The Academic College At Wingate

מכון וינגייט
WINGATE INSTITUTE

ISRAEL ישראל

סמינר פריודיזציה בספורט

מארחים: המכללה האקדמית בוינגייט, היחידה לספורט הישגי, מכון וינגייט והוועד האולימפי

SAVE THE DATES:

JANUARY 10-11, 2018 כ"ג-כ"ד בטבת, תשע"ח

PERIODIZATION IN SPORT SEMINAR

Hosted by the Academic College at Wingate, The Elite Sport Department, The Wingate Institute and Olympic Committee of Israel

KEYNOTE SPEAKERS מרצים אורחים

Prof. Carlo Castagna, University of Rome Tor Vergata, Rome, Italy

Dr. Genadijus Sokolovas, Global Sport Technology, Inc., Colorado Springs, USA

Training Load Control in Football

Carlo Castagna PhD

UNIVERSITA' degli STUDI di ROMA TOR VERGATA

SETTORE TECNICO FIGC.IT

Laboratorio di Metodologia e Biomeccanica Applicata al Calcio
Coverciano **(Firenze)**

Plan of the Talk

Dose Response

- What Why When?
- External Load
- Internal Load
- Future direcions
- Conclusion

Before Starting

Data Analysis

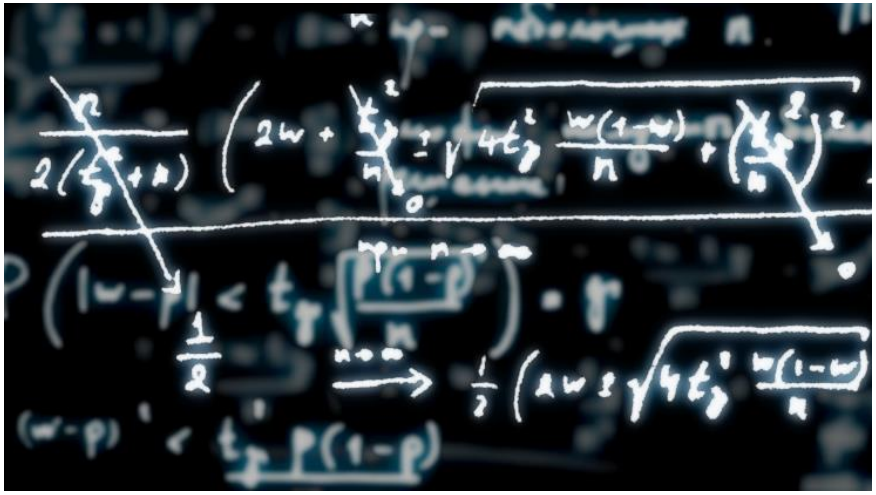
- What Why When?
- The Who?

- Data Analyst
- Data Scientist

The Who's

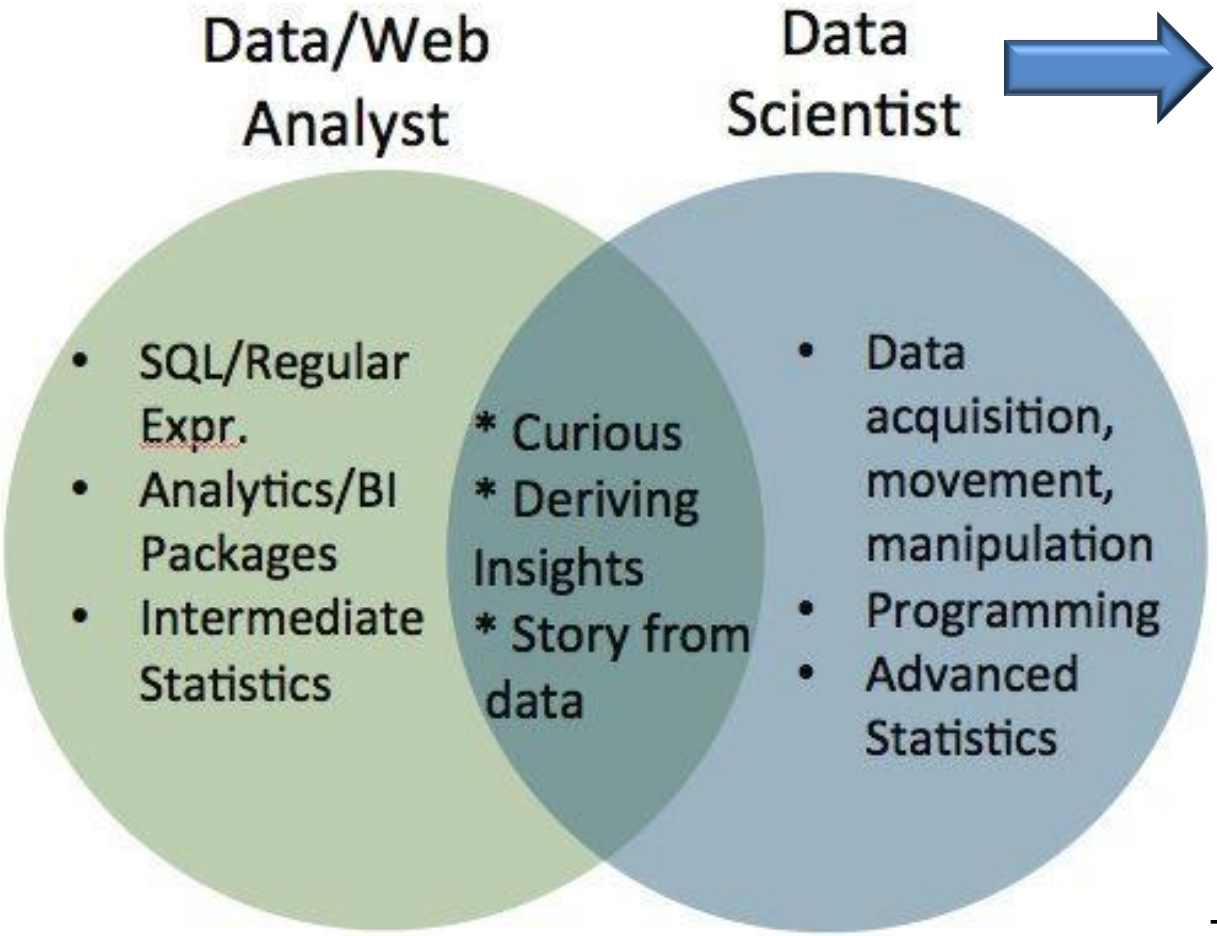
Data Analyst

Data Scientist



The Who's

https://www.import.io/post/data-scientists-vs-data-analysts-why-the-distinction-matters/



