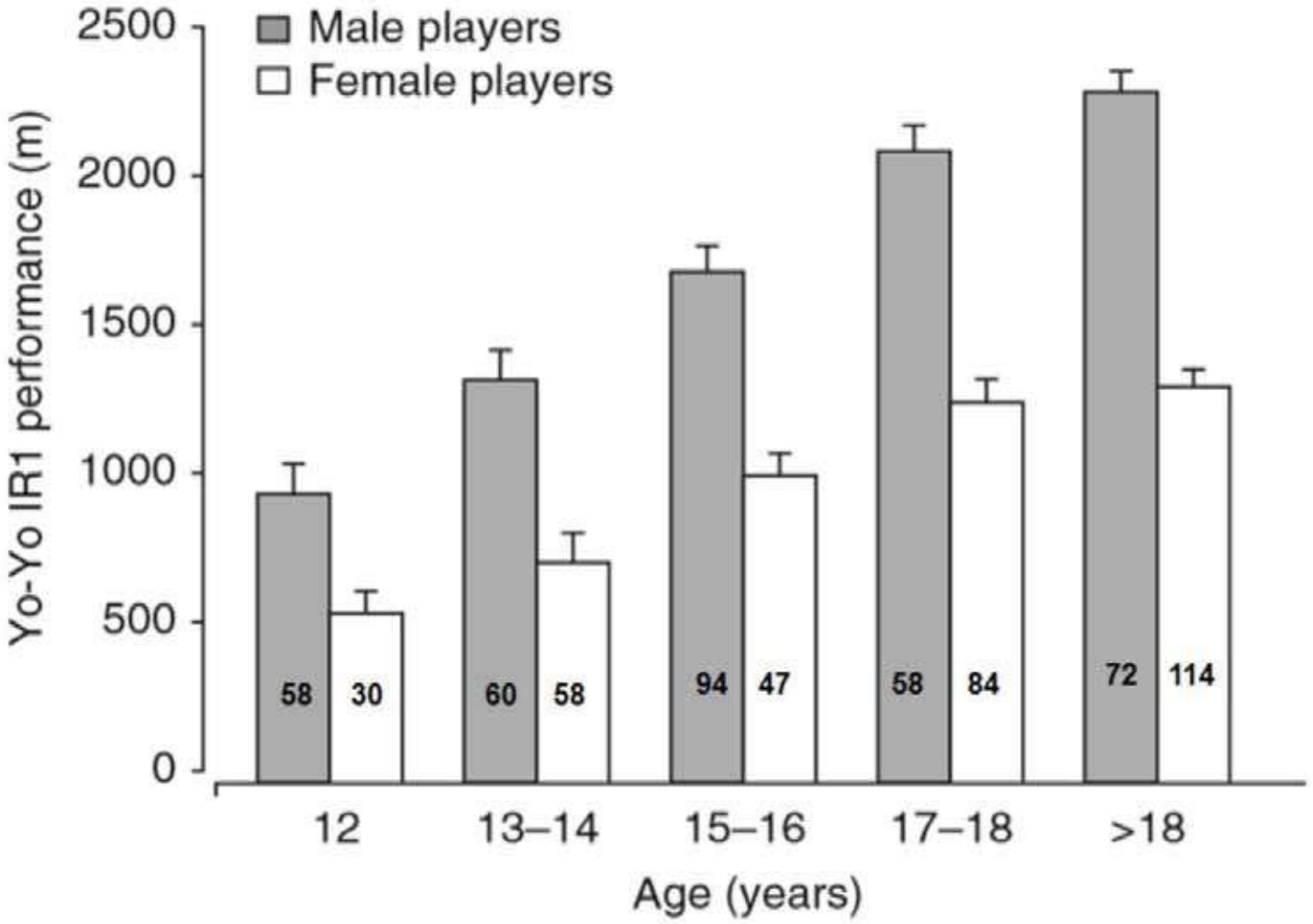
Background: Although Yo-Yo intermittent tests are frequently used in a variety of sports and research studies to determine physical fitness, no structured reference exists for comparison and rating of test results. This systematic review of the most common Yo-Yo tests aimed to provide reference values for test results by statistical aggregation of published data.

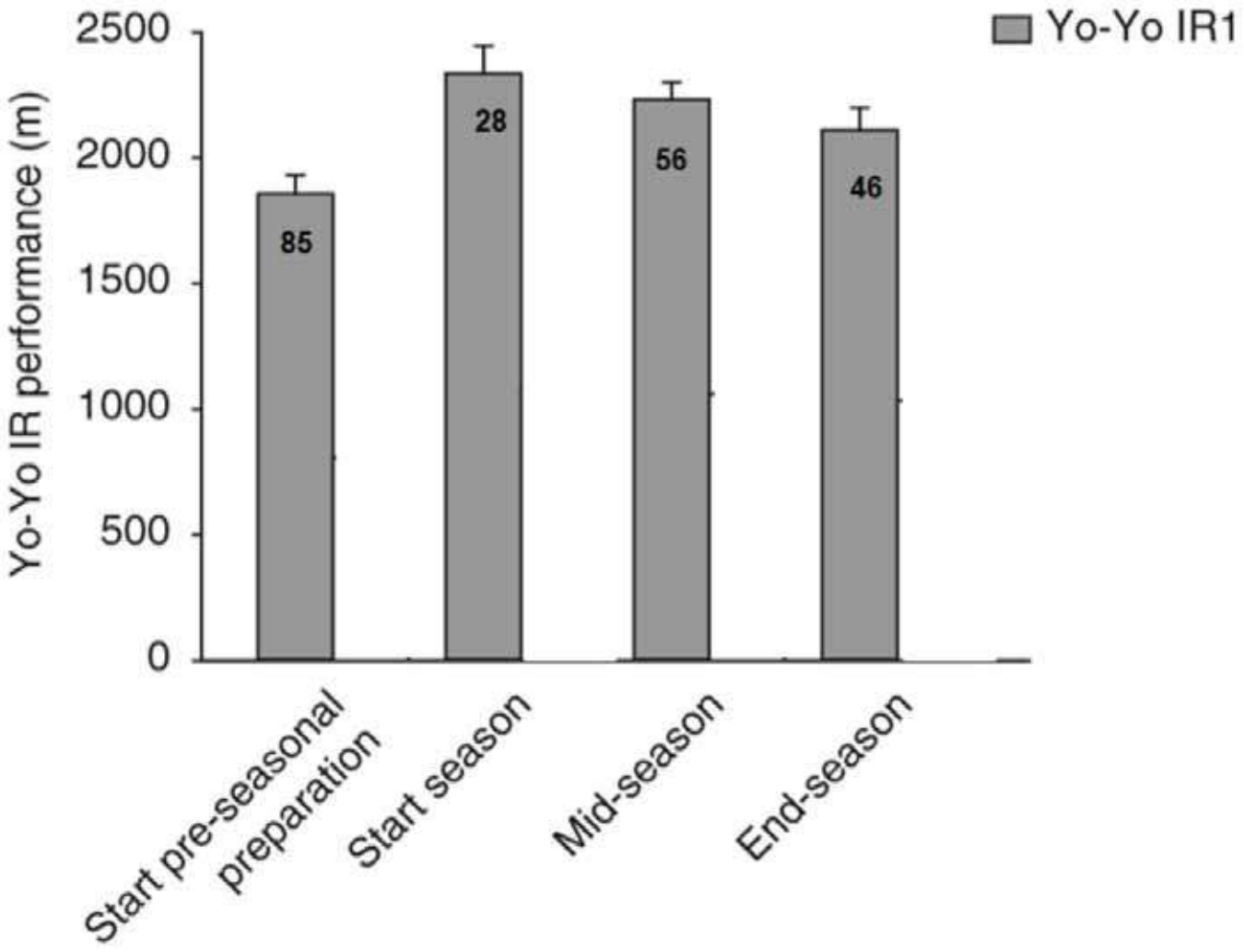
Positional differences in the YYIRT-L1



Relative Age Differences in the YYIRT-L1



Seasonal changes in YYIRT-L1



USA Women U-20 YYIRT-L1 results over 1 y in preparing for World Cup for U-20

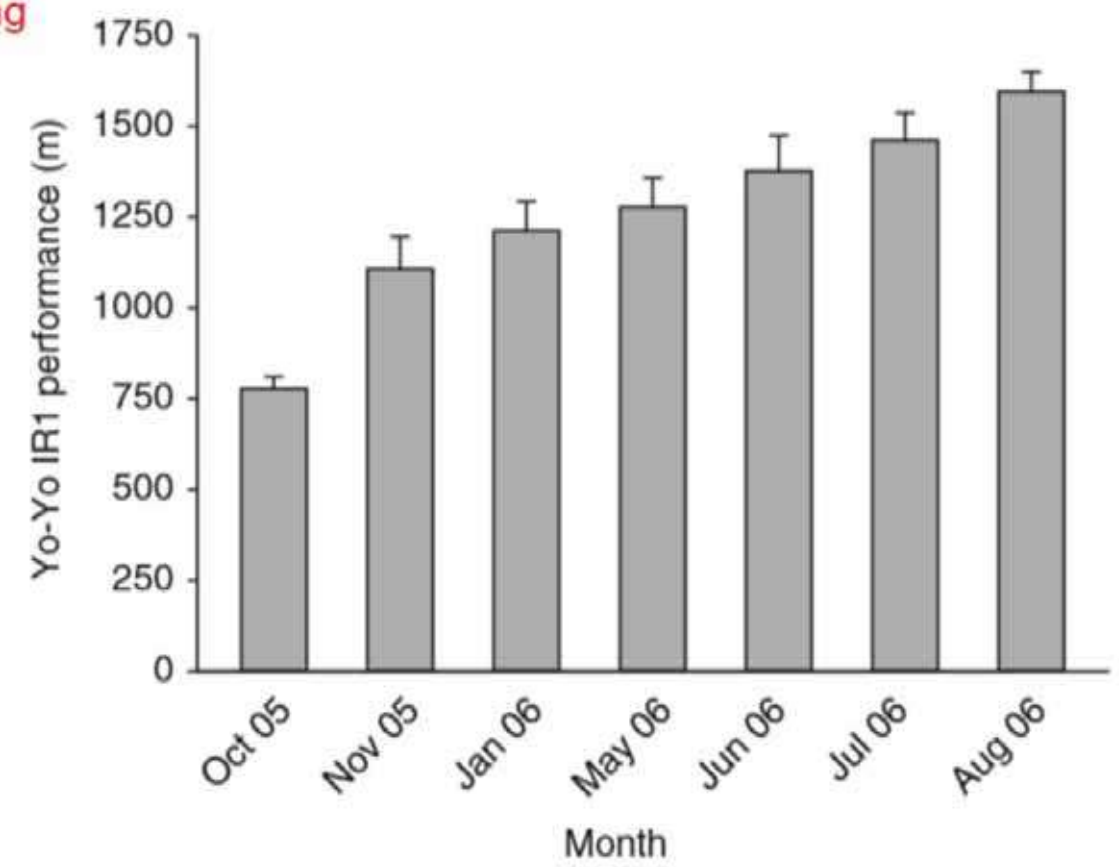
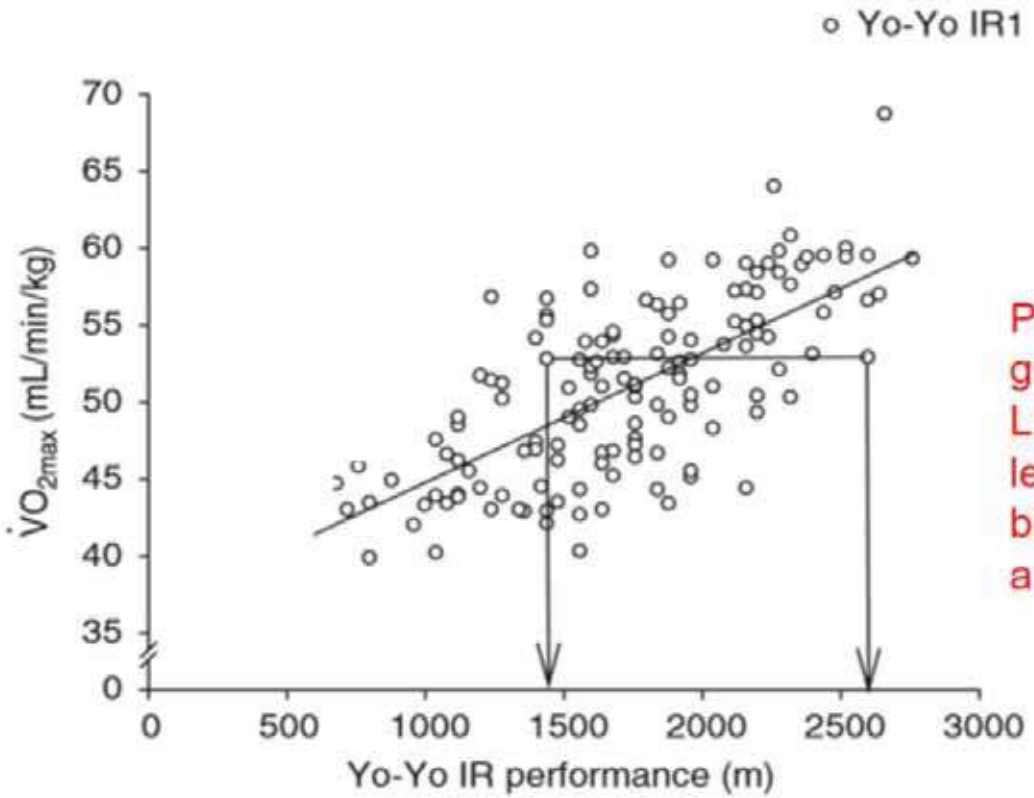


Fig. 11. Yo-Yo intermittent recovery level 1 (Yo-Yo IR1) test performance of under 20 years (U20) national female soccer players (n = 17–20) throughout a 1-year period. Start of World Cup (WC) squad selection process (Oct 2005); end of phase 1 development (Nov 2005); end of phase 2 development (Jan 2006); post-qualification – start of WC preparation (May 2006); mid-WC preparation (Jun 2006); late WC preparation (Jul 2006); final squad for U20 WC (Aug 2006) [Tunstall H, personal communication]. Values are mean ± standard error of the mean.

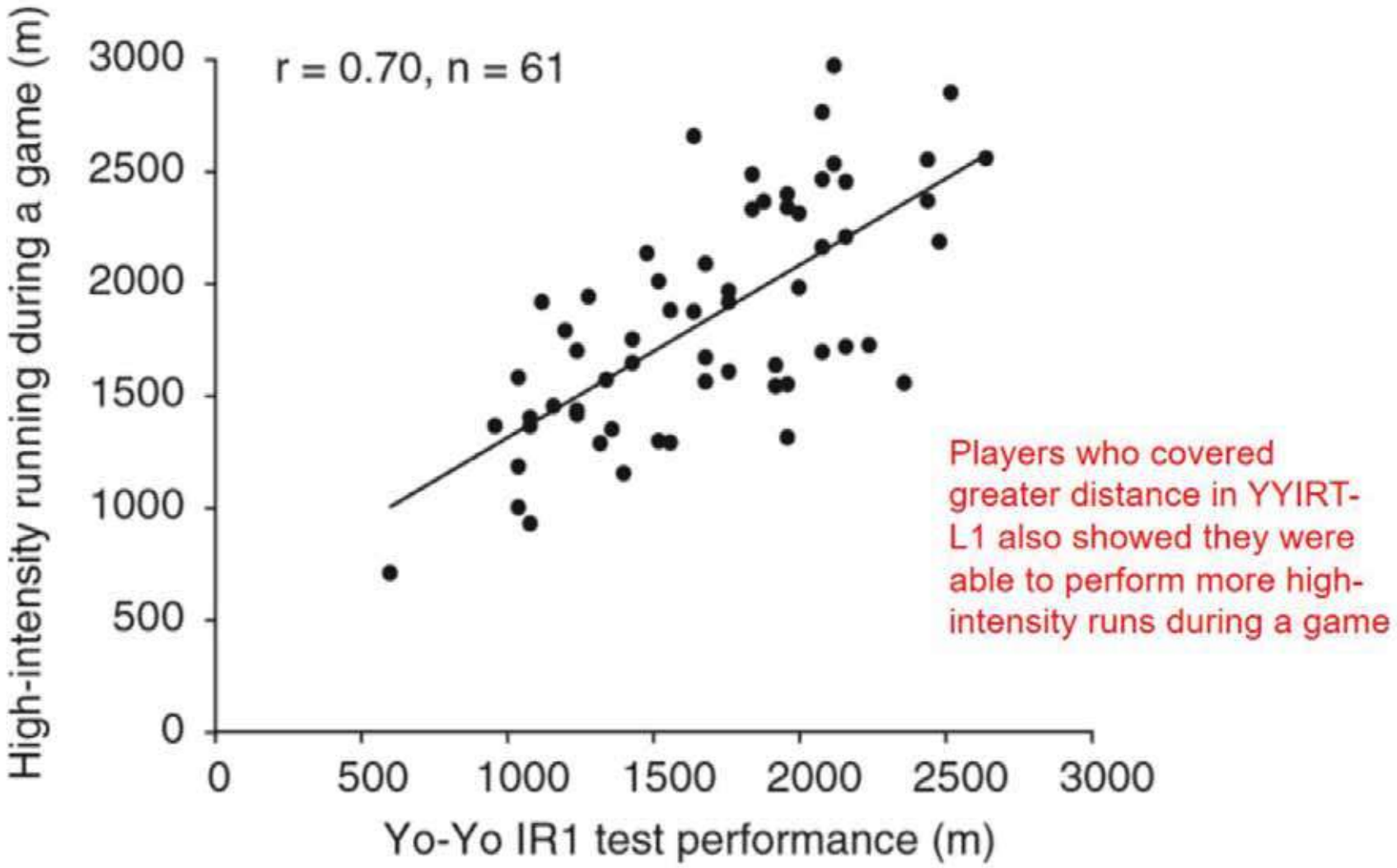
Relationship between YYIRT-L1 and VO2max



Players who covered greater distance in YYIRT-L1 also possessed high levels of VO_{2max}, $r = 0.70$; but the relationship is only a weak one

Fig. 12. Individual relationship between maximal oxygen uptake ($\dot{V}O_{2max}$) and performance during the Yo-Yo intermittent recovery level 1 (Yo-Yo IR1) [n = 141; r = 0.70; p < 0.05] and Yo-Yo IR2 (n = 71; r = 0.58; p < 0.05) tests. The graph shows individual data points and the regression lines. The two vertical arrows indicate the variation of the Yo-Yo IR1 test performance for a given $\dot{V}O_{2max}$ of 53 mL/min/kg.