- Validity
- Reliability
- Relevance

Thomson Nguyen

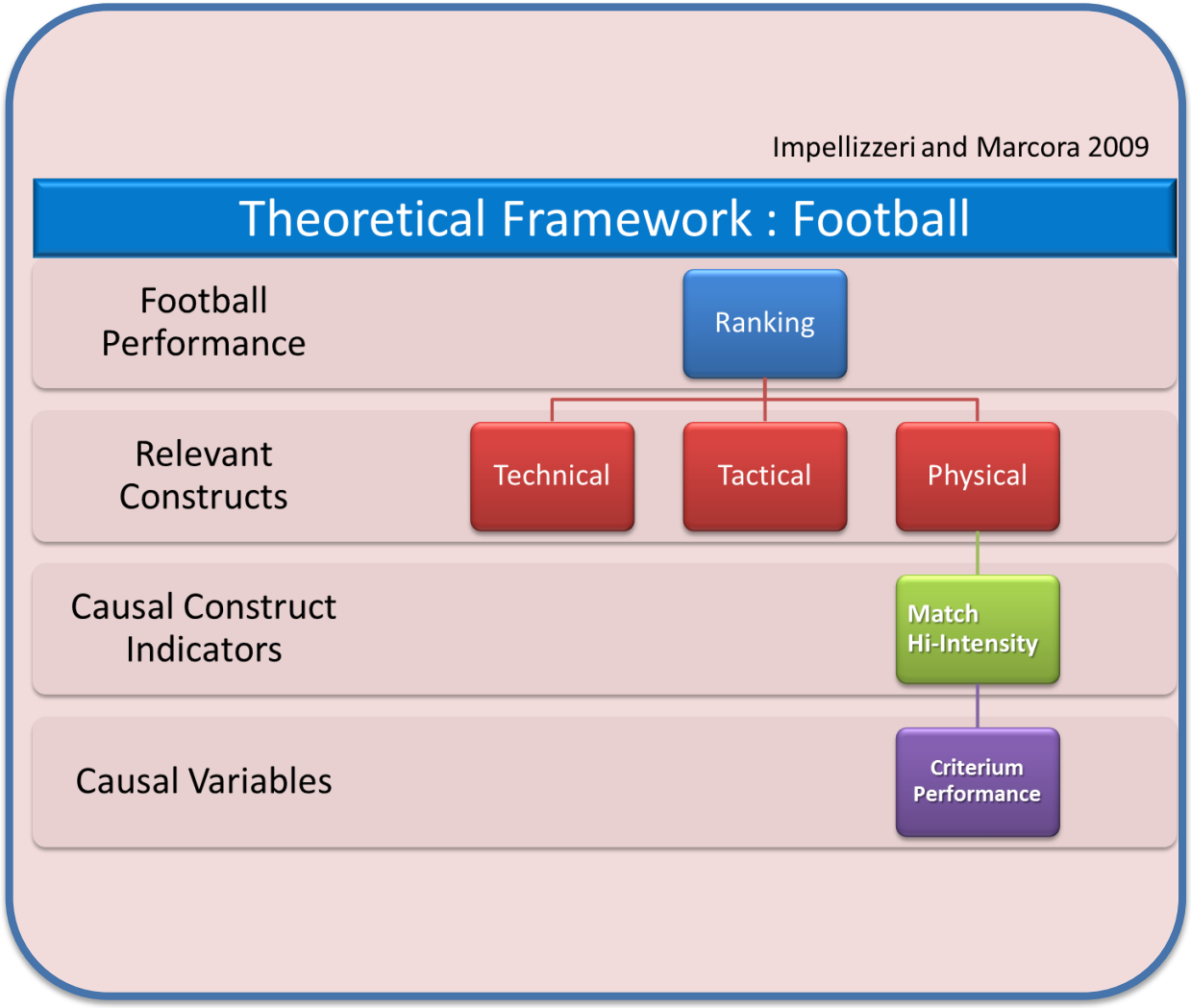
Training in Football

- Basic Training
- Specific
- Functional

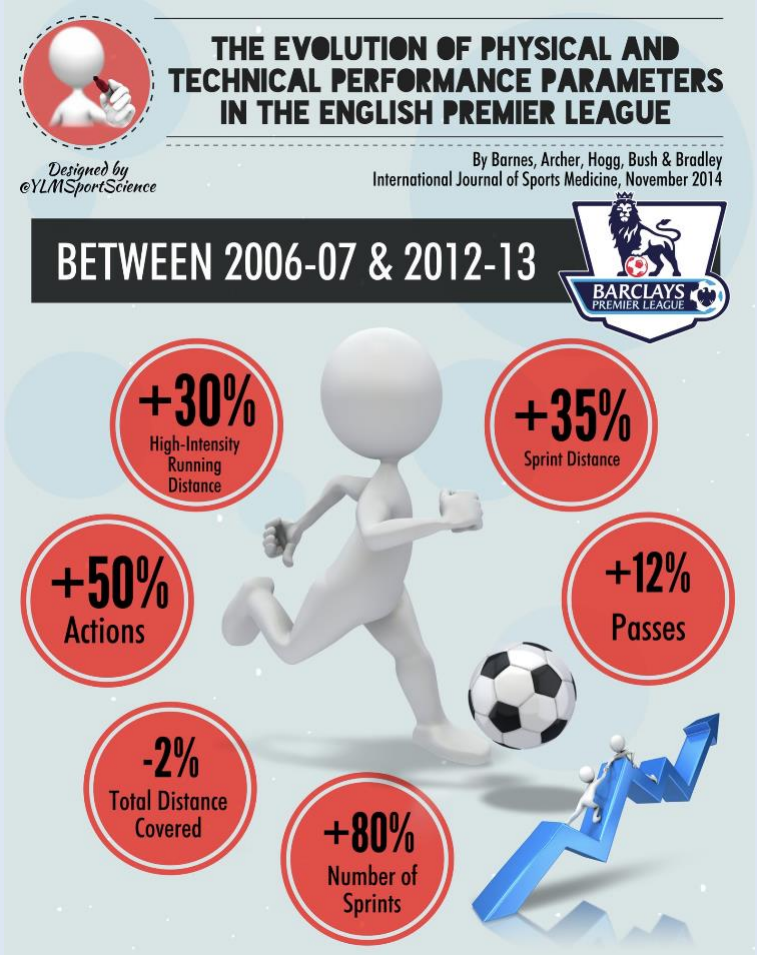
Game like drills

Fitness for Football: Constructs

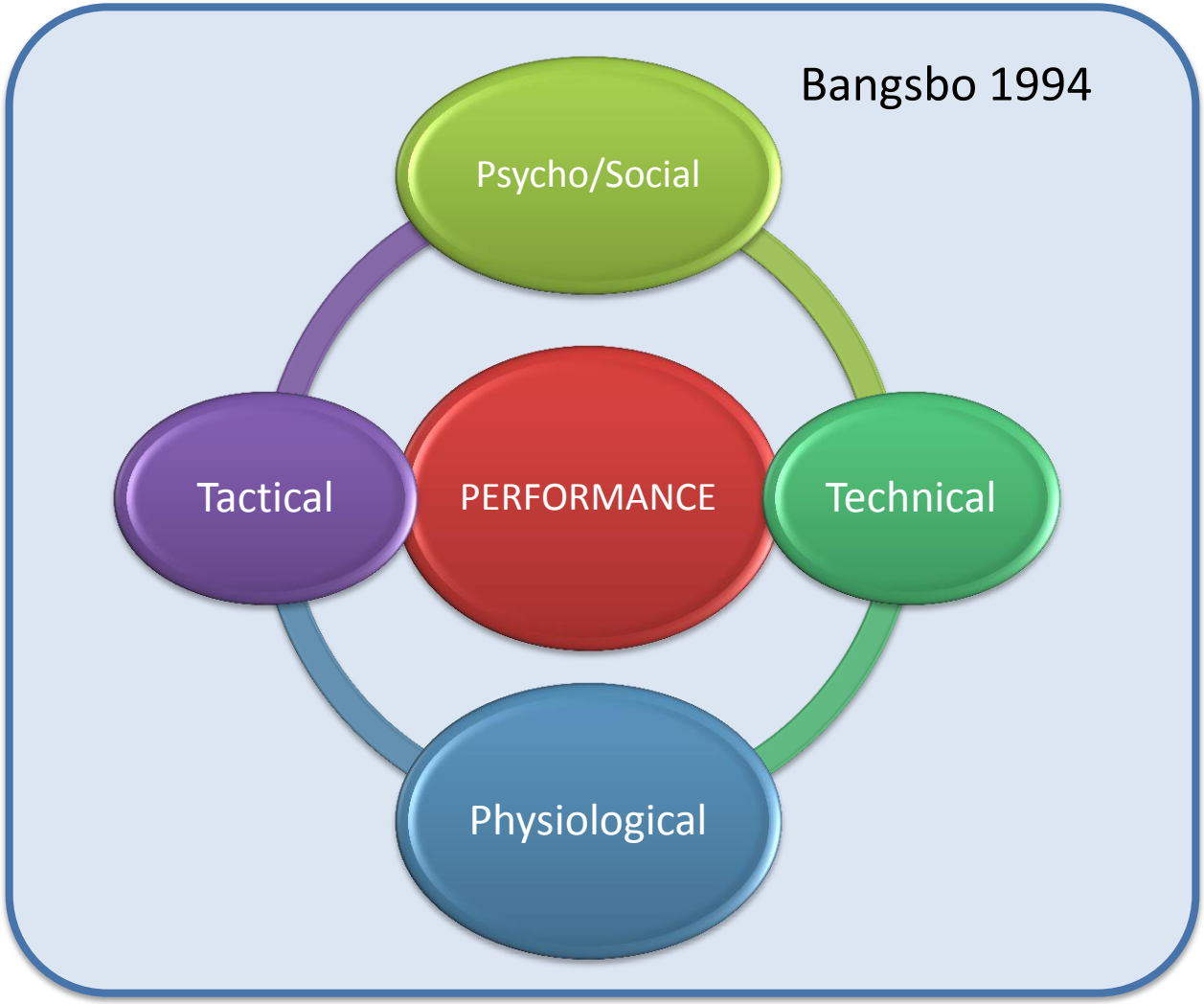
Impellizzeri and Marcora 2009



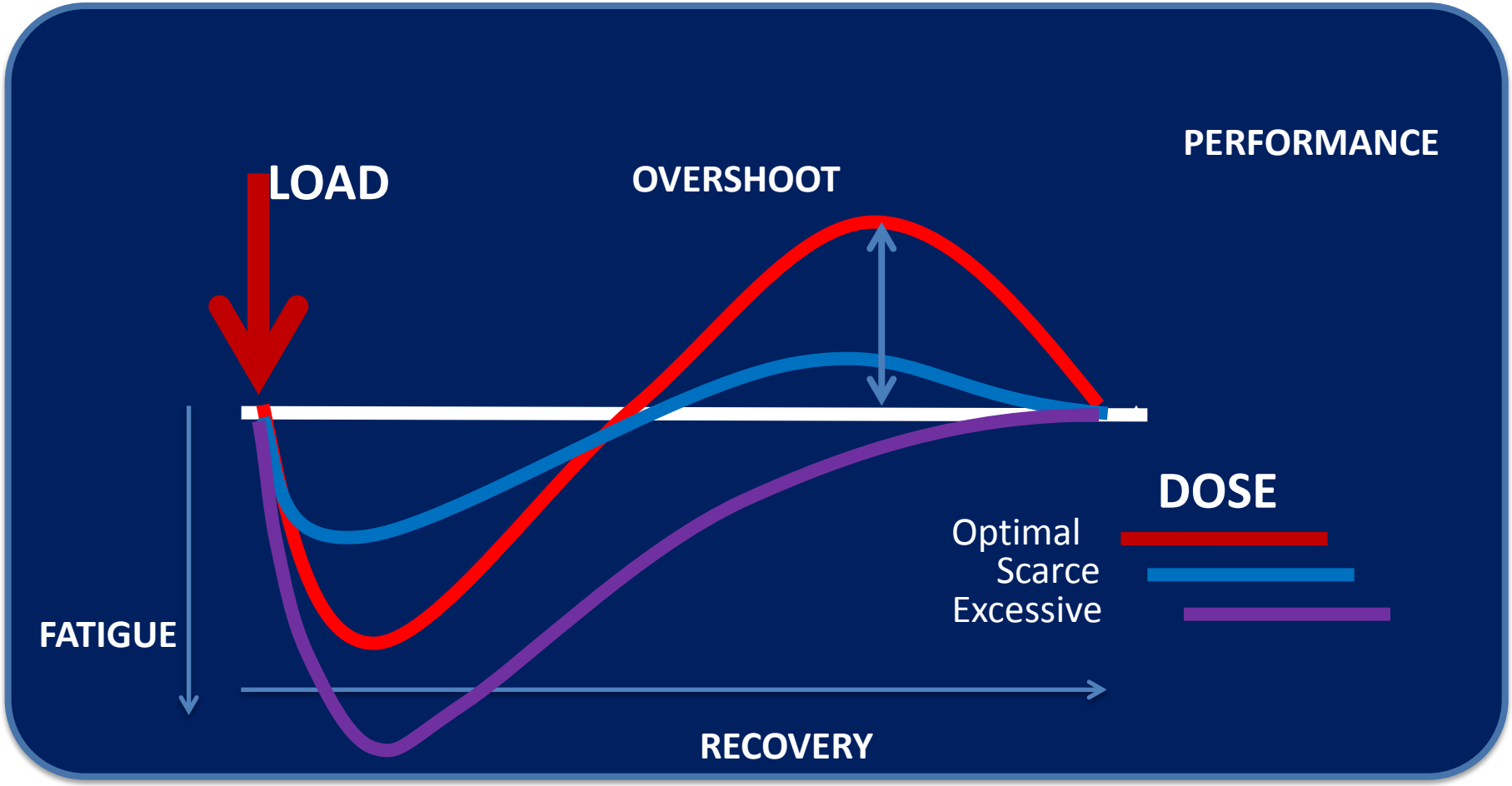
Fitness for Football: Constructs



Fitness for Football: Constructs



Dose-Response



Performance Constructs

Banister 1975

Performance = Fitness – Fatigue

Key Words; ***Hormesis, Homeostasis, Allostasis, Personalization***

Load= Volume · Intensity

Actions: Training Load Control @ Regulation

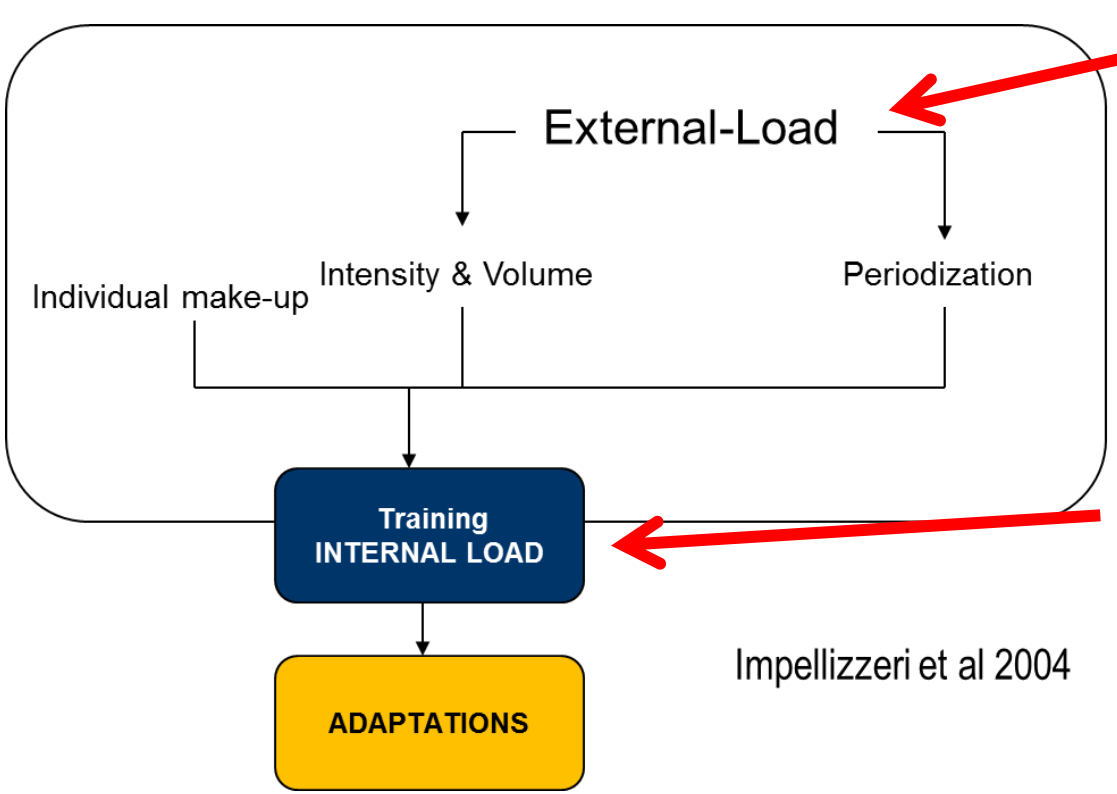
Dose —— Response

HORMESIS

"*All things are poison and nothing is without poison, only the dose permits something not to be poisonous*"