YYIRT-L1 in relation to match performance (rather than VO_{2max})



Players who covered greater distance in YYIRT-L1 also showed they were able to perform more high-intensity runs during a game

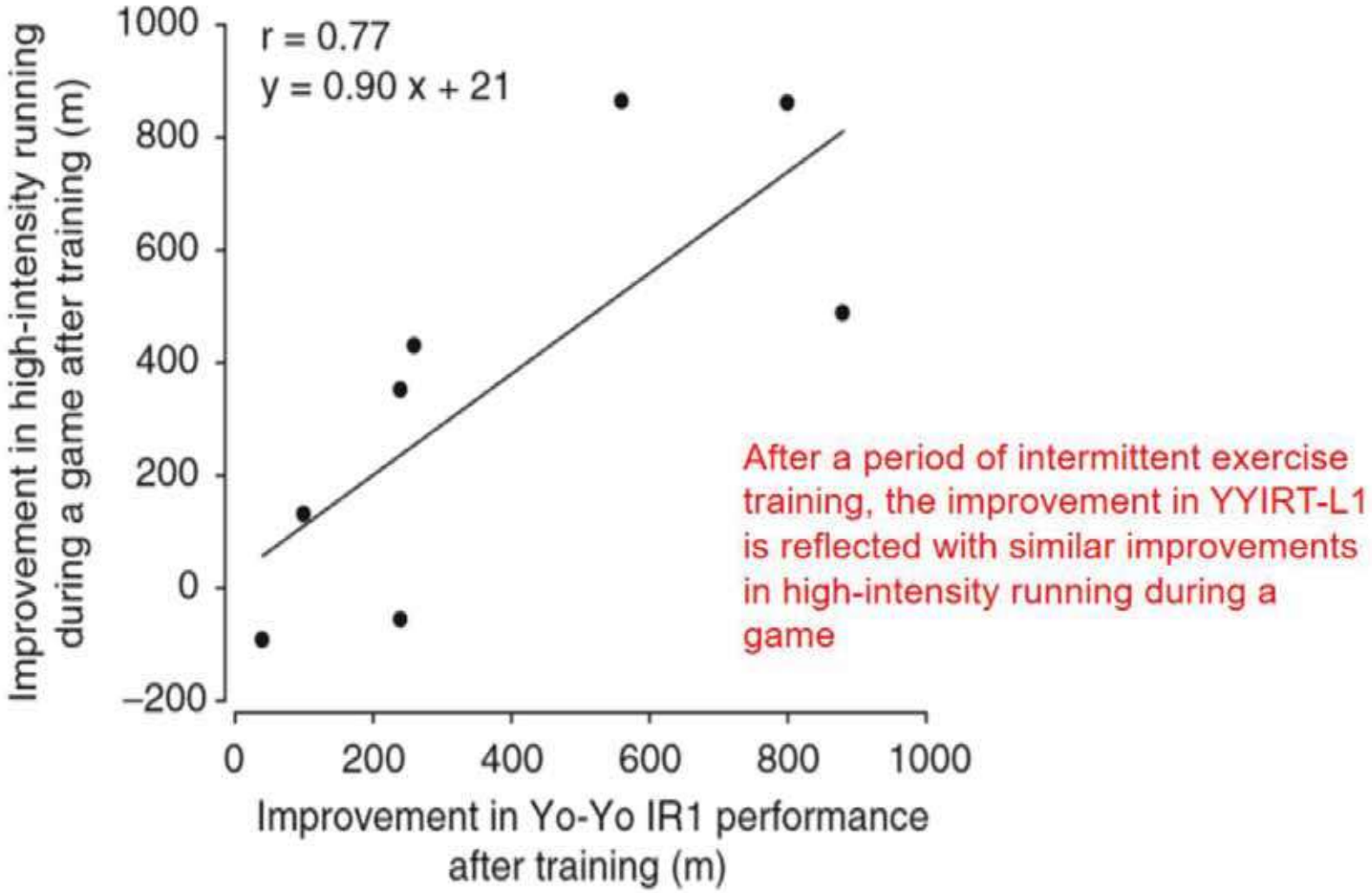


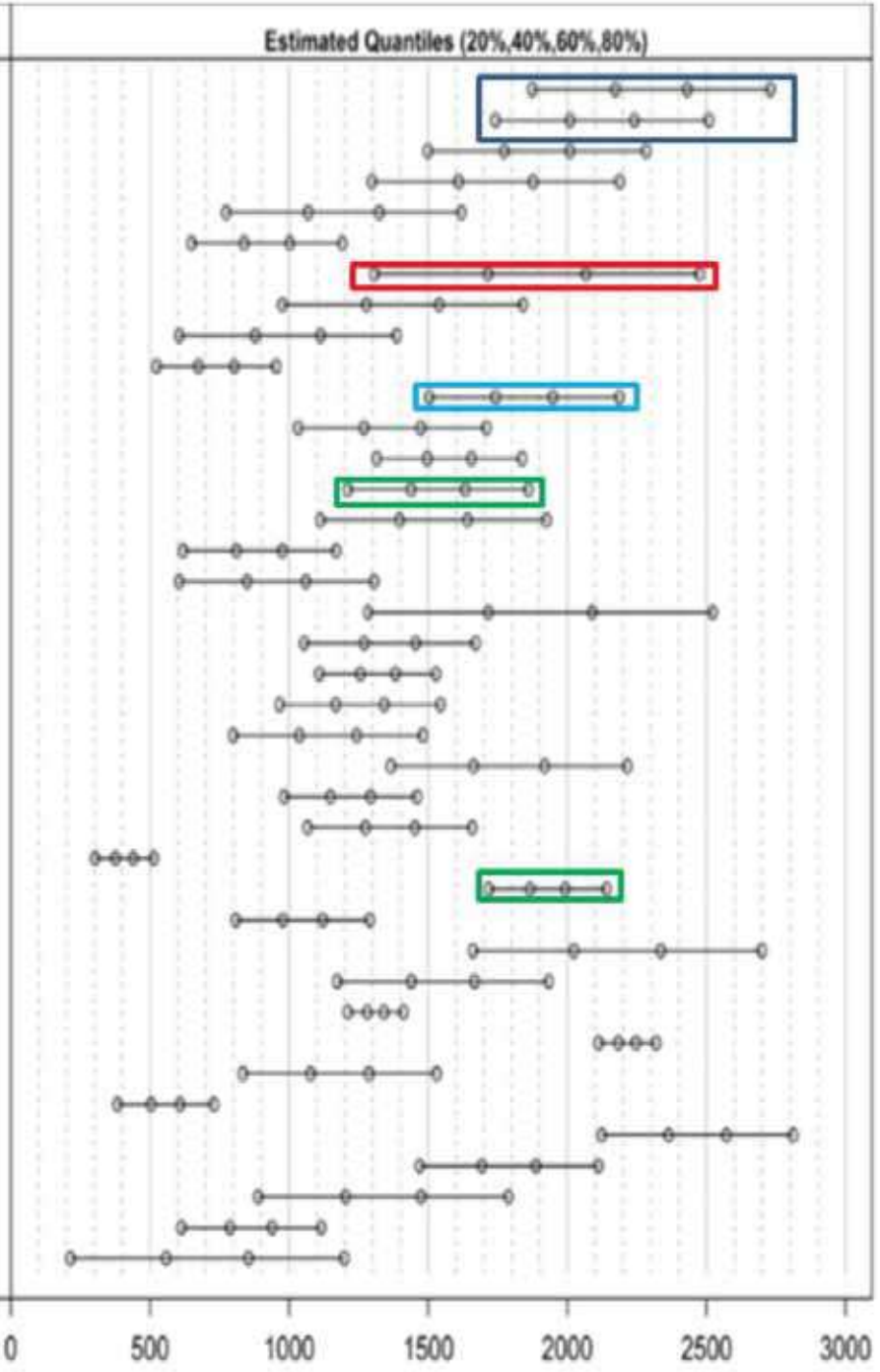
Fig. 9. Relationship between the improvement in Yo-Yo intermittent recovery level 1 (Yo-Yo IR1) test performance and the amount of high-intensity running (>15 km/h) of elite referees during a soccer game after a period of intermittent exercise training ($n = 8$; $p < 0.05$).[14]

YYIRT-L1 – What's a good score?*

**recommended guidelines only; also depends on level of competitiveness and sports participated*

CLASSIFICATION OF AEROBIC FITNESS	MALES Distance covered (m)	FEMALES Distance covered (m)
Poor	< 1200	< 600
Minimal Level	1200 - 1500	600 - 800
Expected Level	1500 -2000	800 - 1200
Good Level	2000 - 2300	1200 - 1500
Superior	> 2300	> 1500

Sport	Sex	Level	Studies/ Subgroups	Subjects	Global mean	Global SD
Soccer	Male	Top-Elite	N=21	n=288	2302	509
Soccer	Male	Elite	N=22	n=429	2126	456
Soccer	Male	Sub-Elite	N=37	n=802	1891	466
Soccer	Male	Amateur	N=15	n=340	1743	529
Soccer	Female	Sub-Elite/Elite	N=15	n=212	1197	502
Soccer	Female	Amateur	N=3	n=19	920	322
Basketball	Male	Elite	N=7	n=109	1891	694
Basketball	Male	Sub-Elite	N=5	n=68	1408	514
Basketball	Male	Amateur	N=1	n=14	996	464
Basketball	Female	Sub-Elite/Elite	N=3	n=44	738	255
Handball	Male	Elite	N=4	n=89	1845	406
Handball	Male	Sub-Elite	N=3	n=103	1371	401
Handball	Female	Elite	N=2	n=47	1576	311
Rugby/RS/GF	Male	Elite	N=10	n=369	1536	385
Rugby/GF	Male	Sub-Elite	N=23	n=652	1519	482
Rugby/RS	Female	Elite	N=3	n=52	894	327
Rugby	Male	Amateur	N=4	n=75	955	416
Football	Male	Sub-Elite/Elite	N=4	n=62	1903	735
Futsal	Male	Elite	N=7	n=105	1362	366
Futsal	Female	Amateur	N=1	n=29	1319	249
Hockey	Female	Elite	N=2	n=44	1255	344
Hockey	Female	Sub-Elite	N=2	n=40	1140	405
Referees	Male	Elite	N=8	n=129	1791	505
Referees	Male	Sub-Elite	N=2	n=25	1221	284
Referees	Male	Amateur	N=2	n=31	1363	351
Referees	Female	Sub-Elite	N=1	n=5	408	125
Cricket	Male	Elite	N=2	n=24	1929	251
Cricket	Male	Sub-Elite	N=1	n=27	1049	285
X-country Skiing	Male	Elite	N=1	n=8	2180	617
X-country Skiing	Male	Amateur	N=1	n=18	1553	451
Netball	Female	Sub-Elite	N=3	n=26	1311	119
Tennis	Male	Elite	N=1	n=14	2216	123
Squash	Male	Elite	N=1	n=9	1182	414
Volleyball	Female	Elite	N=1	n=13	556	206
Hurling	Male	Elite	N=1	n=30	2468	409
Ultimate Frisbee	Male	Sub-Elite	N=1	n=15	1790	382
Recreational	Male	-	N=13	n=211	1339	534
Recreational	Female	-	N=2	n=47	864	298
Inactive	Male	-	N=4	n=102	706	584



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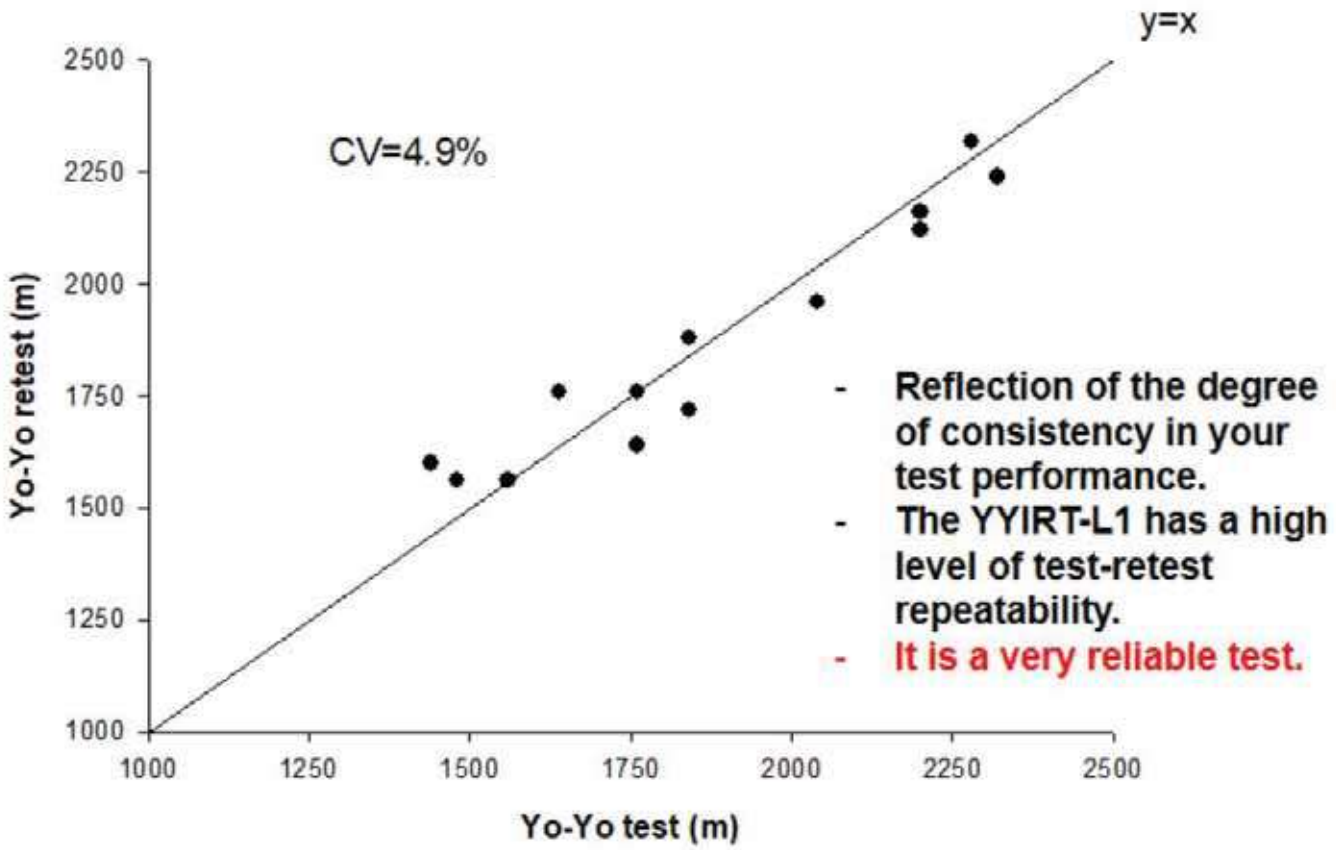
Interpretation of results

- Report results with the Individual's previous score, group average (individual relative to team scores) and reference/ norm available of the appropriate population sample
- Test results should include the precision of measurement
  - **Variability of test score ("noise") vs. Magnitude of change made**

YYIRT-L1 Scores Interpretation

- Note: every individual has small variation in their YYIRT-L1 performance.
- This amount of variation is the "noise" of the test or coefficient of variation (or CV)



YYIRT-L1 Scores Interpretation

- Estimated to be 5% (lower end for well-trained and higher end for less trained athletes). Note: 5% is 100 m for a 2000 m distance covered during test.
- Implication: the individual player must improve by more than 100 m (or 3 x 40 m = 120 m) compared to their previous performance to indicate a true change
- i.e., only an improvement or decline of 120 m is deemed as a substantial physiological significant (OR a REAL or ACTUAL performance effect has occurred in the individual)

YYIRT-L1 Score sheet

L 5	1 (40)							
L 9	1 (80)							
L 11	1 (120)	2 (160)						
L 12	1 (200)	2 (240)	3 (280)					
L 13	1 (320)	2 (360)	3 (400)	4 (440)				
L 14	1 (480)	2 (520)	3 (560)	4 (600)	5 (640)	6 (680)	7 (720)	8 (760)
L 15	1 (800)	2 (840)	3 (880)	4 (920)	5 (960)	6 (1000)	7 (1040)	8 (1080)
L 16	1 (1120)	2 (1160)	3 (1200)	4 (1240)	5 (1280)	6 (1320)	7 (1360)	8 (1400)
L 17	1 (1440)	2 (1480)	3 (1520)	4 (1560)	5 (1600)	6 (1640)	7 (1680)	8 (1720)
L 18	1 (1760)	2 (1800)	3 (1840)	4 (1880)	5 (1920)	6 (1960)	7 (2000)	8 (2040)
L 19	1 (2080)	2 (2120)	3 (2160)	4 (2200)	5 (2240)	6 (2280)	7 (2320)	8 (2360)
L 20	1 (2400)	2 (2440)	3 (2480)	4 (2520)	5 (2560)	6 (2600)	7 (2640)	8 (2680)
L 21	1 (2720)	2 (2760)	3 (2800)	4 (2840)	5 (2880)	6 (2920)	7 (2960)	8 (3000)
L 22	1 (3040)	2 (3080)	3 (3120)	4 (3160)	5 (3200)	6 (3240)	7 (3280)	8 (3320)
L 23	1 (3360)	2 (3400)	3 (3440)	4 (3480)	5 (3520)	6 (3560)	7 (3600)	8 (3640)

Analysis/Interpretations: Take into consideration

- What was done in the interim period or between the last and present test? -e.g., fitness training, tactics, strength - would have implications to the current result outcome
- Current level or state of players are in e.g., pre- or in-season, injury or rehab, etc?
- Comparison with players' in same position or with the average team score

Disadvantages

- There is no very clear standard or benchmarks available, especially for specific sports
- Correlation with measured VO_{2max} is less sensitive (vs. Beep test)
- Pace of test is dictated and not self-selected.
- The determination of "termination" of the test is apparent difficulty in 'policing' the test. Experience in the conduct of the Yo-Yo test suggests that players tended to "cheat" much more during the test.
- The reliability of the test will depend on the familiarity of the participants and how strictly the test is administered (the scoring of when a person is out of the test can be subjective)

Issues with Maximal-Effort testing

- Players do not like to be tested, especially when need to go maximal or until physical exhaustion
- Football players nowadays have long competitive season, play more matches and have a hectic training and competition schedule due possibly travelling, and relatively short preparation period – hence field and laboratory testing takes time-off from preparing and focus on future competition
- Is there a test that can assess an elite player's aerobic fitness with the players not-having to go maximally for many minutes - a submaximal test of aerobic fitness?