Paracelsus

Training Load Dichotomy

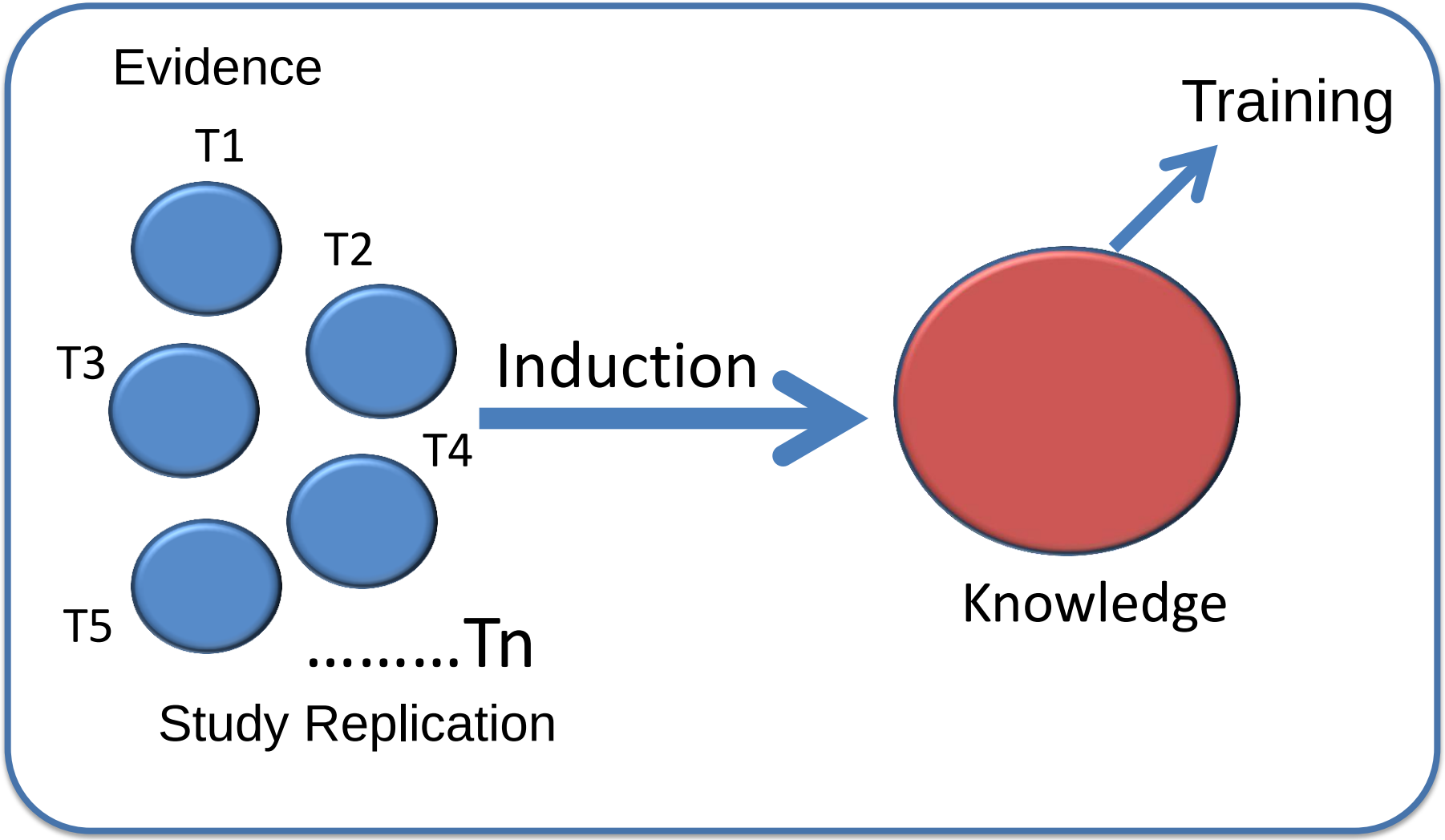


Dose

Response

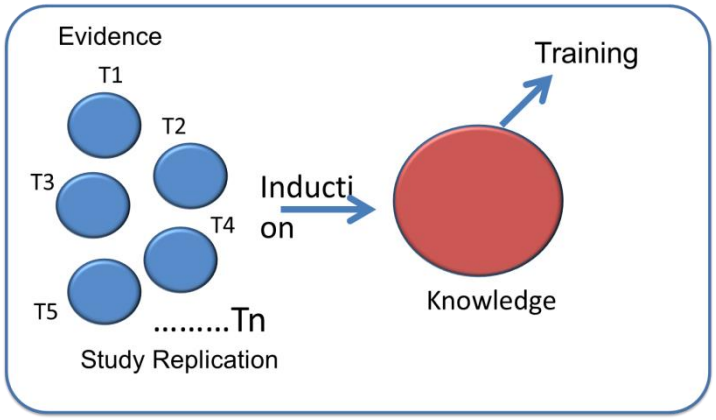
Impellizzeri et al 2004

TS Philosophy: Induction



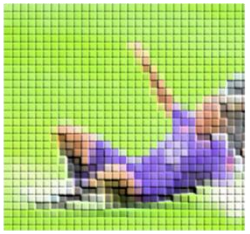
The Internal-Load in Football

Team-Studies Philosophy



Research Design

Professional PLayersn=18



Manzi e coll. 2013

Dose-Response

TRIMPi= mX+q

- **S4 → 454 AU**
- **VO_2max → 498 AU**
- **VO_2VT → 415 AU**
- **Yo-Yo IR1 → 510 AU**

Training-Load Analysis

$$\sum_{i=1}^{n} t_i = D\sum_{i=1}^{n}(\Delta HR_r)_i \cdot y_i$$

$$\Delta HR_r = \frac{HR_i - HR_{rest}}{HR_{max} - HR_{rest}}$$

$$y_i = B \cdot e^{C\,(\Delta HR_r)_i}$$

INDIVIDUAL TRAINING-LOAD AND AEROBIC-FITNESS VARIABLES IN PREMIERSHIP SOCCER PLAYERS DURING THE PRECOMPETITIVE SEASON

VINCENZO MANZI,[1] ANTONIO BOVENZI,[2] MARIA FRANCO IMPELLIZZERI,[3] IVAN CARMINATI,[4] AND CARLO CASTAGNA[1,5]

ABSTRACT

INTRODUCTION

Manzi e coll. 2013

Team-Studies: HR Validity

Heart Rate Monitoring

Training Intensities:

Low	HR< S2
Mean	S2< HR<S4
High	HR>S4

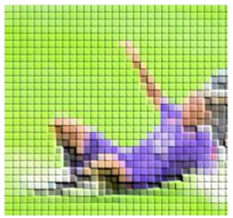
Castagna et al. 2011, 2013

Heart Rate Monitoring

Results:

- Training Load (%time):

Low	74%
Medium	19%
High	7%



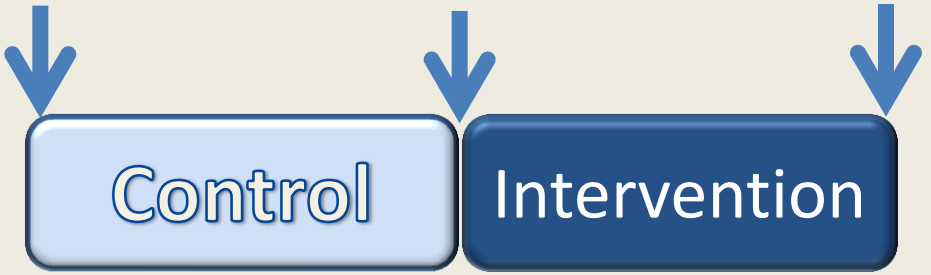
Castagna et al. 2013

Dose-Response

- Relevance of HR>90% FC_{max}
- High-Intensity 6-8% weekly Training Load
- HR monitoring Longitudinal Validity
- Effect on Aerobic Fitness

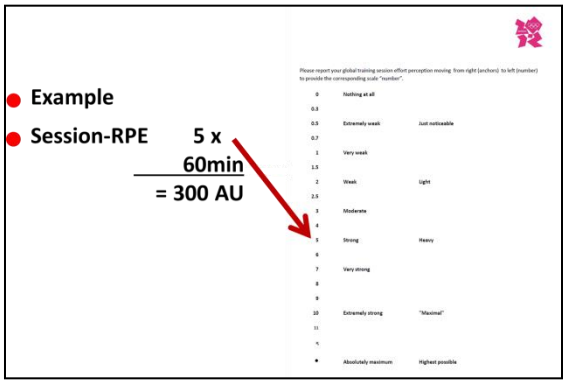
TS Philosophy: Own-Control Designs

- Elite – Competive Set-up
- No parallel Control
- No RTM
- Control Period
- Own Control Design



Internal Load Estimation

Session-RPE (S-RPE)



- Börg CR10 Scale (RPE)
- Training Duration (TD)
- S-RPE= RPE x TD
- Rate Average Intensity
- Timing
- 90-120’ range of validity?