6 min YYIRT-L1 Sub-maximal Run

- Players run for the first 6 min of the YYIRT-L1 – a total distance of 720 m and stopped. HR during the last 30 s of the 6 min run test is noted and used as the "marker" of aerobic fitness attained

L 5	1 (40)							
L 9	1 (80)							
L 11	1 (120)	2 (160)						
L 12	1 (200)	2 (240)	3 (280)					
L 13	1 (320)	2 (360)	3 (400)	4 (440)				
L 14	1 (480)	2 (520)	3 (560)	4 (600)	5 (640)	6 (680)	7 (720) X	8 (760)
L 15	1 (800)	2 (840)	3 (880)	4 (920)	5 (960)	6 (1000)	7 (1040)	8 (1080)
L 16	1 (1120)	2 (1160)	3 (1200)	4 (1240)	5 (1280)	6 (1320)	7 (1360)	8 (1400)
L 17	1 (1440)	2 (1480)	3 (1520)	4 (1560)	5 (1600)	6 (1640)	7 (1680)	8 (1720)
L 18	1 (1760)	2 (1800)	3 (1840)	4 (1880)	5 (1920)	6 (1960)	7 (2000)	8 (2040)
L 19	1 (2080)	2 (2120)	3 (2160)	4 (2200)	5 (2240)	6 (2280)	7 (2320)	8 (2360)
L 20	1 (2400)	2 (2440)	3 (2480)	4 (2520)	5 (2560)	6 (2600)	7 (2640)	8 (2680)
L 21	1 (2720)	2 (2760)	3 (2800)	4 (2840)	5 (2880)	6 (2920)	7 (2960)	8 (3000)
L 22	1 (3040)	2 (3080)	3 (3120)	4 (3160)	5 (3200)	6 (3240)	7 (3280)	8 (3320)
L 23	1 (3360)	2 (3400)	3 (3440)	4 (3480)	5 (3520)	6 (3560)	7 (3600)	8 (3640)

Conducting of Test

- Put on the HR strap and watch - ensure that HR recording system is working well
- No need for extensive warm-up – perhaps a few minutes of light limbering and stretching
- Before start of the run test – ensure that HR is below 100 $b \cdot min^{-1}$. If above 100 ($b \cdot min^{-1}$), allow a longer passive rest
- When the running distance reaches 640 m mark, ask athlete to look at his watch and to take note of the HR at this point of time (this is the start of the last 30 s of the test) and again, ask for the HR at the end of the test (at end of 720 m). Averaged out these two reading to provide the HR result of the last 30 s of the YYIRT-L1 SubMax run

6 min YYIRT-L1 Sub-maximal Run

- 6 min duration to allow exercise HR to reach a steady-state
- Primary comparison is WITHIN the player – same player tested over time
  - in subsequent test, a lowering of exercise HR indicates improvement in the individual's aerobic fitness
- Secondary comparison BETWEEN players – applicable but not encouraged
  - At end of 6 min run; Player A: 165 $b \cdot min^{-1}$ and Player B: 165 $b \cdot min^{-1}$.
  - Player A's HR_{max} is 185 $b \cdot min^{-1}$ and Player's B HR_{max} is 195 $b \cdot min^{-1}$.
  - Player A is exercising at 89.2% relative to his HR_{max} while Player B is exercising at 84.6% relative to his HR_{max}.
  - Therefore, Player B is aerobically fitter.
- In general, the lower the exercise HR at the end of the 6 min Sub-max run indicates better aerobic fitness levels
- Because it is a non-exhausting test
  - it can be use frequently during the season to track the aerobic fitness of players
  - as part of warm-up before actual training session

Short Communication

The reliability of the submaximal version of the Yo-Yo intermittent recovery test in elite youth soccer

Charlie Owen, Paul Jones, Paul Comfort

Objectives: To determine the test-retest reliability of the submaximal version of the Yo-Yo Intermittent Recovery Test – Level 1 (Yo-Yo IR1-sub), which is a valid aerobic assessment.

Design: Test-re-test.

Methods: Elite youth soccer players (n = 10, age: 18.8 ± 0.5 years, height: 181.1 ± 4.9 cm, body mass: 74.2 ± 7.6 Kg) completed the Yo-Yo IR1-sub on two consecutive weeks to determine the reliability of a non-exhaustive alternative to maximal aerobic testing. Relative and absolute reliability of the Yo-Yo IR1-sub was assessed for heart rate response and recovery metrics (HR6, HR30, HR60, HR90, HR120, HRR30, HRR60, HRR90 and HRR120).

Results: The Yo-Yo IR1-sub was determined to be a reliable alternative to maximal testing, with the final heart rate at the end of the 6 minute test (HR6) shown to be the most reliable metric (ICC = 0.96; SDD = 5.4 bpm). The percentage of heart rate recovered after 2 min (HRR120) was the most reliable recovery metric (ICC = 0.93; SDD = 4.6%).

Conclusion: If maximal testing is not a feasible option, particularly during the competitive season or during the rehabilitation of an injured player, then a submaximal test is a reliable alternative to monitor fitness in elite young soccer players, with HR6 and HRR120 being the most stable parameters.

(*Journal of Trainology* 2017;6:31-34)

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Routledge
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ARTICLE

Reliability of heart rate responses both during and following a 6 min Yo-Yo IR1 test in highly trained youth soccer players

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ABSTRACT

Purpose: To examine the reliability of heart rate (HR) measures obtained during a 6-min Yo-Yo Intermittent Recovery Test Level 1 (Yo-Yo IR1), and following a 3-min passive recovery, within a group of highly trained youth soccer players

Methods: Eight players completed three separate 6-min Yo-Yo IR1 tests, with a passive recovery, over a 2-week period. Measures of absolute heart rate (bpm) and relative HR (%HR_{max}) were obtained at the 3rd and 6th min of the test, with measures relative to the end HR (%HR_{end}) 10, 20, 30, 60, 90, and 180 s, during the 3-min passive recovery. Variability in HR measures were assessed across successive trials (trial 1 vs. 2 and trial 2 vs. 3) and across all three trials, using the intraclass correlation coefficient (ICC), coefficient of variation (CV) and typical error (TE).

Results: HR measures obtained during the 6-min Yo-Yo IR1 test displayed good levels of reliability (ICC: 0.95–0.98, CV: 1.1–1.3% and TE: 0.96–2.44). Results, display a potential learning effect, with lower levels of variability between trial 2 and trial 3. Examination of %HR_{end} obtained during the passive 3-min recovery demonstrated an increased variance, as the passive-recovery period progressed.

Conclusion: The 6-min Yo-Yo IR1 test presents a novel and potentially practical approach to regularly assessing youth soccer players' physical response to intermittent exercise. Practitioners and researchers should, however, consider the need for appropriate familiarisation when undertaking this test.

ARTICLE HISTORY
Accepted 8 May 2018

KEYWORDS
Youth development; training; variance; fitness testing; fitness monitoring

Reliability and Validity of a Submaximal Warm-up Test for Monitoring Training Status in Professional Soccer Players

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Abstract

Rabbani, A, Kargarfard, M, and Twist, C. Reliability and validity of a submaximal warm-up test for monitoring training status in professional soccer players. *J Strength Cond Res* 32(2): 326–333, 2018–Two studies were conducted to

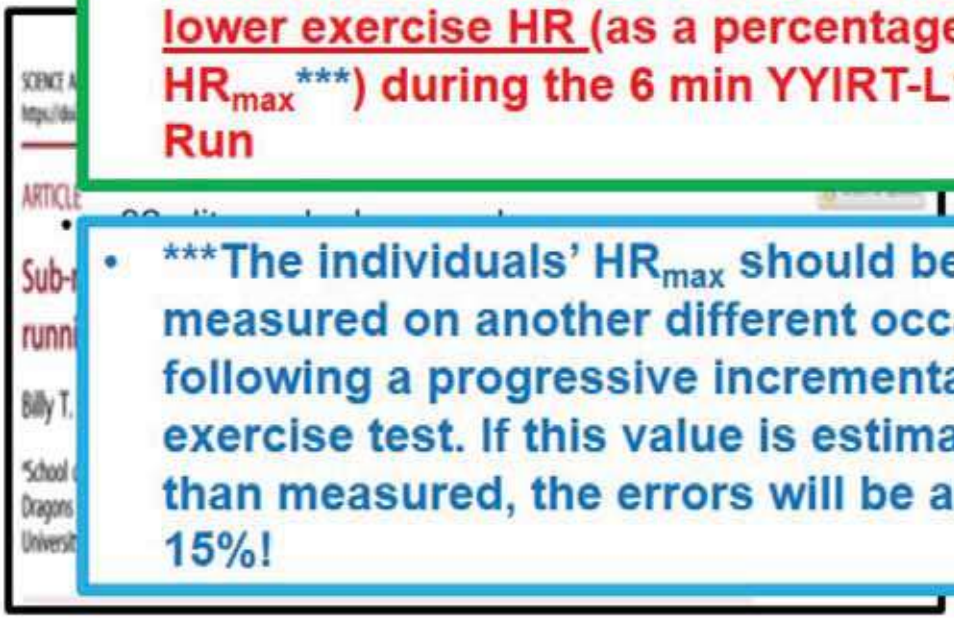
Key Words monitoring, high-intensity intermittent running performance, 30-15 intermittent fitness test, exercise heart rate, heart rate recovery

Introduction

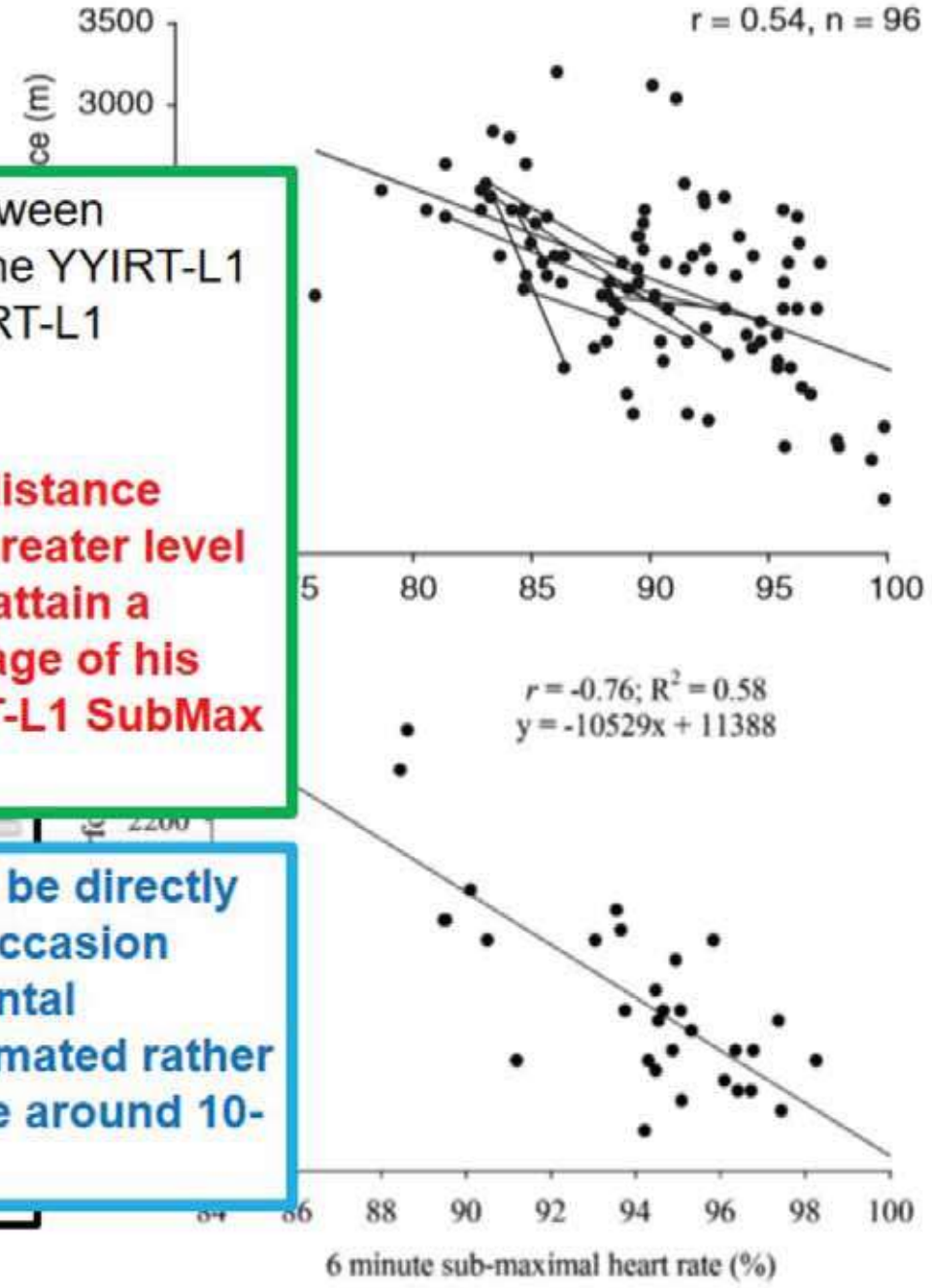
- Every individual has small variation in their YYIRT-L1 heart rate measures
- This amount of variation of is the "noise" of the test or coefficient of variation (or CV, between 1.5-2.2%; estimated to between 2-3 b·min-^{1})

- Significant negative correlation between maximal performance attained in the YYIRT-L1 and HR achieved in the 6 min YYIRT-L1 SubMax Run

- **Players who achieved a higher distance covered in the YYIRT-L1 (i.e., a greater level of aerobic fitness) also likely to attain a lower exercise HR (as a percentage of his HR_{max}***) during the 6 min YYIRT-L1 SubMax Run**



- ***The individuals' HR_{max} should be directly measured on another different occasion following a progressive incremental exercise test. If this value is estimated rather than measured, the errors will be around 10-15%!



REVIEW ARTICLE

Sports Med 2008; 38 (1): 37-51
0112-1642/08/0001-0037/$48.00/0

The Yo-Yo Intermittent Recovery Test

A Useful Tool for Evaluation of Physical Performance in Intermittent Sports

Jens Bangsbo,[1] *F. Marcello Iaia*[1,2] and *Peter Krustrup*[1]

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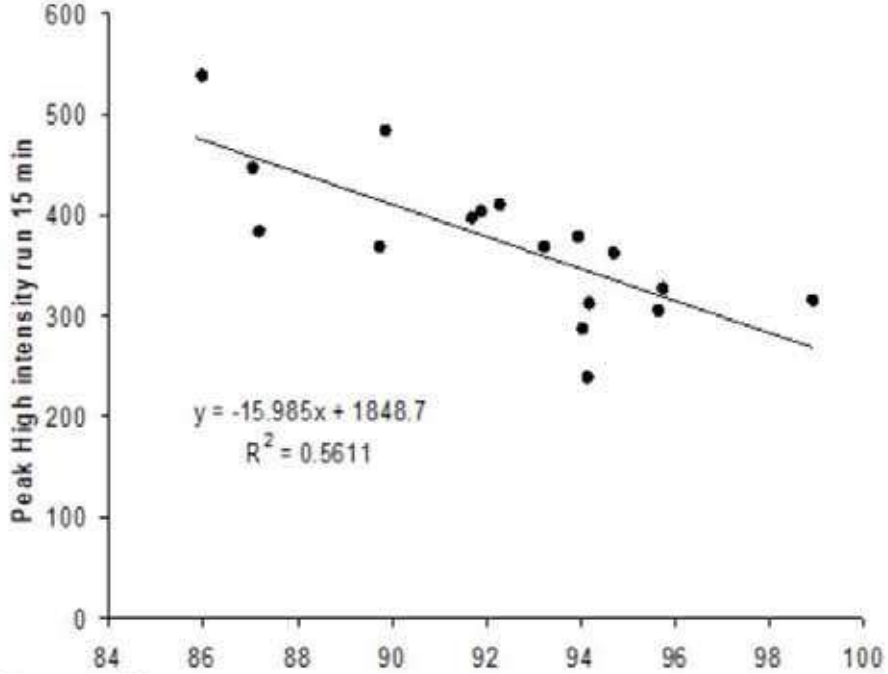
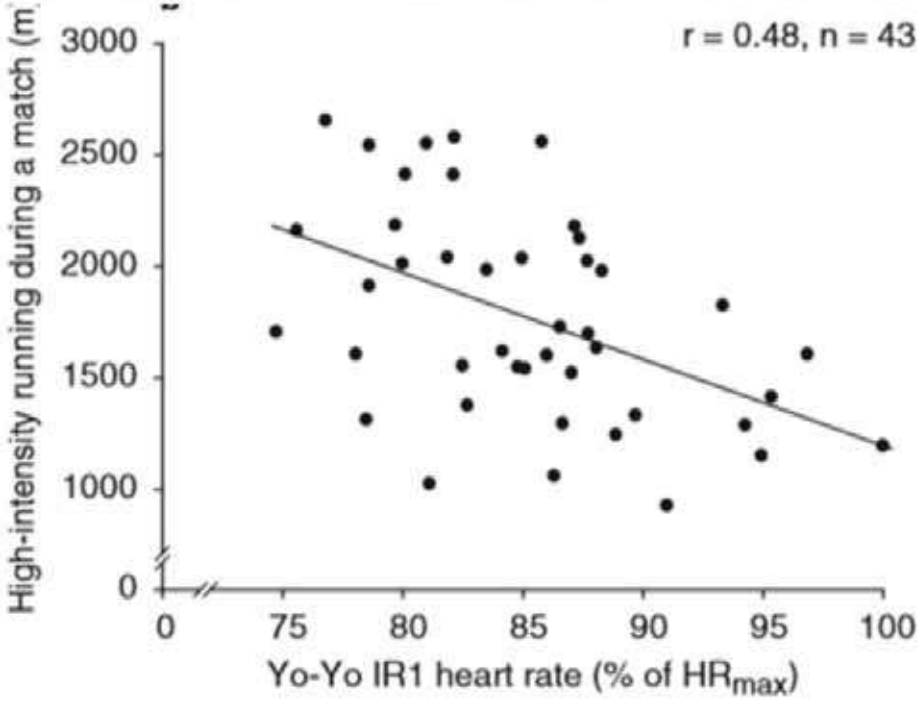


Lower exercising HR (in this example, calculated as a %tage of the individuals' HR_{max}) during the YYIRT-L1 SubMax Run is associated with a higher distance covered in high-intensity running during a match



Seasonal changes in HR during 6 min YYIRT-L1 SubMax run of individual elite soccer players

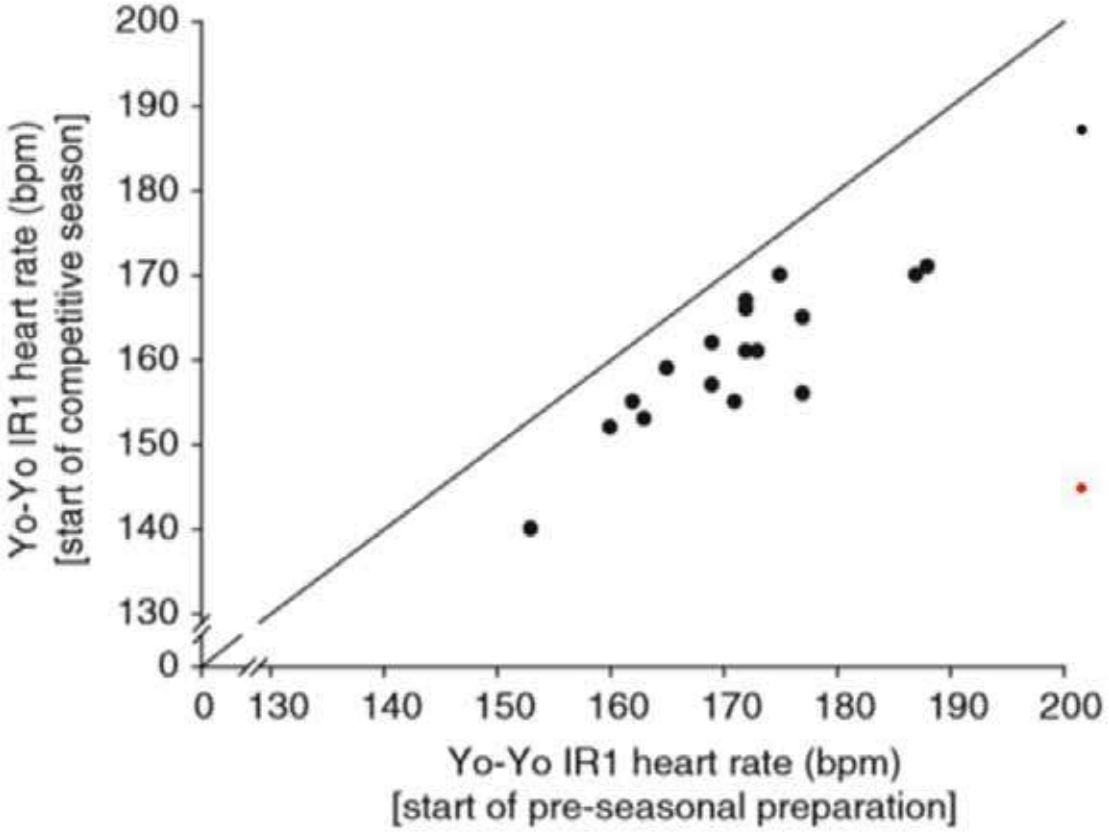


Fig. 16. Heart rate after 6 minutes of the Yo-Yo intermittent recovery level 1 (Yo-Yo IR1) test, expressed in beats per minute (bpm), at the start of pre-seasonal preparation and at the start of the competitive season for 17 Danish elite soccer players. The solid line is the line of identity (x = y).[15]

- Lower exercising HR at the start of pre-season vs. at the start of the competitive season – indication improvements in the players' levels of aerobic fitness
- HR measured at the end of YYIRT-L1 6 min Submax is sensitive to changes in fitness

4th AFC Conference on Science and Football Medicine
Kuala Lumpur | 18-20 March 2011

POSTER 59

IMPACT OF RAMADAN FASTING ON SUBMAXIMAL RUNNING PERFORMANCE OF PROFESSIONAL FOOTBALL PLAYERS

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University, Singapore.

- **Compare the aerobic fitness between fasting and non-fasting players over a 12 week period (4 weeks before, 4 weeks during and 4 weeks after the Ramadan month)**
- **Use the YYIRT-L1 Submax Run to track players aerobic fitness levels before, during and after Ramadan month.**
- **The study showed that HR achieved during the Submax run was able to track aerobic fitness levels of these players**

SCIENCE AND MEDICINE IN FOOTBALL, 2018
https://doi.org/10.1080/24733938.2018.1475748

Routledge
Taylor & Francis Group

ARTICLE

Sub-maximal heart rate is associated with changes in high-intensity intermittent running ability in professional rugby league players

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ABSTRACT

Objectives: We examined: (1) relationships among sub-maximal heart rate ($_{sub\text{-}max}$HR) following 4 minutes of the Yo-Yo intermittent recovery test level 1 (IR1) and maximal-effort performance (distance covered at volitional exhaustion), (2) test re-test reliability of $_{sub\text{-}max}$HR, and (3) whether changes in maximal-effort Yo-Yo performance are related with changes in $_{sub\text{-}max}$HR in professional rugby league players.

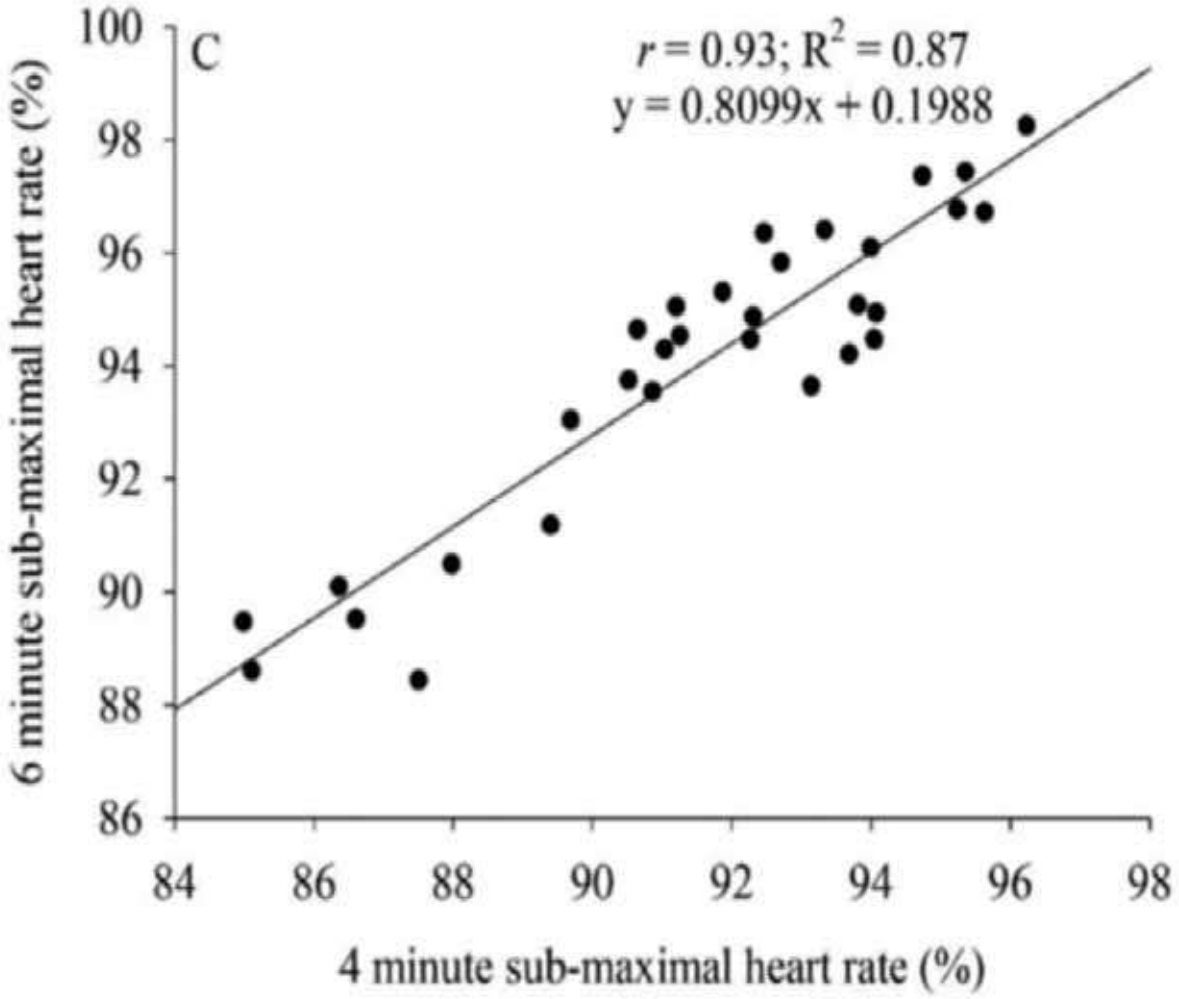
Methods: Yo-Yo IR1 performances of 32 players were assessed before and after 28.5 ± 6.8 days of pre-season training. Relationships between $_{sub\text{-}max}$HR and maximal-effort Yo-Yo performance, and changes in maximal-effort performance and $_{sub\text{-}max}$HR were compared.

Results: Maximal-effort Yo-Yo IR1 performance and $_{sub\text{-}max}$HR correlated negatively (r = −0.73, CI −0.85 to −0.55, *very large*). Coefficient of variation (CV) of $_{sub\text{-}max}$HR was 2.4% (CI 2.0–3.3%), worthwhile changes of *small* (0.7 [CI 0.5–1.0%]), *moderate* (2.1 [CI 1.6–3.0%]) and *large* (4.3 [CI 3.3–6.1%]) were identified. Training-induced changes in $_{sub\text{-}max}$HR and Yo-Yo IR1 performance displayed a negative correlation (r = −0.57, CI −0.74 to −0.33, *large*).

Conclusions: $_{sub\text{-}max}$HR has a *very large* negative relationship with maximal-effort Yo-Yo IR1 performance. Training-induced changes in $_{sub\text{-}max}$HR demonstrated a *large* negative relationship with changes in Yo-Yo IR1 performance. The CV and worthwhile changes can determine meaningful variations in $_{sub\text{-}max}$HR in professional rugby league players.

ARTICLE HISTORY
Accepted 8 May 2018

KEYWORDS
Validity; reliability; monitoring; fitness


C
$r = 0.93$; $R^2 = 0.87$
y = 0.8099x + 0.1988
6 minute sub-maximal heart rate (%)
4 minute sub-maximal heart rate (%)
100
98
96
94
92
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88
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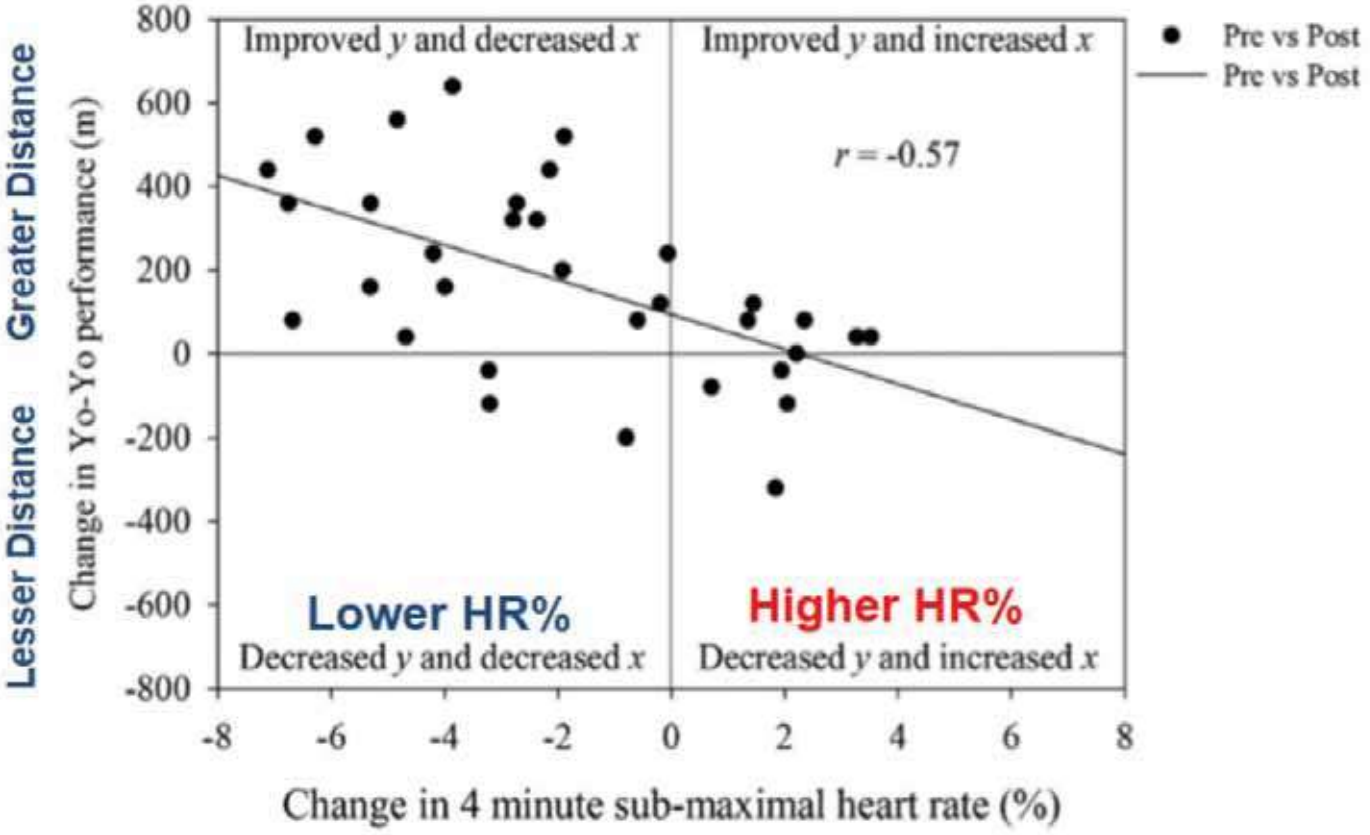


Figure

- **Change in YYIRT-L1 performance (as reflected either by an increase or decrease in relative HR during the YYIRT-L1 Submax test) showed a corresponding change their maximal performance in the YYIRT-L1**

rt and changes in maxi isons of testing conduct ranged from a minimu 5 ± 6.8 days), $r = -0.$

6 min YYIRT-L1 SubMax run Interpretations

- Mean HR for the last 30 s of the run is used ($b \cdot min^{-1}$)
  [to allow HR to reach a steady-state during exercise, usually between 75-90% of individual HR_{max}]
- To compare WITHIN player = use absolute HR values attained during the test – a lower absolute HR vs. previous test results means aerobic fitness has improved
- Implication: individual must improve by 4 $b \cdot min^{-1}$ or more compared to their previous performance is deemed as a substantial physiological significant (OR a REAL or ACTUAL performance effect has occurred in the individual)
- To compare BETWEEN players, use %tage of the individual's HR_{max} - lower %tage of individual's HR_{max} means aerobically fitter (Note: need to be determined directly; estimating the individuals' HR_{max} will add errors to theis calculation

YYIRT-L1 vs. 6 min YYIRT-L1 SubMax run: Which one?

- Both.
- Use the Maximal test once every 3-4 months
- Monitor the same individual's progress using the SubMax run test every 3-4 weeks – can easily include this non-exhaustive test as part of the warm-up for the session

Repeated Testing to Monitor Players' Performance

- As similar as possible in environmental conditions, footwear, warm-up, well-rested conditions, etc., as in the previous testing conditions
- Test administration e.g. instructions must be standardized
- At the same location, same warm-up, etc,
- At the same time of day test
- Provide result of previous performance – for comparison

Prescribing Aerobic Training for Intermittent Sports

Aerobic endurance training improves soccer performance

JAN HELGERUD, LARS CHRISTIAN ENGEN, ULRIK WISLØFF, and JAN HOFF

Norwegian University of Science and Technology, Department of Sport Sciences, N-7491 Trondheim, NORWAY

ABSTRACT

HELGERUD ...nce. *Med. Sci. Sports Exerc.* ...erobic training on performan... 18.1 ± 0.8 yr, randomly ass... ...erobic training consisted of ... per week for 8 wk. Players w... up: a) maximal oxygen uptak... ...ctate threshold improved fro... ...proved by 6.7% ($P < 0.05$); d... ...ts increased by 100% ($P < 0$... during a soccer match, meas... h) no changes were found i... ...asses after the training period. The control group showed no changes in any of the tested parameters. **Conclusion:** Enhanced aerobic endurance in soccer players improved soccer performance by increasing the distance covered, enhancing work intensity, and increasing the number of sprints and involvements with the ball during a match. **Key Words:** $\dot{V}O_{2max}$, LACTATE THRESHOLD, RUNNING ECONOMY, SKILL

The study's specific aerobic training consisted of running interval training, 4 x 4 min at 90–95% of HR_{max}, with a 3-min jog in between (at around 60-70% HR_{max}), performed twice per week for 8 week

– still somewhat of a continuous type of exercise; with the lacked of the key "intermittent" pattern of the sport

Sprint vs. Interval Training in Football

Authors D. Ferrari Bravo[1], F. M. Impellizzeri[1,2], E. Rampinini[1], C. Castagna[1], D. Bishop[4], U. Wisloff[5]

Affiliations The affiliations are listed at the end of the article

Key words
- soccer
- aerobic power
- anaerobic training
- specific endurance

Abstract

The aim of this study was to compare the effects of high-intensity aerobic interval and repeated-

height and power, and RSA. Significant group × time interaction was found for YYIRT ($p = 0.003$) with RSG showing greater improvement (from 1917 ± 439 to 2455 ± 488 m) than ITG (from

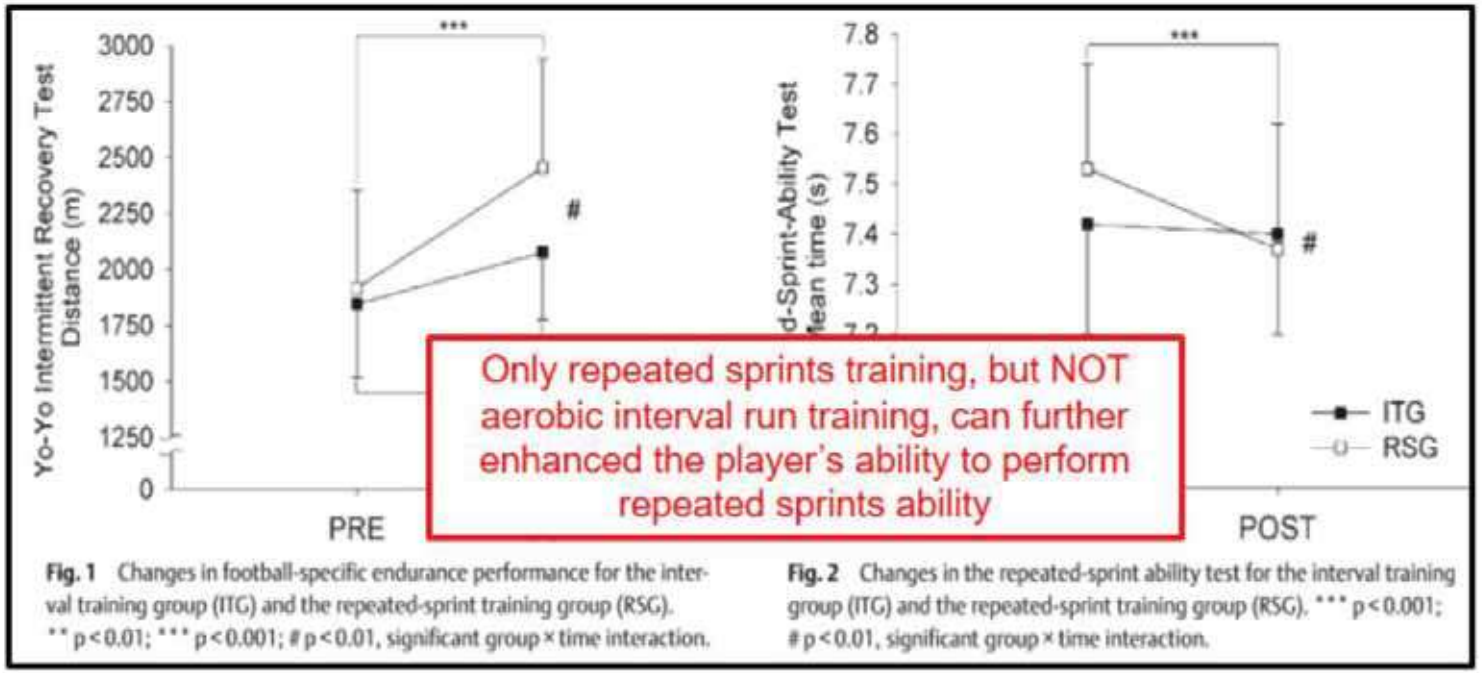
- Comparison between 2 groups
  - Interval training (ITG, 4 × 4min running at 90–95% of HR_{max}; n=21) vs.
  - Repeated-sprint training (RSG, 3×6 maximal shuttle sprints of 40 m; n=21).