Foster et al 2001
Impellizzeri et al 2004
Manzi et al 2010

Internal Load Estimation

- **Perceived Average Training Intensity**

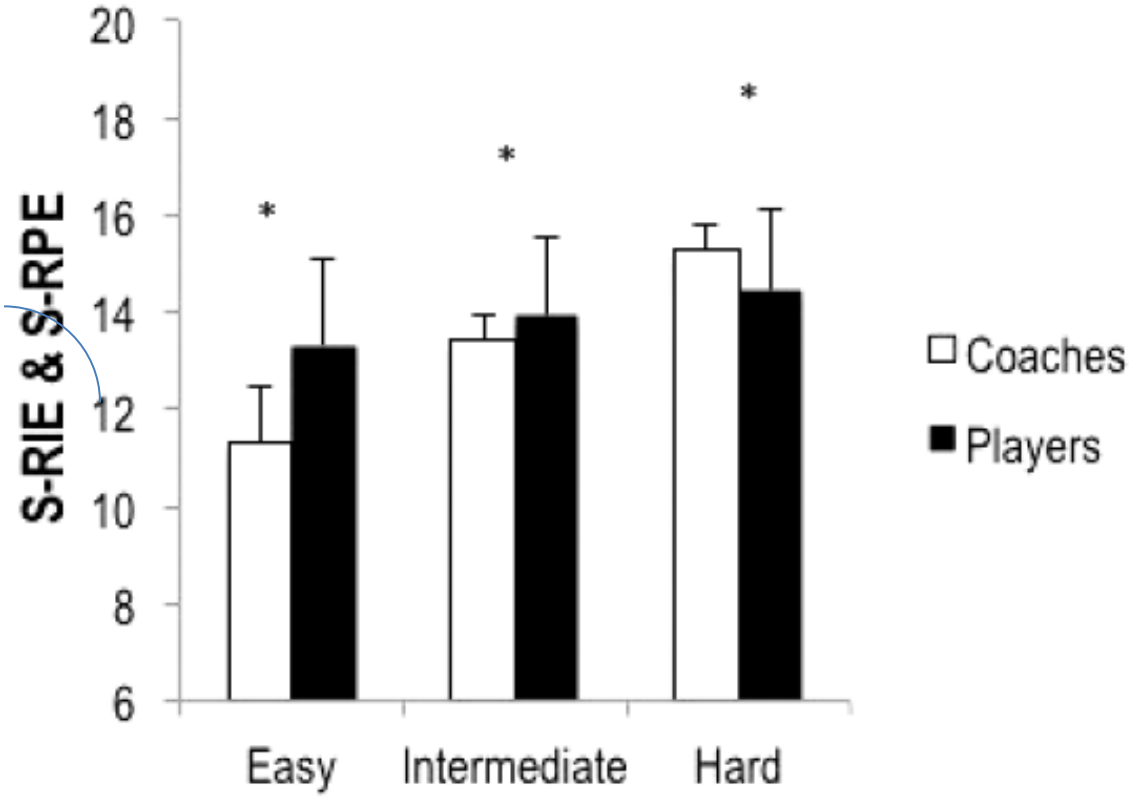
- **Example**
- **Session-RPE** $\frac{5 \times 60\text{min}}{} = 300\ \text{AU}$

Please report your global training session effort perception moving from right (anchors) to left (number) to provide the corresponding scale "number".

0	Nothing at all	
0.3		
0.5	Extremely weak	Just noticeable
0.7		
1	Very weak	
1.5		
2	Weak	Light
2.5		
3	Moderate	
4		
5	Strong	Heavy
6		
7	Very strong	
8		
9		
10	Extremely strong	"Maximal"
11		
½		
•	Absolutely maximum	Highest possible

S-RPE Prediction Bias

Brink et al IJSPP 2014

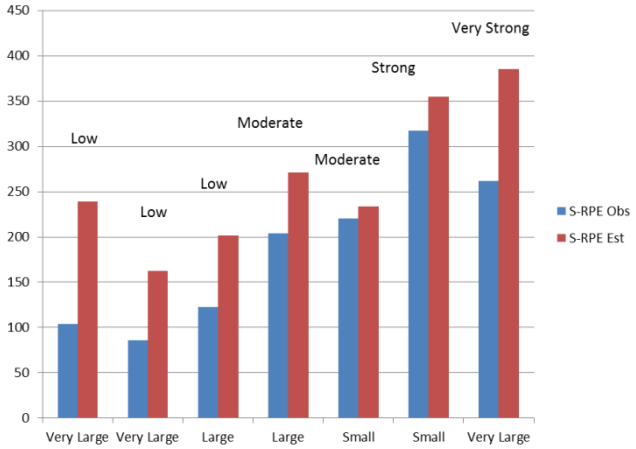


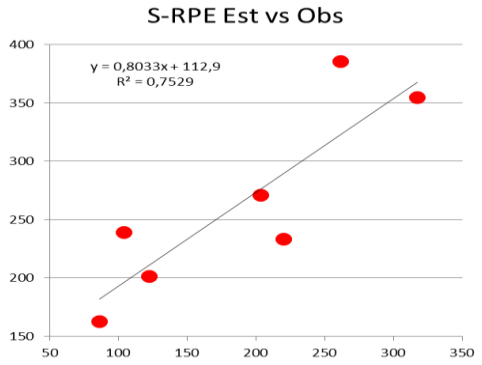
S-RPE Prediction Bias

Observed vs Estimanted

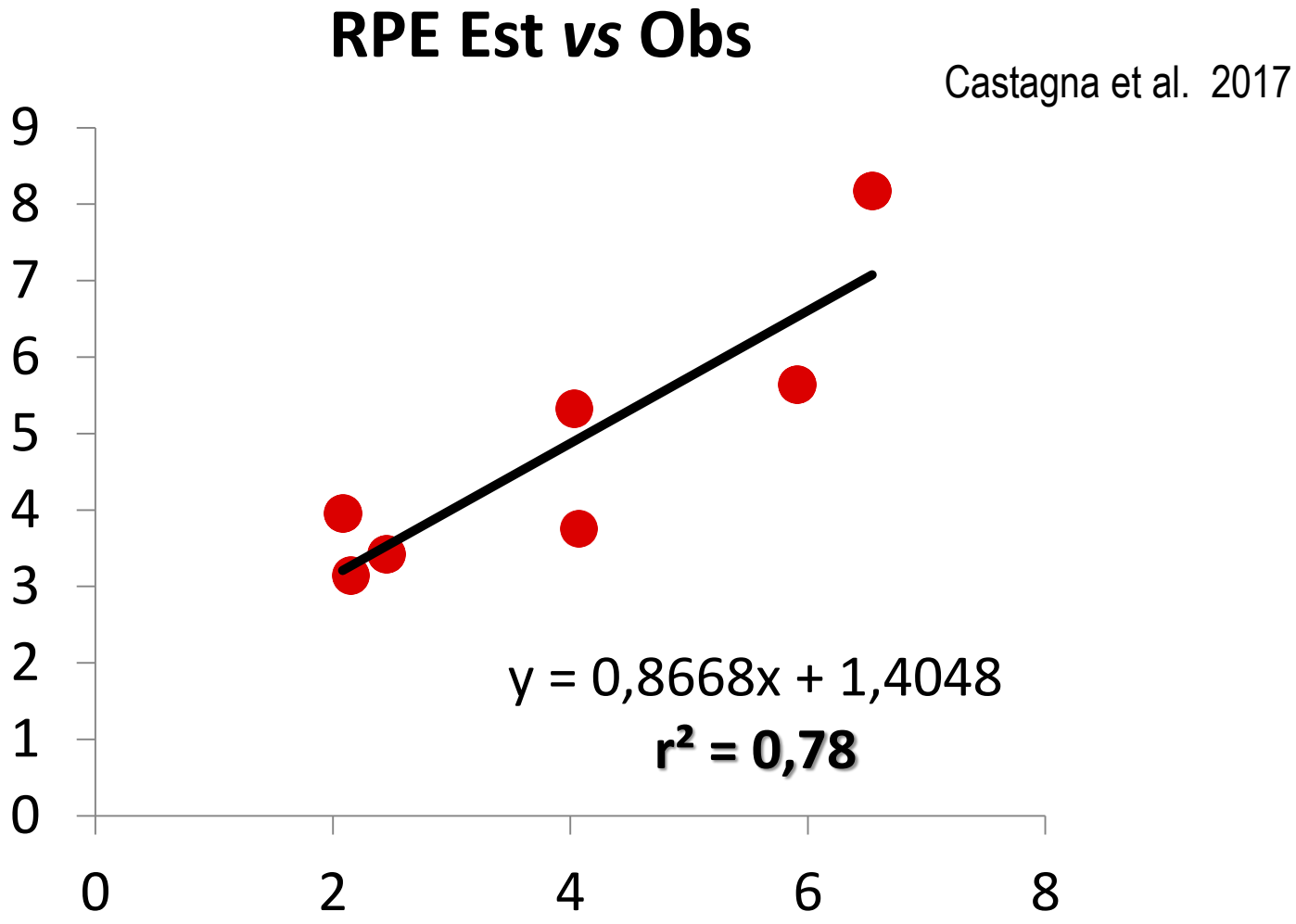
- S-RPE → Oss. Vs Pred.
- Coach TL Over Estimation
- Careful Prescription?