- Training was twice a week for 7 weeks of training + 2-3 football specific sessions

Table 1 Effects of high-intensity aerobic interval training and repeated sprint training on aerobic fitness, jumping and sprinting abilities

Variables	Interval training group (n = 13)		Repeated sprint group (n = 13)		Inter-action	Effect size
	Pre	Post	Pre	Post	p level	η^2
Aerobic fitness						
$\dot{V}O_{2max}$ ($L \cdot min^{-1}$)	3.94 ± 0.32	4.21 ± 0.42	3.99 ± 0.48	4.18 ± 0.56	0.404	0.029
$\dot{V}O_{2max}$ ($mL \cdot kg^{-1} \cdot min^{-1}$)	52.8 ± 3.2	56.3 ± 3.1	55.7 ± 2.3	58.5 ± 4.1	0.581	0.013
$\dot{V}O_{2max}$ ($mL \cdot kg^{-0.75} \cdot min^{-1}$)	155.0 ± 7.8	165.4 ± 9.1	161.9 ± 7.9	169.9 ± 12.4	0.524	0.017
$\dot{V}O_2$ at RCP ($L \cdot min^{-1}$)				0.43	0.631	0.010
$\dot{V}O_2$ at RCP ($mL \cdot kg^{-1} \cdot min^{-1}$)				4.1	0.796	0.003
$\dot{V}O_2$ at RCP ($mL \cdot kg^{-0.75} \cdot min^{-1}$)				11.5	0.749	0.004
Power measurements						
Countermovement jump height (cm)				3.0	0.567	0.014
Countermovement jump peak power ($W \cdot kg$				5.1	0.486	0.020
Squat jump height (cm)				3.1	0.457	0.023
Squat jump peak power ($W \cdot kg^{-1}$)	53.3 ± 4.7	53.7 ± 4.0	51.8 ± 5.7	53.4 ± 4.6	0.335	0.039
10-m sprint time (s)	1.77 ± 0.06	1.77 ± 0.06	1.77 ± 0.06	1.76 ± 0.06	0.458	0.023

Both continuous aerobic interval runs and repeated sprints type of training, improved a football player's aerobic fitness – and no difference between groups in the magnitude of training-induced improvements



Only repeated sprints training, but NOT aerobic interval run training, can further enhanced the player's ability to perform repeated sprints ability

Fig. 1 Changes in football-specific endurance performance for the interval training group (ITG) and the repeated-sprint training group (RSG). ** p < 0.01; *** p < 0.001; # p < 0.01, significant group × time interaction.

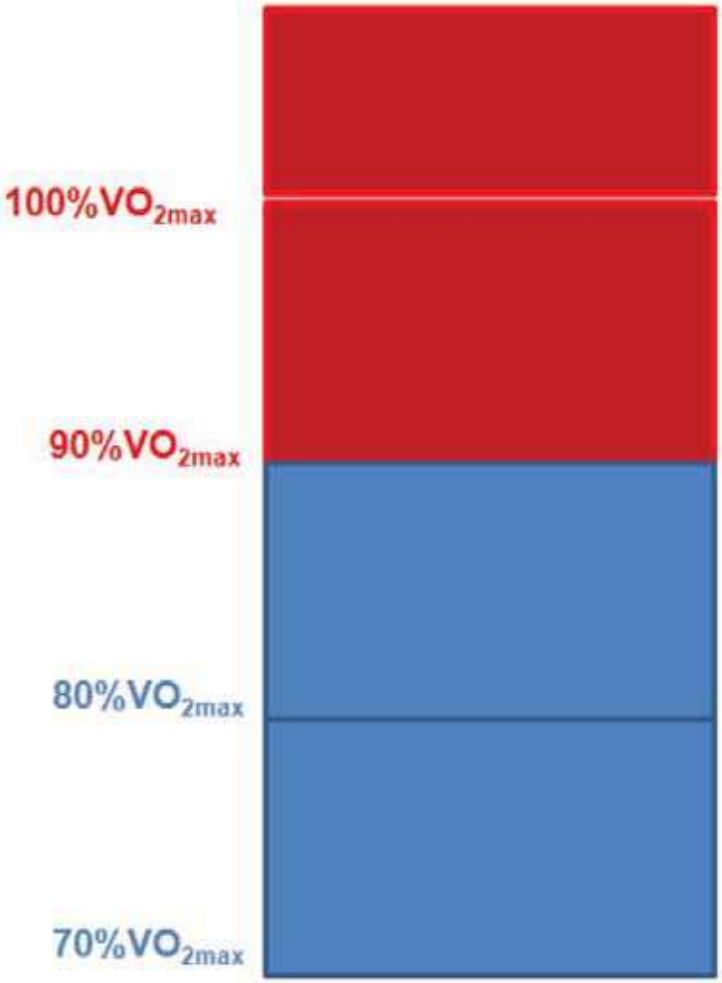
Fig. 2 Changes in the repeated-sprint ability test for the interval training group (ITG) and the repeated-sprint training group (RSG). *** p < 0.001; # p < 0.01, significant group × time interaction.

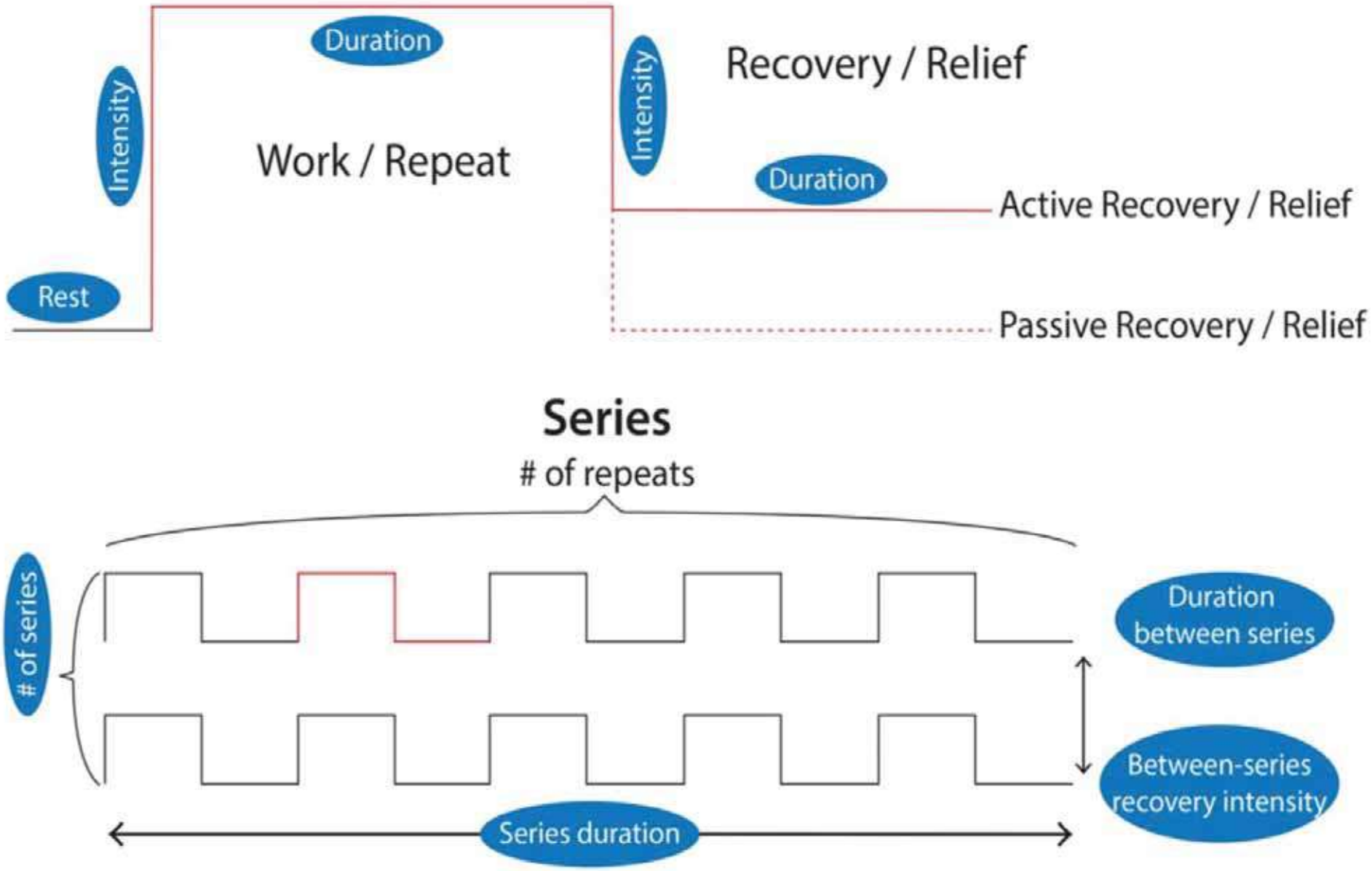
How to improve Maximal Aerobic Power using the shorter intermittent exercise protocol

- A school of thought suggests that to improve VO_2max and vVO_2max (maximal aerobic speed or MAS), the training sessions should accumulate as much time at (or close to) and above VO_2max (Red Zone) [*Buchheit & Laursen, 2013*]

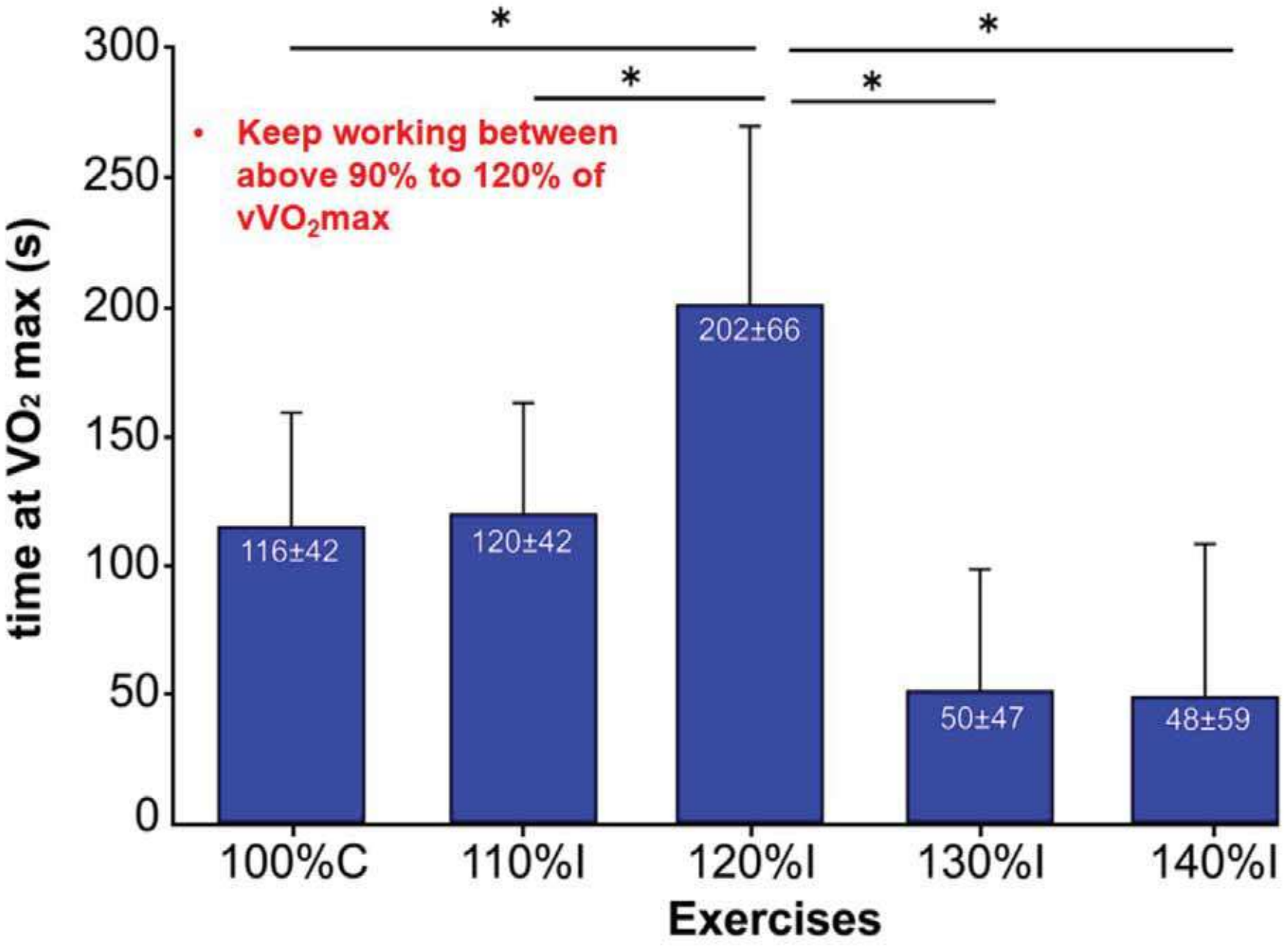
- The more time you spent "exercising" in the red zone, the greater the mechanical and metabolic stimulus on your cardiovascular and muscular-metabolic systems, and hence, the greater will be your training-induced adaptations.

- **Intensity of the exercise bout is inversely proportional to the duration of the bout**





Adapted from Buchheit & Laursen. 2013, Sports Med, p.316.



Dupont et al. 2002 CJAP, p.109

Determining MAS in intermittent sports athletes

- Determining the player's **Maximal Aerobic Speed** (MAS) = Velocity at which the person is in the VO_{2max} zone
- Use a 2000 m continuous run (Bellenger et al. 2005)
- For example, covered 2.0 km in 8 min 20 seconds
- MAS = 2000 m / 660 s + 20 s
  = 4.0 $m \cdot s^{-1}$ (this is the distance to be covered every second)
- 100% MAS = 4.0 $m \cdot s^{-1}$
  120% MAS = 4.0 x 1.2 = 4.8 $m \cdot s^{-1}$
- Separate the entire team into 3 groups of different levels of "aerobic fitness abilities" LOW, MODERATE and HIGH

Aerobic Fitness Grouping	2000m Distance	100% MAS	120%MAS
LOW	8 min 20 s	4.0 $m \cdot s^{-1}$	4.8 $m \cdot s^{-1}$
MODERATE	8 min 55 s	4.4 $m \cdot s^{-1}$	5.3 $m \cdot s^{-1}$
HIGH	7 min 5 s	4.7 $m \cdot s^{-1}$	5.6 $m \cdot s^{-1}$

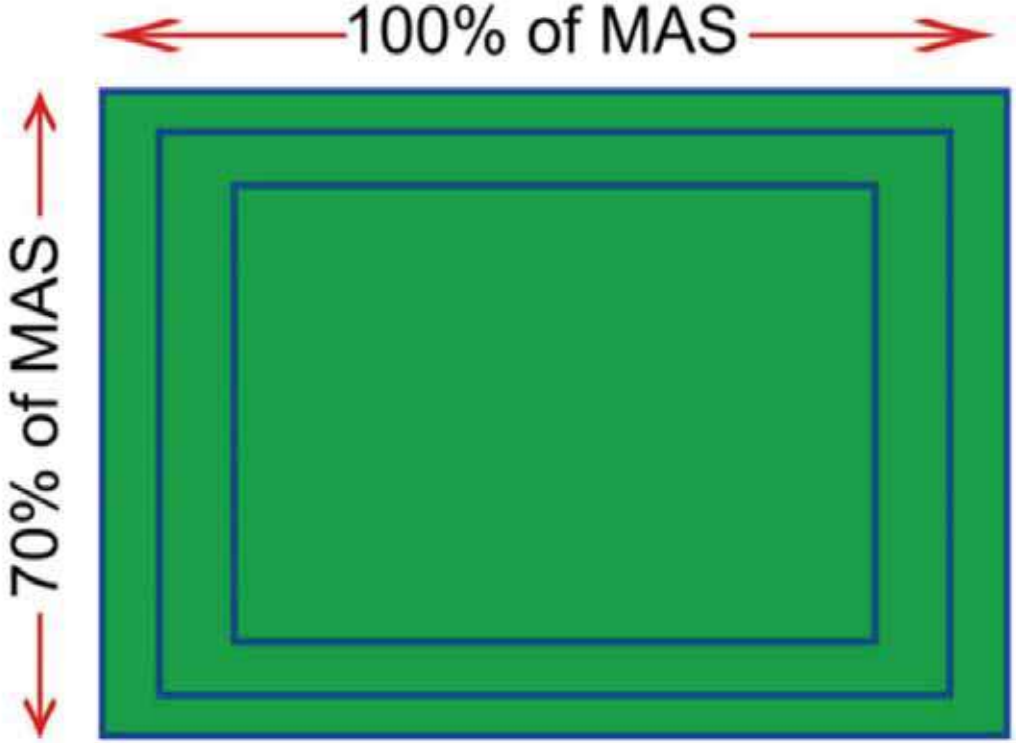
Can we use the YYIRT-L1 to determine MAS?

- Peak velocity of YYIRT-L1 and MAS should not be used interchangeably
- Below a speed of 16.3 $km.h^{-1}$ YYIRT-L1 tend to be higher than MAS with the opposite above 16.3 $km.h^{-1}$ (Dupont et al. 2010, J Sci Med Sport)

Aerobic Interval Trainings to Improve Maximal Aerobic Speed and VO_2max

Maximal Aerobic Grid method

- Run 15 s at 100% MAS with 15 s of active recovery (slow jog) at 50-70% MAS. W:R ratio is 1:1
- Do this running continuously for 5 min per set for 2-3 sets with 3 min rest between sets.
- Progress to 7-8 min per set. Add 1-2 additional set.
- Grid design is based on groups' different abilities – fitter individuals on the outside grid and less fit individuals inside grid – both groups will always end and start at one of the corners – allowing ease of management
- Using whistle to indicate the 15 s work and 15 s recovery timings



LOW: 4.0 m·s-^{1}x 15 s = 60 m; 2.8 m·s-^{1}x 15 s = 42 m

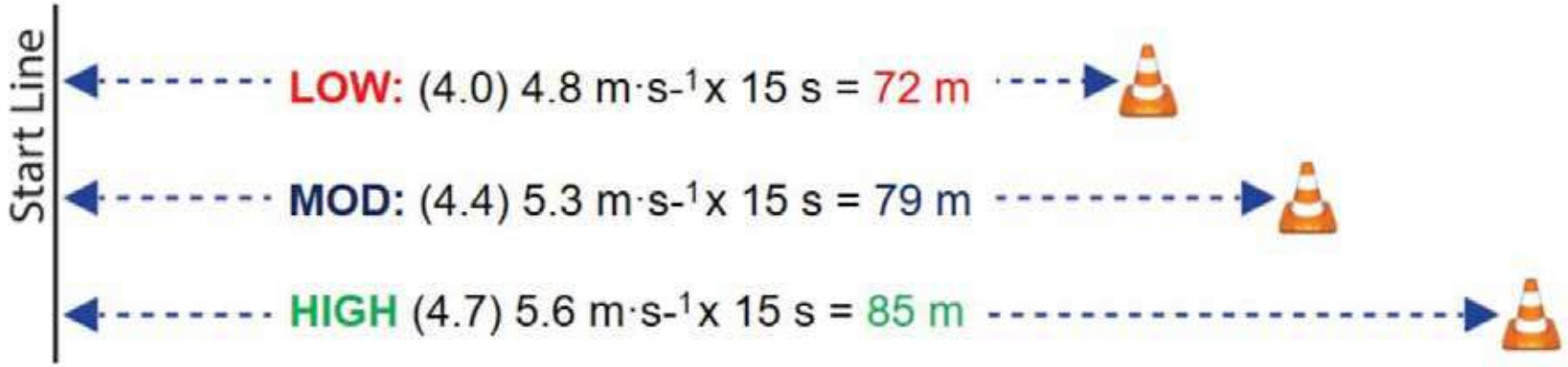
MOD: 4.4 m·s-^{1}x 15 s = 66 m; 3.1 m·s-^{1}x 15 s = 46 m

HIGH: 4.7 m·s-^{1}x 15 s = 70 m; 3.3 m·s-^{1}x 15 s = 49 m

Source: Baker 2015 on-line Article.

Eurofit method

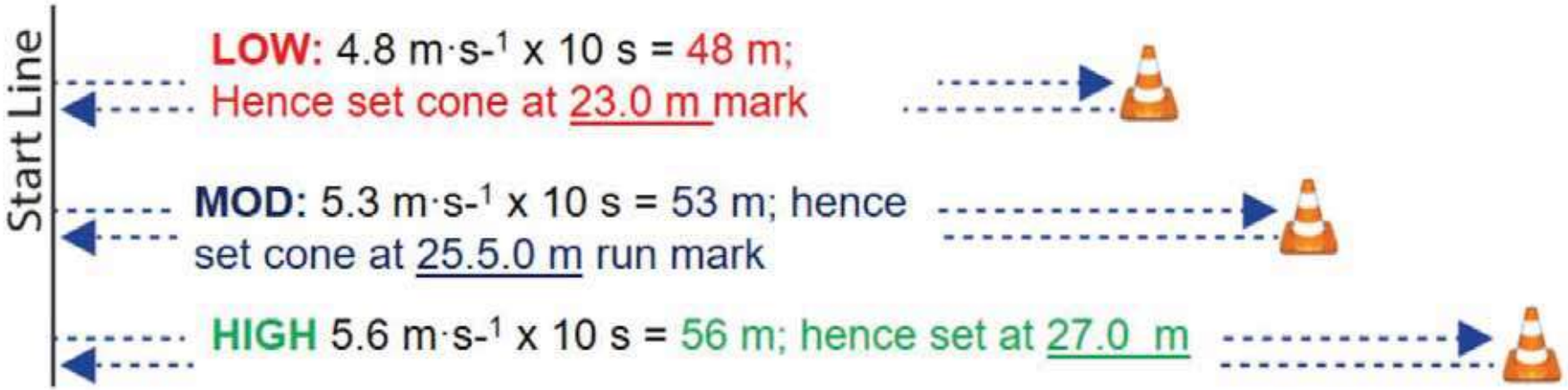
- Calculate the distance to be covered for 15 s at 120% MAS for each group
- Spread the team into groups. Run to first marker within 15 s, rest 15 s and then run back 15 s, and keep repeating until complete 5 min of exercise. 3 min passive rest between sets. Work: Rest is 1:1
- Easy to manage and control session since all athletes start and stop at the cones
- Start with 5 min of exercise per set for 1-2 sets. Build –up to 8-10 min per set and increase to 3-4 sets only. Thereafter may progress runs to intensity of 130% or 140% MAS



Source: Baker 2015 on-line Article.

Tabata Out & Back method

- Calculate the distance to be covered for 10 s at 120% MAS for each group
- Spread the team into groups. Run to marker within 10 s, pivot-turn quickly and run back for 10 s to start point. Passive rest for 10 s and repeat until complete 5 min of exercise time. 3 min passive rest between sets. Work: Rest is 20s:10 s or 1:0.5
- Start with 5 min of exercise per set for 1-2 sets. Build –up to 8-10 min per set and increase to 3-4 sets only. Thereafter may progress runs to intensity of 130% or 140% MAS
- Distance set is slightly shortened by 0.5 – 1 m to allow deceleration and loss of speed when turning/pivoting at the cone



Source: Baker 2015 on-line Article.

Progressive Overload of Sprints

- Higher speeds to be performed
- Longer run/sprint distances
- More repeats or bouts and/or sets
- Less recovery time between repeats and/or sets
- Add resistance or overload (but must NOT too heavy and will negatively influence the individual's biomechanical movement pattern during sprints

Variety

- Mix things up once every 2-3 weeks, by manipulating the various exercise variables :
  - Intensity of sessions
  - Active versus passive recovery
  - Use Small Sided Games – like an interval exercise session
  - Modified Tabata intervals
  - Repeated sprint sessions – maximal sprints with passive recoveries

Acknowledgement

Recent trends in high-intensity aerobic training for field sports

Dan Baker PhD, ASCA Level 3 Master Coach of Elite Athlete Strength & Conditioning.

Introduction

Field sports such as football, team handball, hockey, rugby union and rugby league, Australian & Gaelic Rules football are characterised by a typically stop-start nature, with varying movement speeds, multiple changes of direction and the execution of decisions and individual skills under conditions of game pressure and/or fatigue. The nature of the movements in these sports requires the utilisation, and therefore training, of all three energy systems (ATP-PC, Glycolitic/Lactic acid and Aerobic systems). Despite the often stop-start nature of these sports, which heralds an increase in anaerobic energy contributions[5], high-intensity aerobic power and conditioning can be critical for success in many field sports.[5,6,7]

Due to the high-intensity and less predictable nature of movement of field sports compared to steady state "aerobic" long-distance sports (eg. triathlon, distance running, cycling, swimming etc), the aerobic and anaerobic conditioning for these sports should differ considerably to the aerobic requirements of "steady state" long-distance sports. To address this, there now appears to be a growing trend towards utilising recent research and training trends to fully develop the high-intensity aerobic power of the field sport athletes.[8]

Historical approach to aerobic conditioning training

Anecdotal evidence gathered by the author suggests that, historically conditioning coaches for field sports would look at the aerobic conditioning programmes of elite steady-state aerobic athletes and basically attempt to mimic these by implementing long, slow distance training (LSD) for 20–40 minutes or more, at intensities equivalent to zones 2 and 3 (and sometimes the more difficult "anaerobic threshold" (AT) or "critical speed" zones from zone 4) listed in *Table 1*. In practical training terms, the AT and critical speed are the highest speed that can be maintained in a single prolonged effort.[9]

The nature of field sports however, is that there are important explosive

- A/Prof Mike Newton, Adjunct Professor at Murdoch University, Perth for his suggestions and inputs

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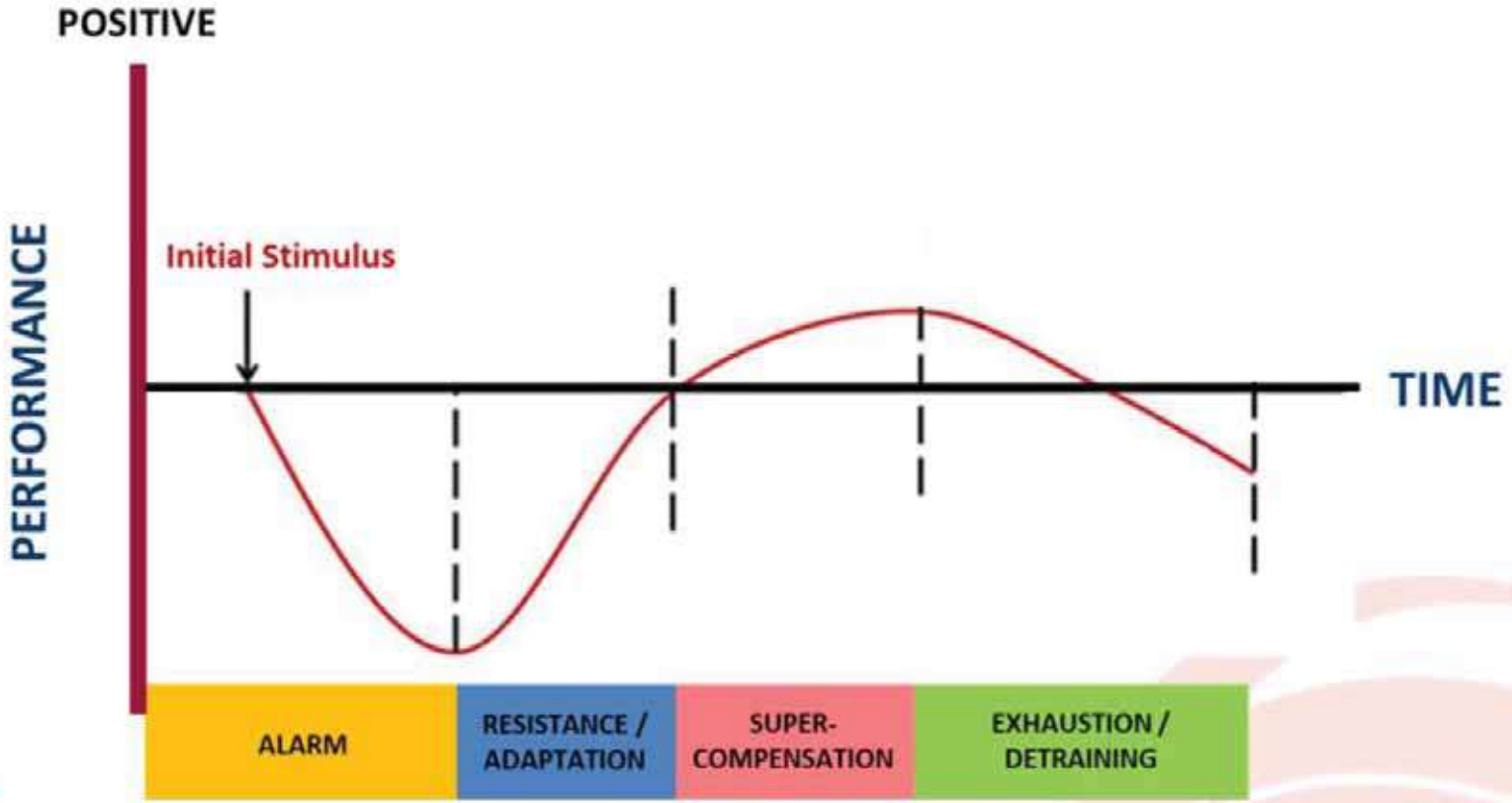
Theory of Training and Performance

General Adaptation Curve



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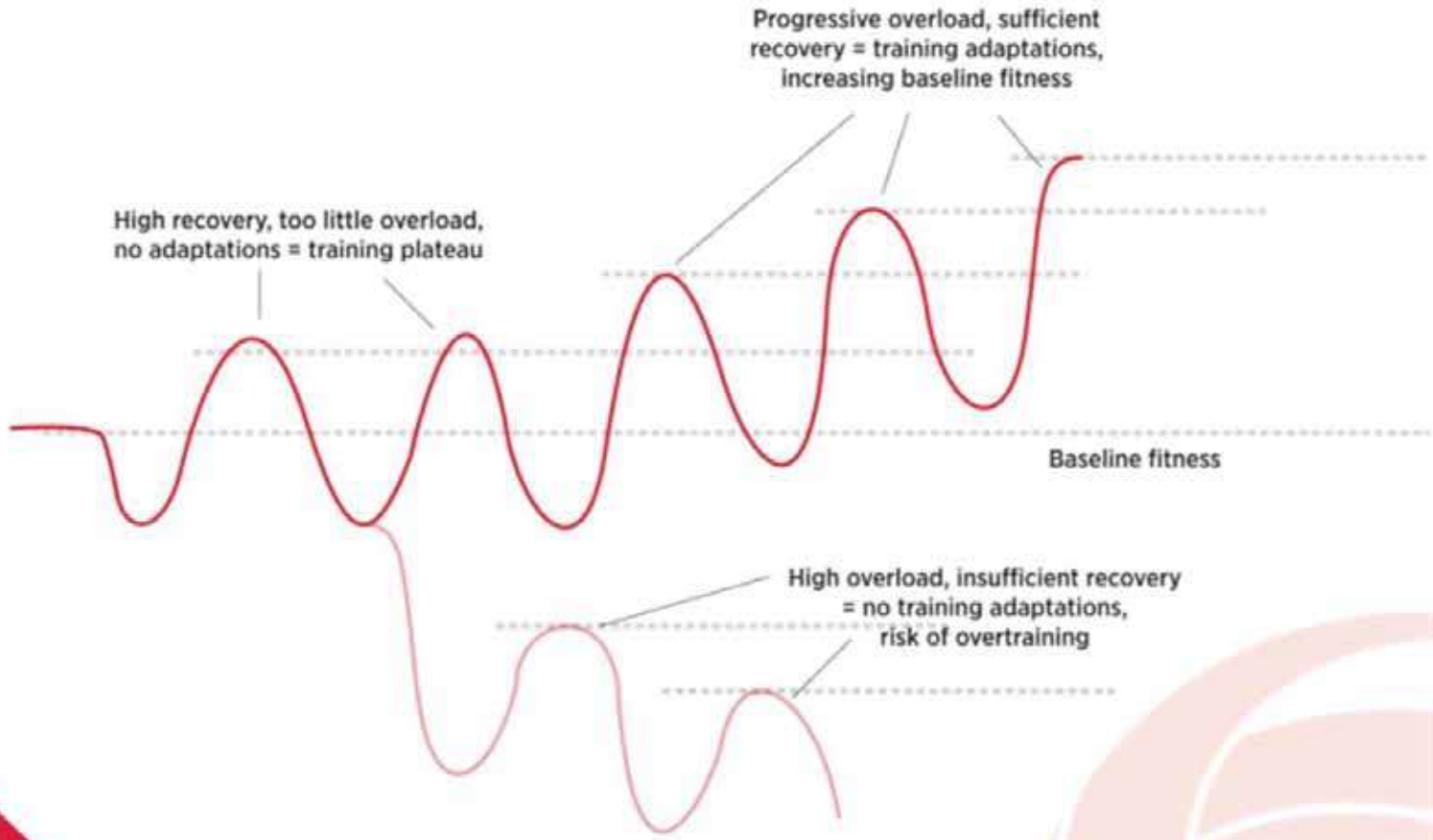
General Adaptation Curve



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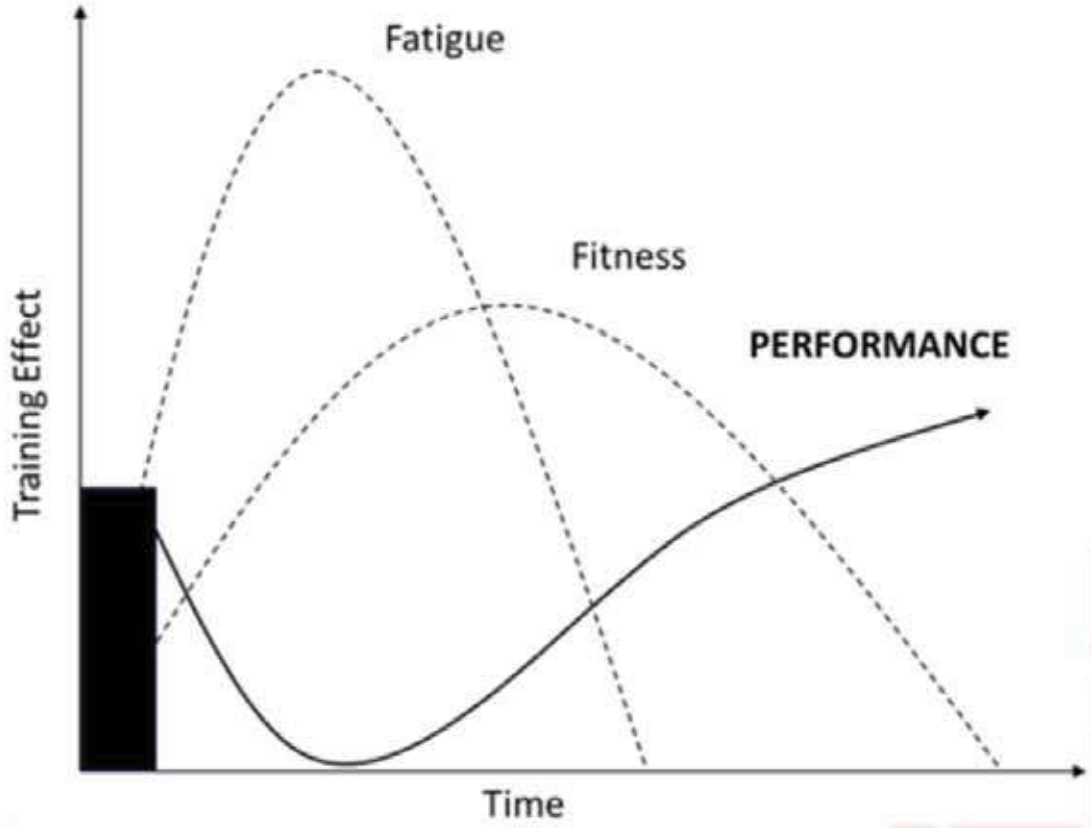
Training Does Response

Performance = Fitness - Fatigue



(Coutts, Crowcroft & Kempton, 2017)

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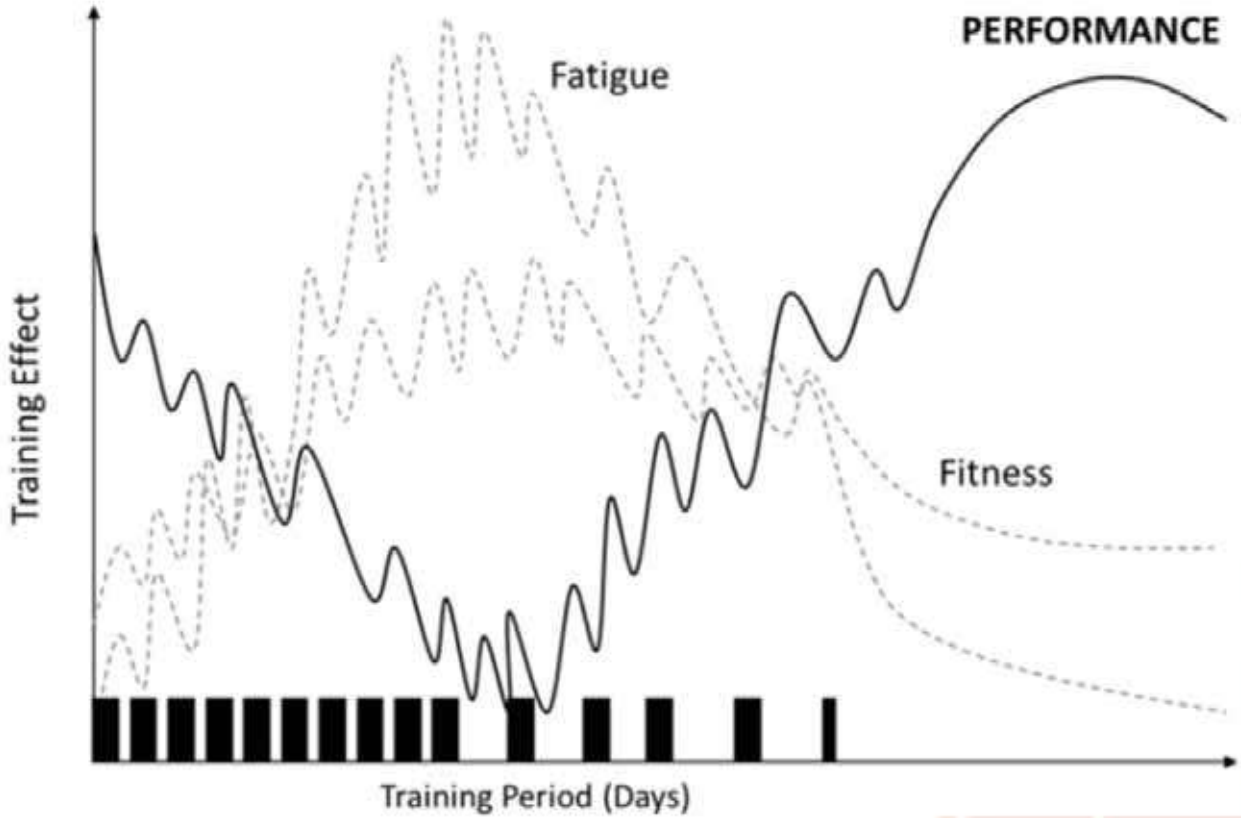
Training Response