Castagna et al. 2017



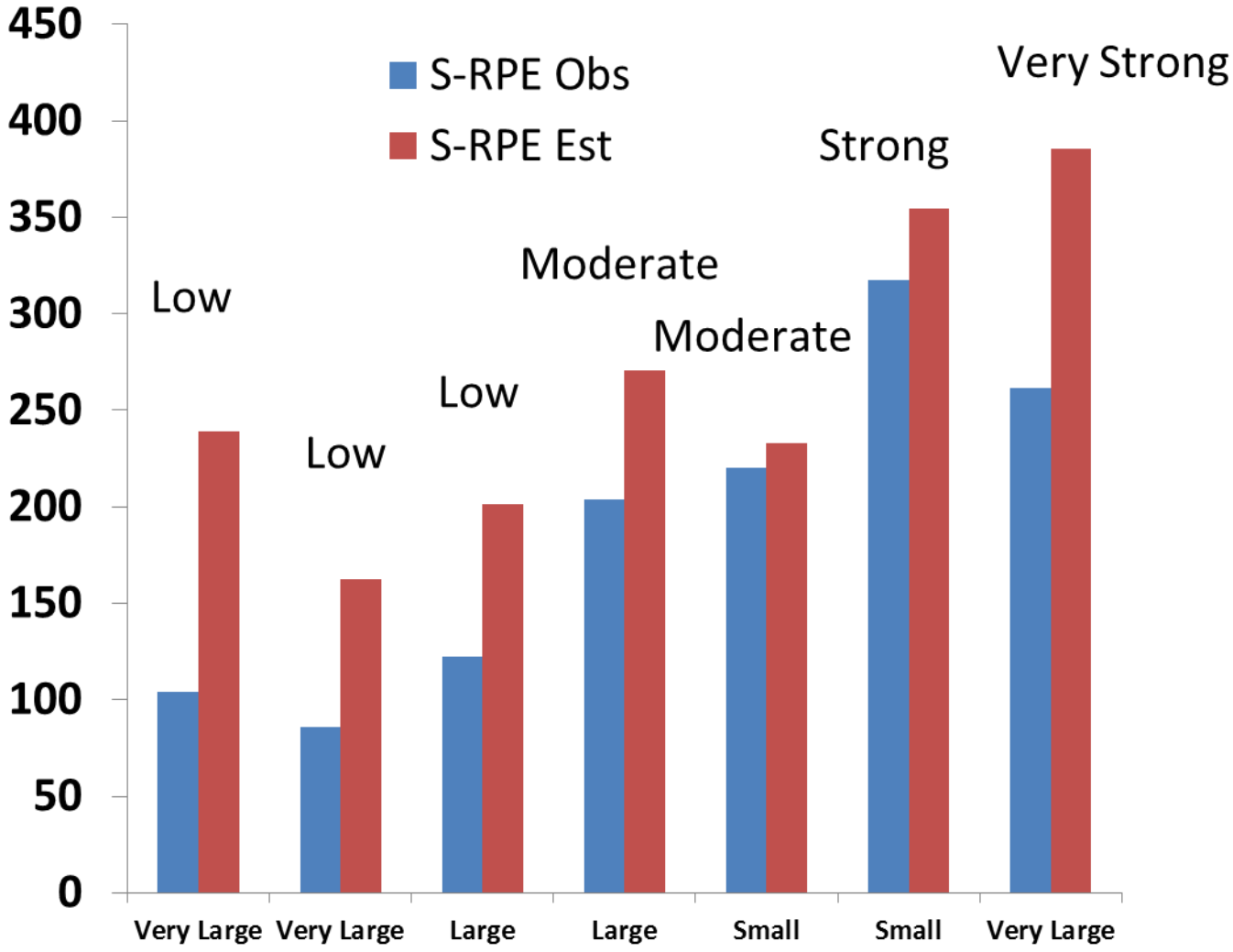


S-RPE Prediction Bias

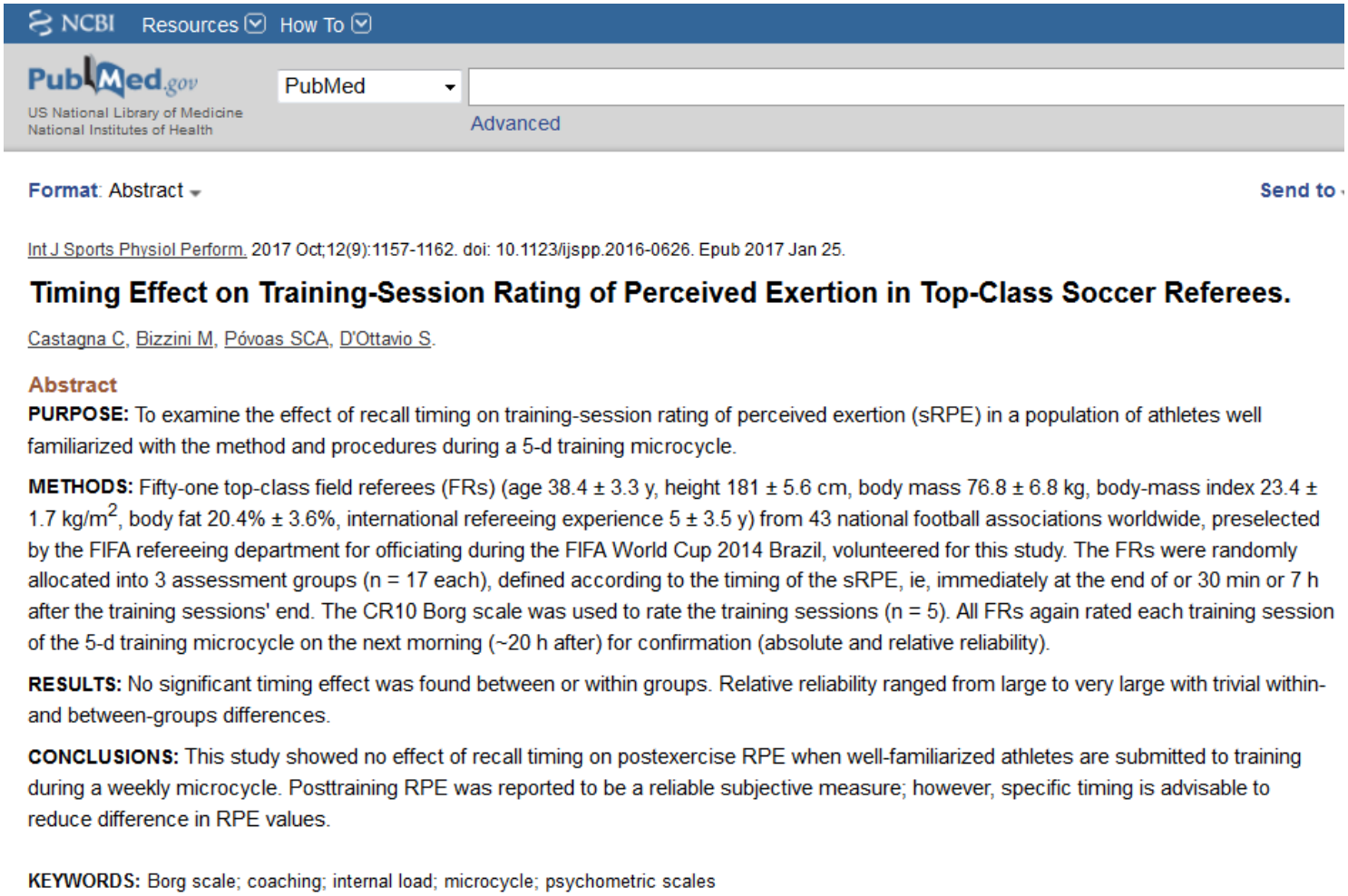


S-RPE Prediction Bias

Castagna et al. 2017



S-RPE Timing



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Int J Sports Physiol Perform. 2017 Oct;12(9):1157-1162. doi: 10.1123/ijspp.2016-0626. Epub 2017 Jan 25.