(Coutts, Crowcroft & Kempton, 2017)

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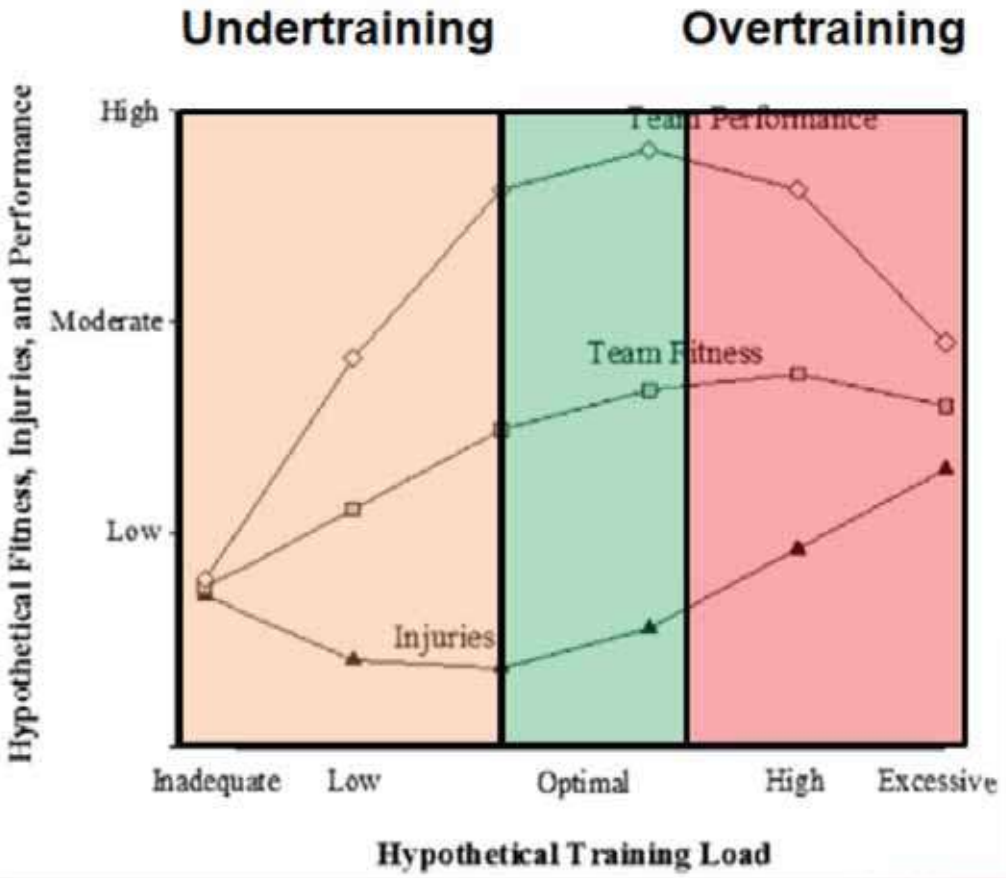
Training Load and Injury



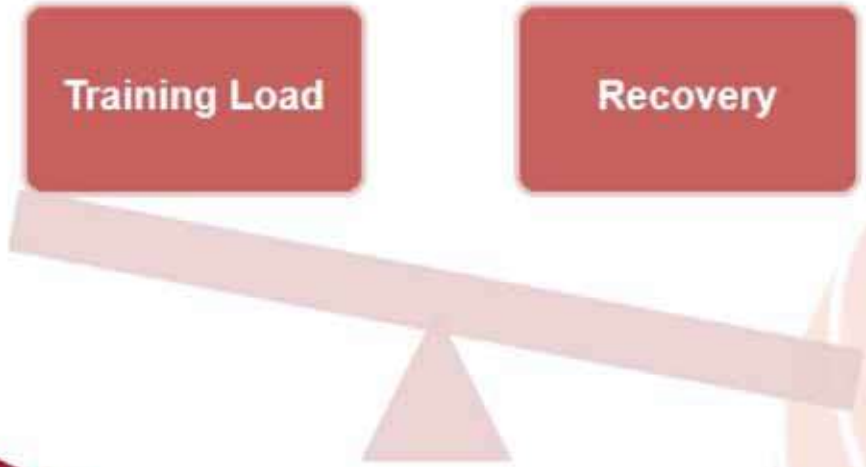
(Gabbett, 2016)

Modeling Training Load

Performance = Fitness – Fatigue

- Beep Tests
- VO_2max
- Repeated Sprints

- Psychological
- Neuromuscular
- Physiological



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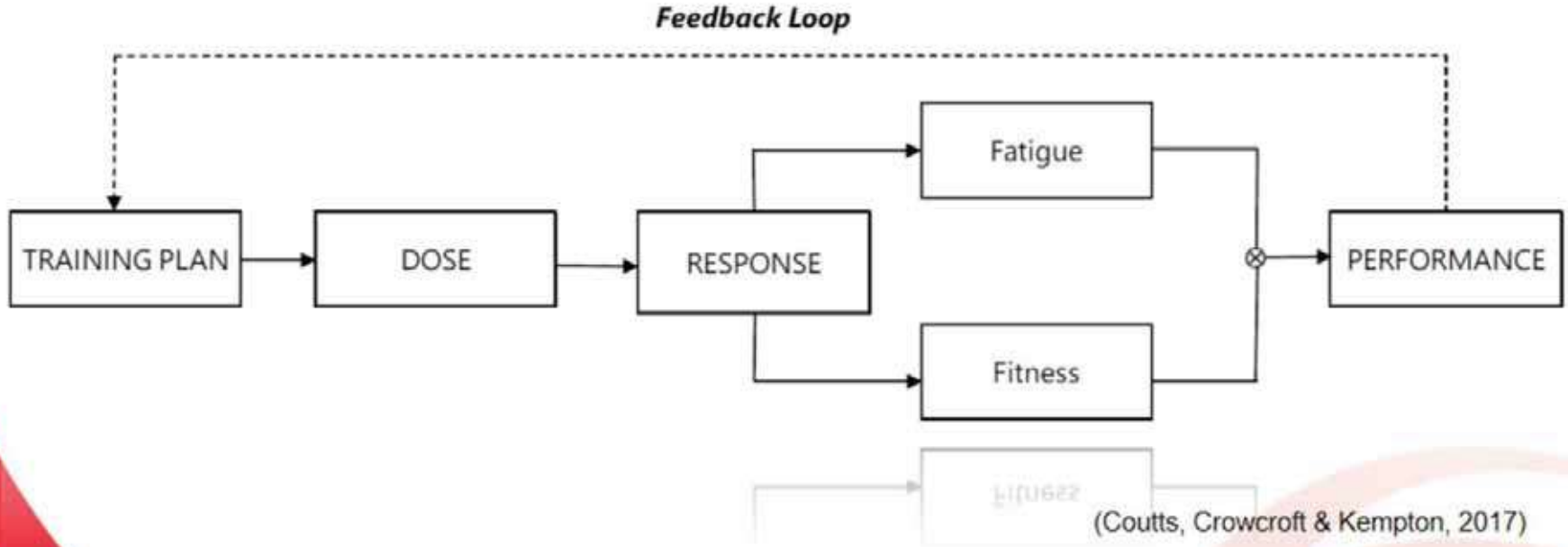
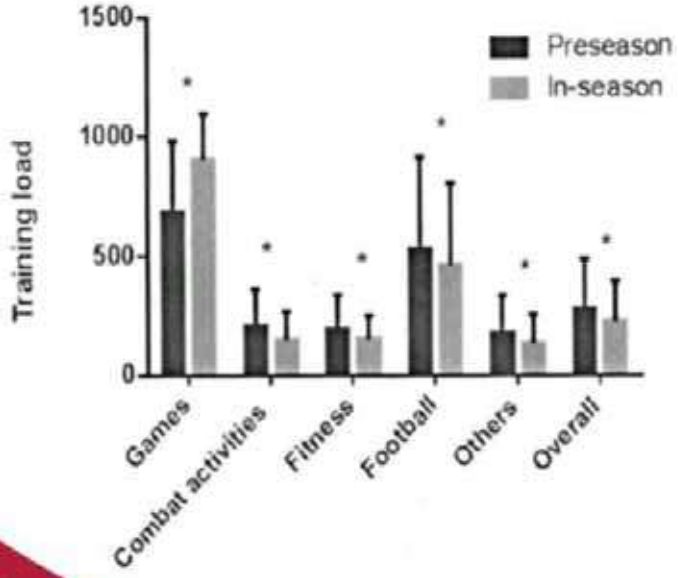
Training Monitoring

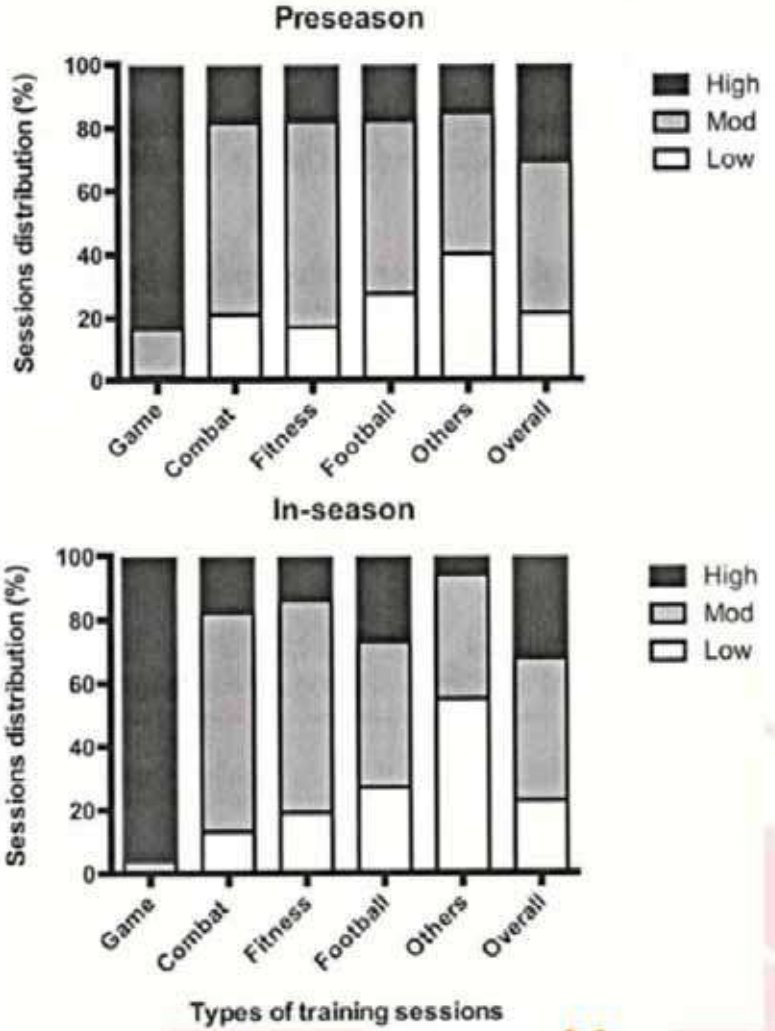


(Coutts, Crowcroft & Kempton, 2017)

Training Monitoring

- Training Monitoring at different phases of the season





(Moreia et al., 2015)

Training Load Monitoring

External Load

- What the athlete did for the session

Credit: Catapult

Credit: IMeasureU

Credit: Babolat

Credit: Catapult

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Internal Load

- How an athlete responds to the training

- Fatigue - Fitness Response

Credit: Google Images

Credit: Cosmed

Credit: 2020genesystems

RPE SCALE	
1	Nothing
2	Very Easy
3	Easy
4	Comfortable
5	Somewhat Difficult
6	Difficult
7	Hard
8	Very Hard
9	Extremely Hard
10	Maximal/Exhaustion

Credit: AussieCoachBoard

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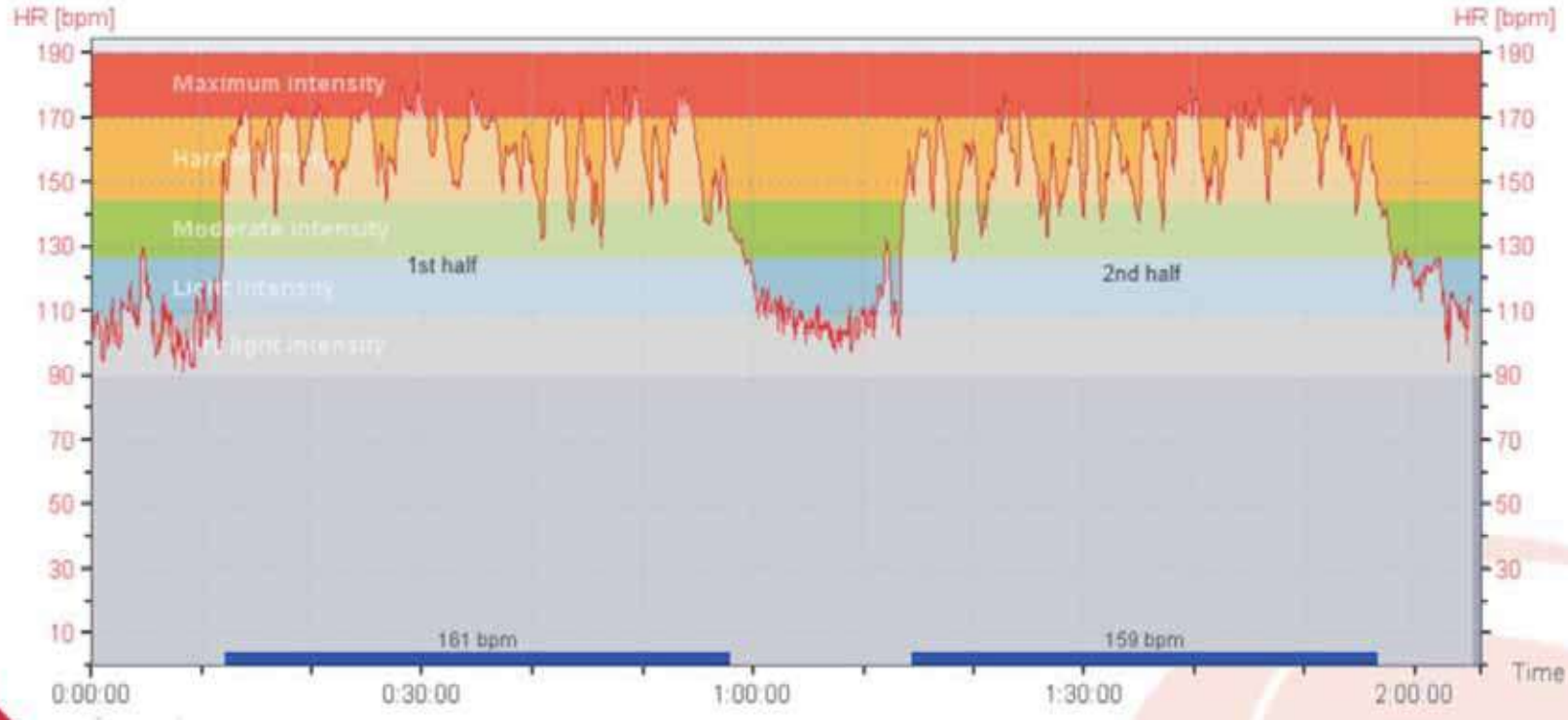
Heart rate Monitoring



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Session RPE

- Subjective rating of exertion

Table 2 The Modified Borg Category Ratio-10 Rating of Perceived Exertion Scale[18]

Rating	Descriptor
0	rest
1	very, very easy
2	easy
3	moderate
4	somewhat hard
5	hard
6	
7	very hard
8	
9	
10	maximal

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Session RPE

- Measurement of HR and RPE in Professional football players

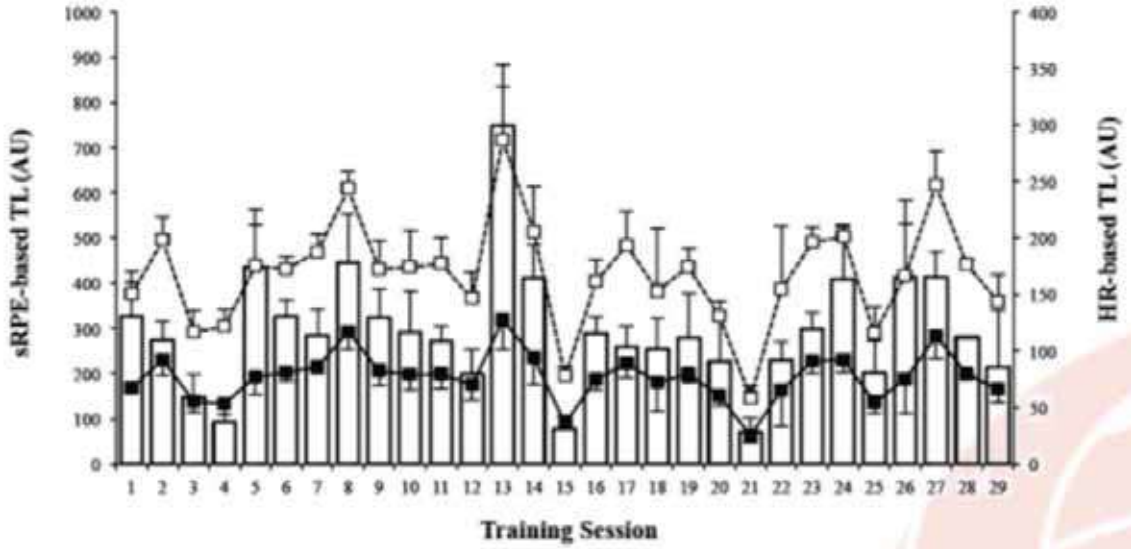

Figure 1 — Internal training load (TL) of professional soccer players (N = 15) during in-season field-training sessions, mean ± SD. AU indicates arbitrary units; white bars, session rating of perceived exertion (sRPE) TL; black boxes on solid line graph, Banister's training impulse (TRIMP); white boxes on dotted line graph, Edwards' TRIMP.