Timing Effect on Training-Session Rating of Perceived Exertion in Top-Class Soccer Referees.

Castagna C, Bizzini M, Póvoas SCA, D'Ottavio S.

Abstract

PURPOSE: To examine the effect of recall timing on training-session rating of perceived exertion (sRPE) in a population of athletes well familiarized with the method and procedures during a 5-d training microcycle.

METHODS: Fifty-one top-class field referees (FRs) (age 38.4 ± 3.3 y, height 181 ± 5.6 cm, body mass 76.8 ± 6.8 kg, body-mass index 23.4 ± 1.7 kg/m^2, body fat 20.4% ± 3.6%, international refereeing experience 5 ± 3.5 y) from 43 national football associations worldwide, preselected by the FIFA refereeing department for officiating during the FIFA World Cup 2014 Brazil, volunteered for this study. The FRs were randomly allocated into 3 assessment groups (n = 17 each), defined according to the timing of the sRPE, ie, immediately at the end of or 30 min or 7 h after the training sessions' end. The CR10 Borg scale was used to rate the training sessions (n = 5). All FRs again rated each training session of the 5-d training microcycle on the next morning (~20 h after) for confirmation (absolute and relative reliability).

RESULTS: No significant timing effect was found between or within groups. Relative reliability ranged from large to very large with trivial within- and between-groups differences.

CONCLUSIONS: This study showed no effect of recall timing on postexercise RPE when well-familiarized athletes are submitted to training during a weekly microcycle. Posttraining RPE was reported to be a reliable subjective measure; however, specific timing is advisable to reduce difference in RPE values.

KEYWORDS: Borg scale; coaching; internal load; microcycle; psychometric scales

Internal *vs* External Load

Relationship Between Indicators of Training Load in Soccer Players

David Casamichana,[1] Julen Castellano,[1] Julio Calleja-Gonzalez,[1] Jaime San Román,[1] and Carlo Castagna[2]

[1]*Faculty of Physical Activity and Sport Sciences, University of the Basque Country (EHU/UPV), Vitoria-Gasteiz, Spain; and* [2]*Football Training and Biomechanics Laboratory, Italian Football Federation (FIGC), Technical Department, Coverciano (Florence), Italy*

Abstract

Casamichana, D, Castellano, J, Calleja-Gonzalez, J, San Román, J, and Castagna, C. Relationship between indicators of training load in soccer players. *J Strength Cond Res* 27(2): 369–374, 2013–This study examined the relationship between work load indicators used to quantify full training sessions in soccer. The participants were 28 semiprofessional male soccer players age 22.9 ± 4.2 years, height 177 ± 5 cm, body mass 73.6 ± 4.4 kg. Players' physical and physiological work load was monitored over 44 training sessions using global positioning system devices (10 Hz) and heart rate, respectively. After each training session, players' training perceived-exertion (rating of perceived exertion [RPE]) was assessed using the Borg CR-10 scale. Players' internal training load was assessed using the session-RPE and the Edwards methods. Total distance, distances covered at arbitrary selected high-intensity speed zones (≥18 and 21 km·h^{-1}), bout frequency at speed >18 and 21 km·h^{-1}, and work:rest ratio during training drills were considered as signs of physical work load. Furthermore, player load assumed as reflection of total center-of-mass acceleration was considered as representative of players' external load. Very-large association of player load with Edwards and session-RPE methods was found. Total distance covered was large to very large associated with Player Load, Session-RPE, and Edwards methods. The findings of this study provided evidence for the safe use of session-RPE, Edwards methods, and Players Load as valid indicators of training responses in soccer.

Key Words association football, training control, session-RPE, heart rate, GPS technology

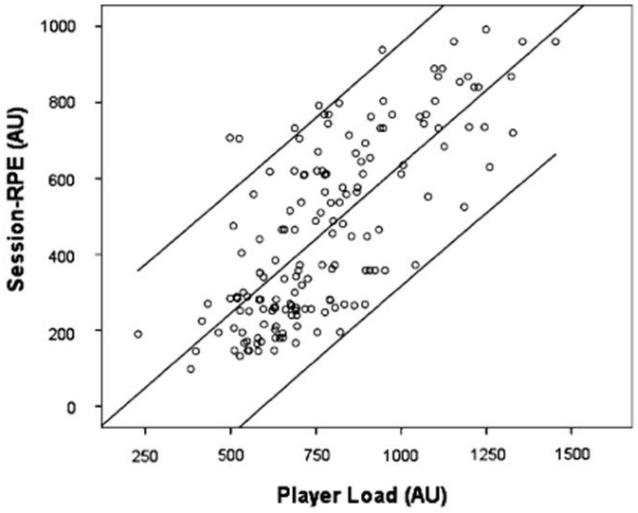
Introduction

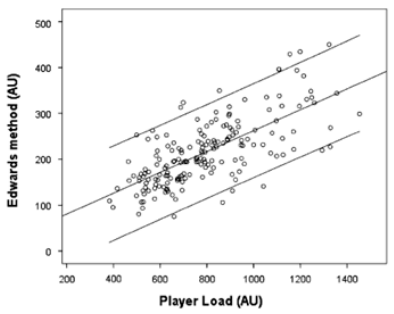
To develop physical fitness and team skills, an extensive use of group training (i.e., specific training) drills is considered in soccer (13). Specific training in soccer assumes the form of small-sided games using different number of players, pitch dimensions, and game rules to promote the requested adaptations (21). Team-skill training load (TL) quantification is of importance when the objective is to evaluate magnitude compliance between planned and performed training drills. This enables TL to be modulated according to seasonal training aims. This assumes value as efficient training prescription is work load dependent (29).

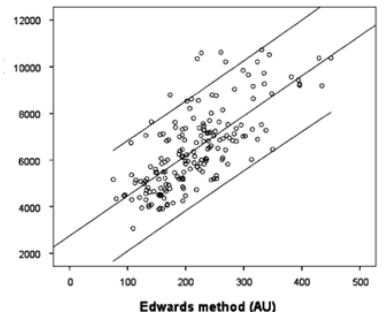
In soccer, the individual training response (internal load) to a given imposed training program (external load) may result in being different among players, and consequently, training individualization may result problematic (12). Therefore, the development of valid methods for TL assessment is paramount in soccer because extreme training responses may result in training maladaptations and injuries (17,18).

With the aim to profile the internal load, a number of methods have been proposed using effort perception or heart-rate (HR) responses to training (3). Recently, the session–rating of perceived exertion method (sRPE) has been the object of studies that examined its validity assuming as construct HR methods (24), which has been correlated with other internal and external TL (8).

Despite the practical interest provided by these studies, a conclusive response as per sRPE method criterion validity is yet to be reported in soccer. Indeed, HR methods were based on theoretical construct and consequently cannot be considered as TL gold-standard criteria.







Internal *vs* External Load

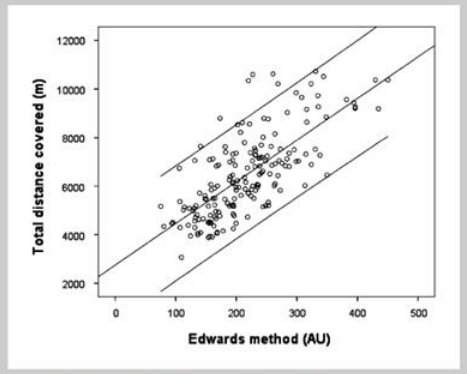


Figure 1. Relationship between the Edwards indicator and the total distance covered for the 210 recordings made ($r = 0.72$; $p < 0.01$). "AU" is arbitrary unit.

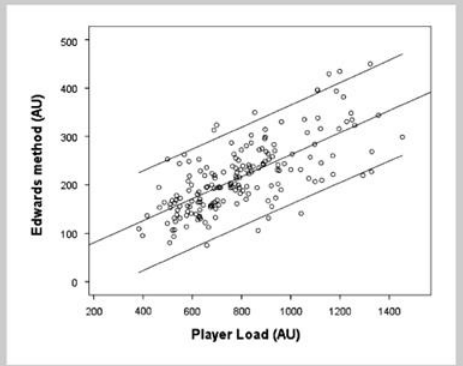


Figure 2. Relationship between player load (determined by accelerometry) and the training load indicator obtained via the Edwards method for the 210 recordings made ($r = 0.70$; $p < 0.01$). "AU" is arbitrary unit.