(Scott et al., 2013)

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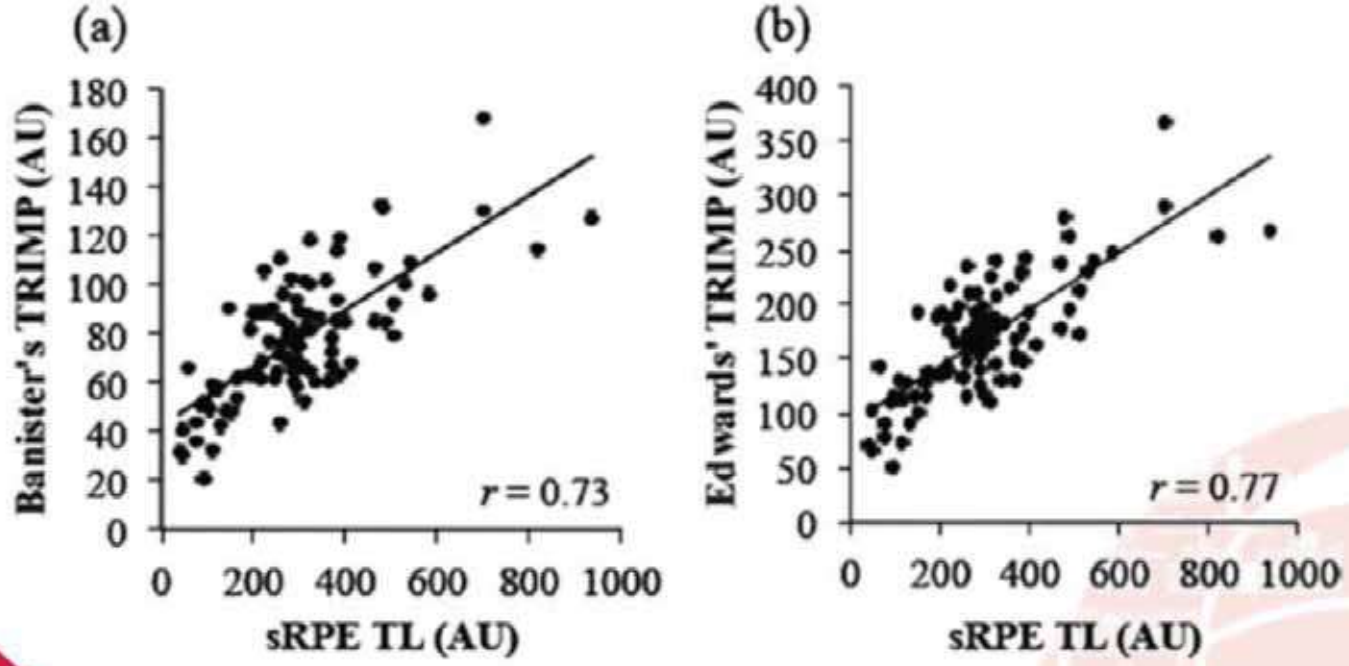
Session RPE

- Measurement of HR and RPE in Professional football players



(Scott et al., 2013)

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Injury Rates and RPE

- Rugby players and RPE measured during training and competition.

(Gabbett, 2004)

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Calculating Training Load

Training Load = Intensity * Duration

Intensity	Duration
How hard was the session?	The volume of the training session
• Heart Rate	• Sets, Repetitions
• Session RPE	• Duration

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Quantifying Training Load

Day	Training Activity	Session RPE	Session Duration (min)	Load
Monday	Technique	6	55	330
Tuesday	Skills & Conditioning	8	70	560
Wednesday	Resistance Training	7	60	420
Thursday	Conditioning	7	50	350
Friday	Skill & Agility	8	60	480
Saturday	Game	8	90	720
Sunday	Rest	0	0	0
	Weekly Load			2860

Quantifying Training Load

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Training Progression

Day	Training Activity	Session RPE	Session Duration (min)	Load
Monday	Technique	6	55	330
Tuesday	Skills & Conditioning	8	70	560
Wednesday	Resistance Training	7	60	420
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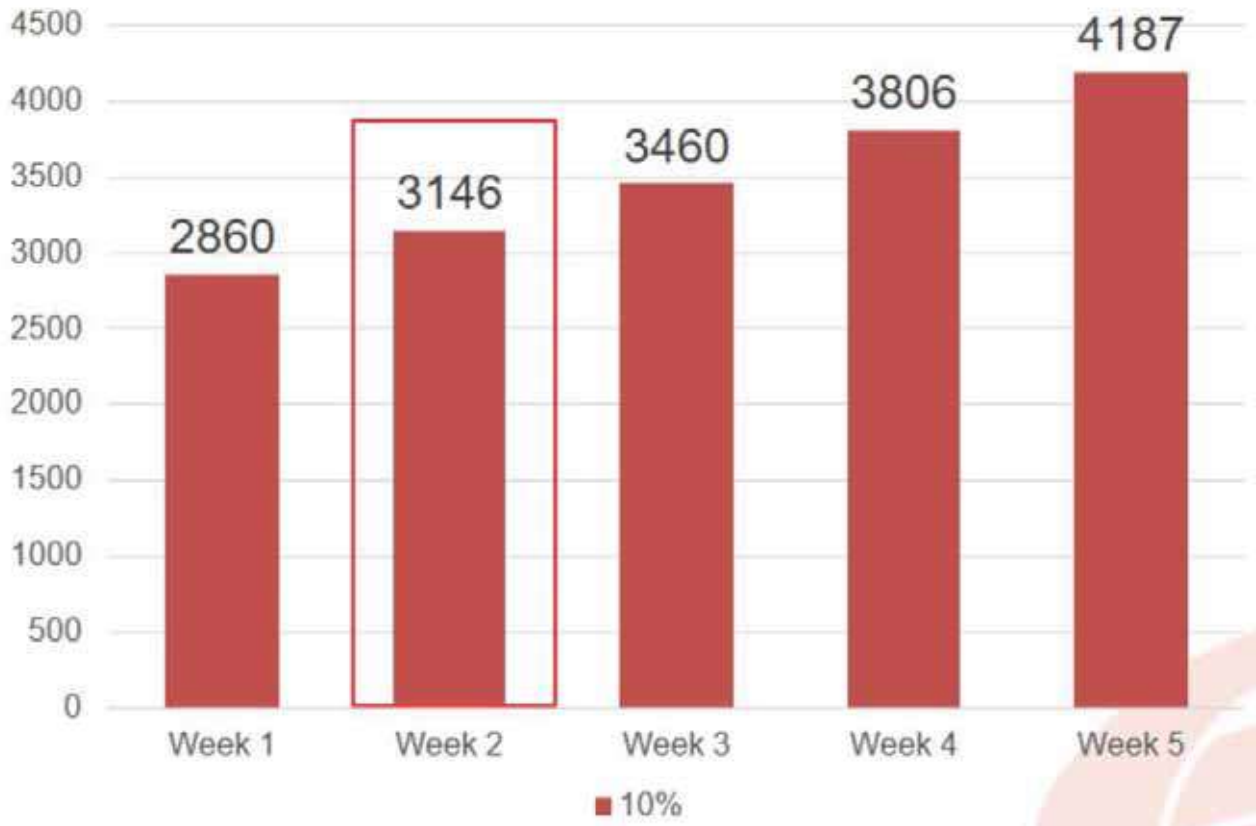
Training Progression



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Training Progression

Day	Training Activity	Session RPE	Session Duration (min)	Load
Monday	Technique			
Tuesday	Skills & Conditioning			
Wednesday	Resistance Training			
Thursday	Conditioning			
Friday	Skills & Agility			
Saturday	Game			
Sunday	Rest			
	Weekly Load			3146

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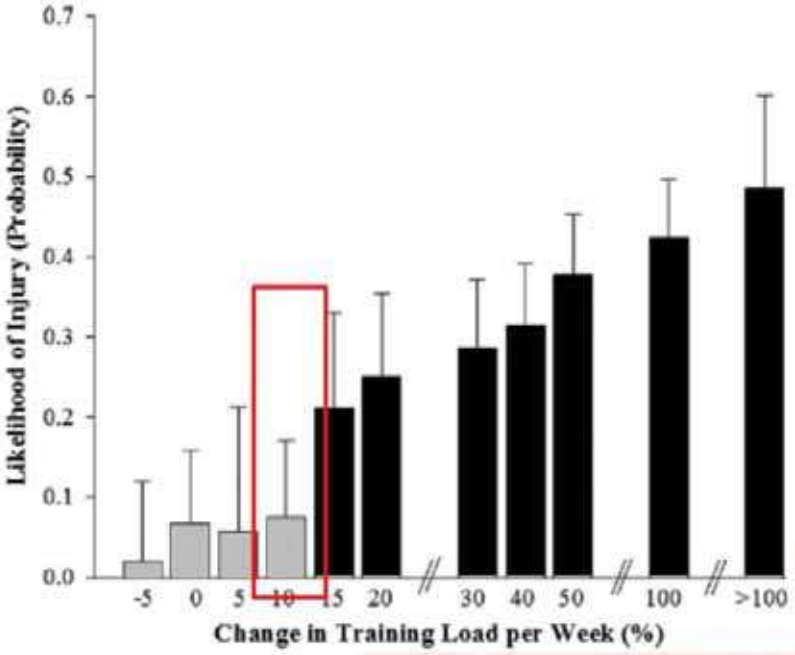
Training Progression

- 40% of injuries due to >10% rapid change in TL[1]
- Changes >1250 in Training Load were related to higher risk of injury [2]

(1 Piggott et al., 2009, 2 Cross et al., 2015)



(Gabbett, 2016)

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Acute:Chronic

- An index of athlete preparedness

Fatigue	Balanced	Fitness
A:C 2.0	**A:C 1.0**	**A:C 0.5**
AcuteWL 600 ChronicWL 300	AcuteWL 600 ChronicWL 600	AcuteWL 300 ChronicWL 600

A:C **0.8 – 1.3**

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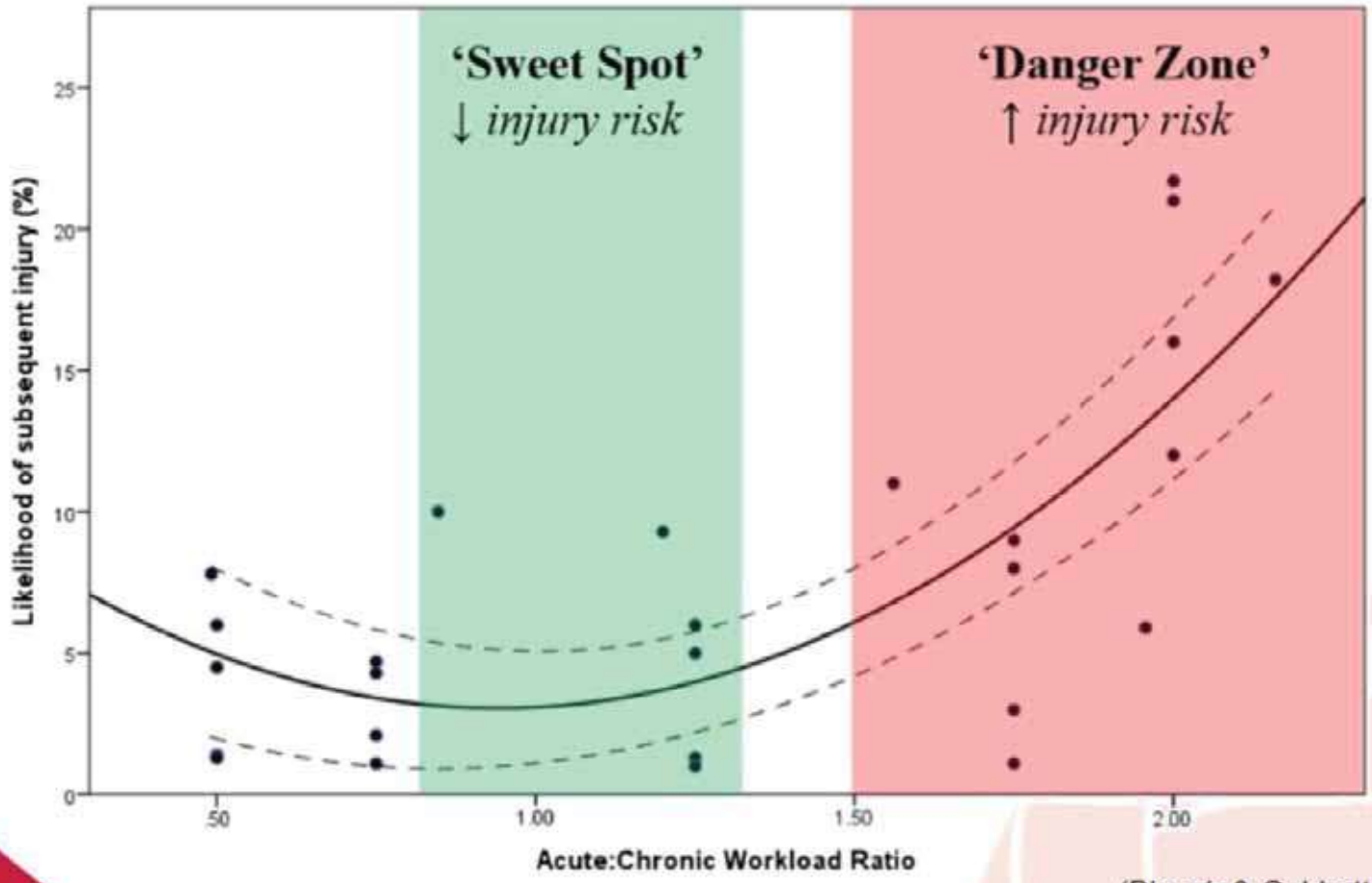
Acute:Chronic and Injury



(Blanch & Gabbett, 2015)

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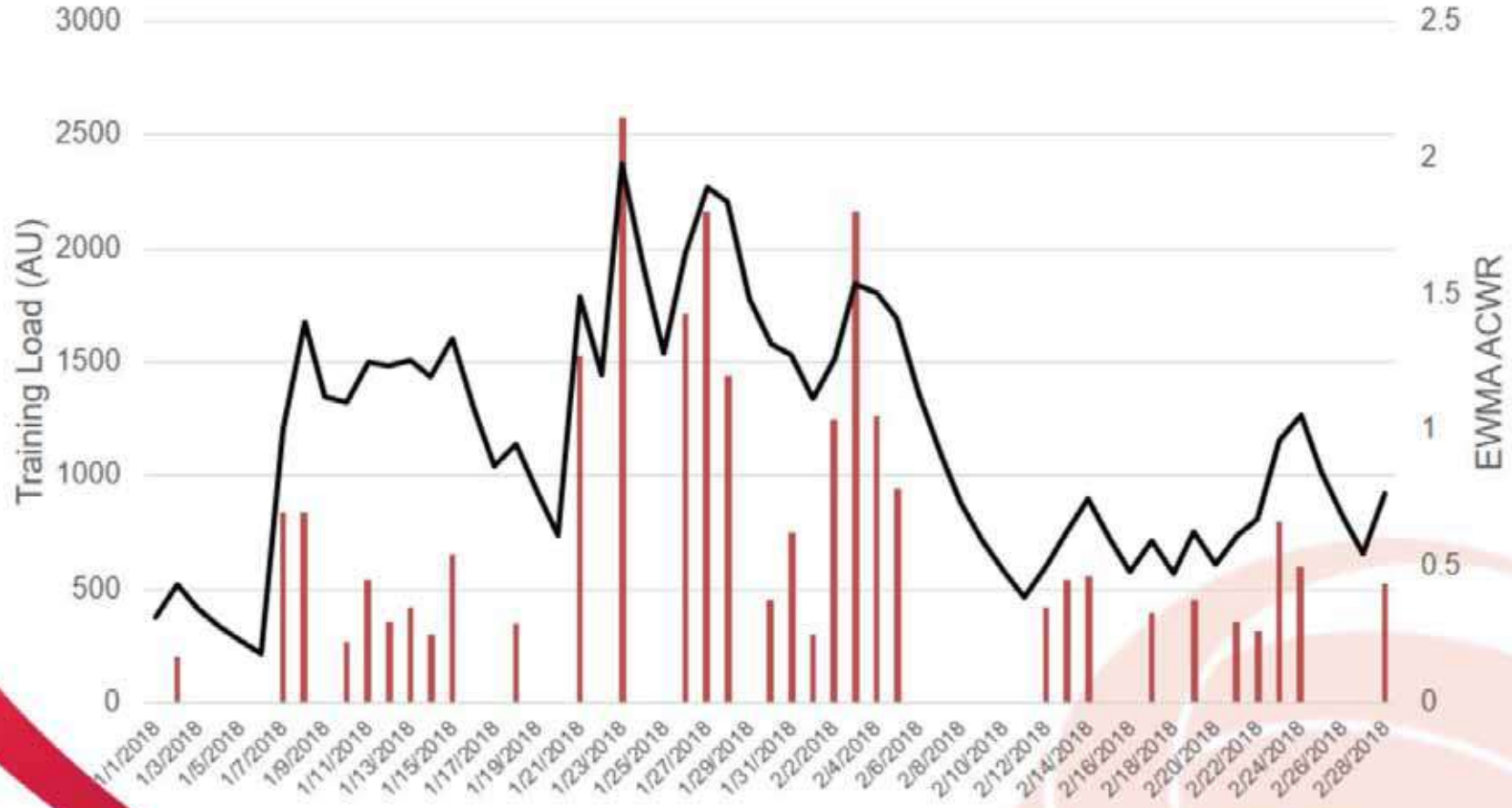
Acute:Chronic and Injury



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Benefits of sRPE

- Convenient, simple and flexible method
- A global measure stress
- Identify and individualize training loads
- Provides vital information regarding injury risk

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Summary

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Practical:
Training Load Monitoring

Training Monitoring

- Download form at https://tinyurl.com/y7fzlxwu

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Training Monitoring

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Training Builder

1) Select the type of Session it is.

2) Enter values in red cells.
- Intensity
- Repetition
- Sets / Duration

WEEK 1

Monday 8/10/2018						Tuesday 9/10/2018					
Session 1						Session 1					
Drill	Competition					Drill	Tactical				
	Int	Reps	Sets	Duration	TL		Int	Reps	Sets	Duration	TL
Ex. 1	5	12	4	48	240	Ex. 1	7	8	5	40	280
Ex .2				0	0	Ex .2				0	0
Ex. 3				0	0	Ex. 3				0	0
Sum				48	240	Sum				40	280
Session 2						Session 2					
Drill						Drill					
	Int	Reps	Sets	Duration	TL		Int	Reps	Sets	Duration	TL
Ex. 1				0	0	Ex. 1				0	0
Ex .2				0	0	Ex .2				0	0
Ex. 3				0	0	Ex. 3				0	0
Sum				0	0	Sum				0	0
Total				48	240	Total				40	280

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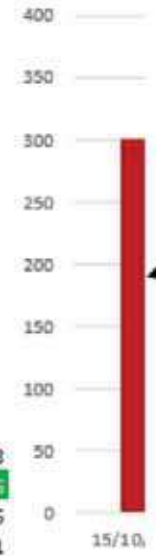
Training Builder

1) Progression Indicator:
- Green = ≤10%
- Red = > 10%

Sunday 21/10/2018					
Session 1					
Drill	Competition				
	Int	Reps	Sets	Duration	TL
Ex. 1				0	0
Ex .2				0	0
Ex. 3				0	0
Sum				0	0
Session 2					
Drill					
	Int	Reps	Sets	Duration	TL
Ex. 1				0	0
Ex .2				0	0
Ex. 3				0	0
Sum				0	0
Total				0	0

Total Vol	393
Total Load	1636
Monotony	1.8055
Strain	0.0011



2) Weekly graphs will be plotted out here

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TL Raw

1) Enter the duration of the session.

Date	Name	Sessior	SessionN	Duratio	Intensit	Load
10/10/2018	Athlete 1	Competition	Session 1	60	3	180
11/10/2018	Athlete 1	Tactical	Session 2	100	5	500
12/10/2018	Athlete 3	Tactical	Session 1	80	6	480
13/10/2018	Athlete 3	Physical	Session 2	100	3	300
31/10/2018	Athlete 1	Tactical	Session 1	120	4	480

2) Enter sRPE value that athlete had indicated.

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Summary

1) Select the name of the athlete to be analysed

2) Enter the start and end date you want the data analysed

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Summary

- Consistency is key
- Goldilocks Principle
- 10% progression in load per week
- Monitor Acute:Chronic to adjust training load

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Q & A