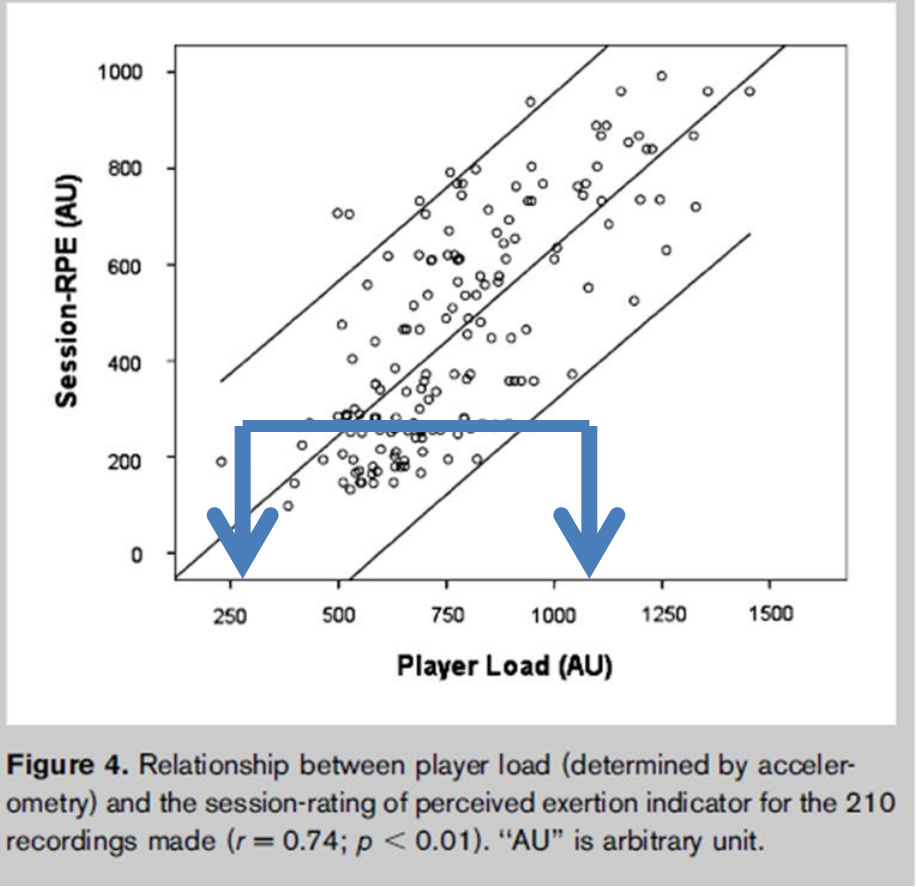


Figure 4. Relationship between player load (determined by accelerometry) and the session-rating of perceived exertion indicator for the 210 recordings made ($r = 0.74$; $p < 0.01$). "AU" is arbitrary unit.

External Load Metrics

Energy Cost and Metabolic Power in Elite Soccer: A New Match Analysis Approach

CRISTIAN OSGNACH[1], STEFANO POSER[2], RICCARDO BERNARDINI[3], ROBERTO RINALDO[3], and PIETRO ENRICO DI PRAMPERO[2]

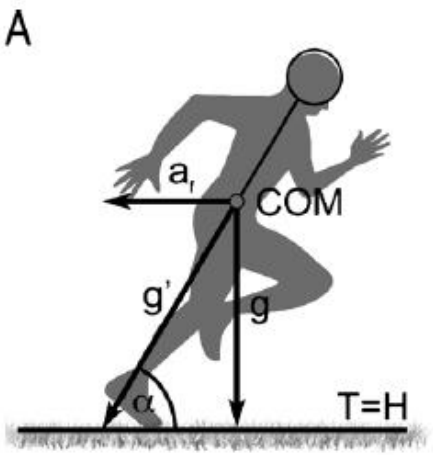
[1]School of Sport Sciences, University of Udine, Udine, ITALY; [2]Section of Physiology, Department of Biomedical Sciences and Technologies, University of Udine, Udine, ITALY; and [3]Department of Electrical, Management and Mechanical Engineering, University of Udine, Udine, ITALY

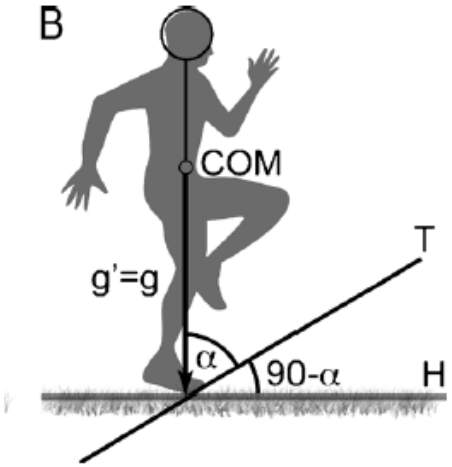
ABSTRACT

OSGNACH, C., S. POSER, R. BERNARDINI, R. RINALDO, and P. E. DI PRAMPERO. Energy Cost and Metabolic Power in Elite Soccer: A New Match Analysis Approach. *Med. Sci. Sports Exerc.*, Vol. 42, No. 1, pp. 170–178, 2010. **Purpose**: Video match analysis is used for the assessment of physical performances of professional soccer players, particularly for the identification of "high intensities" considered as "high running speeds." However, accelerations are also essential elements setting metabolic loads, even when speed is low. We propose a more detailed assessment of soccer players' metabolic demands by video match analysis with the aim of also taking into account accelerations. **Methods**: A recent study showed that accelerated running on a flat terrain is equivalent to running uphill at constant speed, the incline being dictated by the acceleration. Because the energy cost of running uphill is known, this makes it possible to estimate the instantaneous energy cost of accelerated running, the corresponding instantaneous metabolic power, and the overall energy expenditure, provided that the speed (and acceleration) is known. Furthermore, the introduction of individual parameters makes it possible to customize performance profiles, especially as it concerns energy expenditure derived from anaerobic sources. Data from 399 "Serie-A" players (mean ± SD; age = 27 ± 4 yr, mass = 75.8 ± 5.0 kg, stature = 1.80 ± 0.06 m) were collected during the 2007–2008 season. **Results**: Mean match distance was 10,950 ± 1044 m, and average energy expenditure was 61.12 ± 6.57 kJ·kg^{-1}. Total distance covered at high power (>20 W·kg^{-1}) amounted to 26% and corresponding energy expenditure to approximately 42% of the total. "High intensities" expressed as high-power output are two to three times larger than those based only on running speed. **Conclusions**: The present approach for the assessment of top-level soccer players match performance through video analysis allowed us to assess instantaneous metabolic power, thus redefining the concept of "high intensity" on the basis of actual metabolic power rather than on speed alone. **Key Words:** ACCELERATION, DECELERATION, SOCCER ENERGY EXPENDITURE, ACTIVITY PROFILE, PERFORMANCE ANALYSIS

Soccer is an activity involving both aerobic and anaerobic exercises; as such, the physiological demand imposed on soccer players during official matches and training sessions has been the subject of research for many years. Early assessments of metabolic demand, which were conducted through measurements of body temperature (14,23,32), demonstrated that the average metabolic load of a soccer player is close to 70% of $\dot{V}O_{2max}$. These results are confirmed by current energy

More recently, assessments of energy expenditure have been performed using continuous HR recording, allowing a detailed analysis of aerobic performance (1,8,16,17). However, this approach is not permitted during official matches. In addition, HR recordings do not yield information on high-intensity bouts. Likewise, direct measurement of oxygen uptake is not suitable to provide data on high-intensity exercise, and its use during training sessions or competitions is not feasible (18). Overall, all these methods





External Load Metrics

$$MP = E_c\, v$$

- **Noisy at *25hz!***
- **Validity?**

Unfortunately, the noise affecting the position values $x(n)$ and $y(n)$ is greatly amplified because it is multiplied by $1/T$. Actually, if σ is the SD of the noise affecting $d(n)$, it is possible to show that $v(n)$ is affected by a noise with a SD equal to:

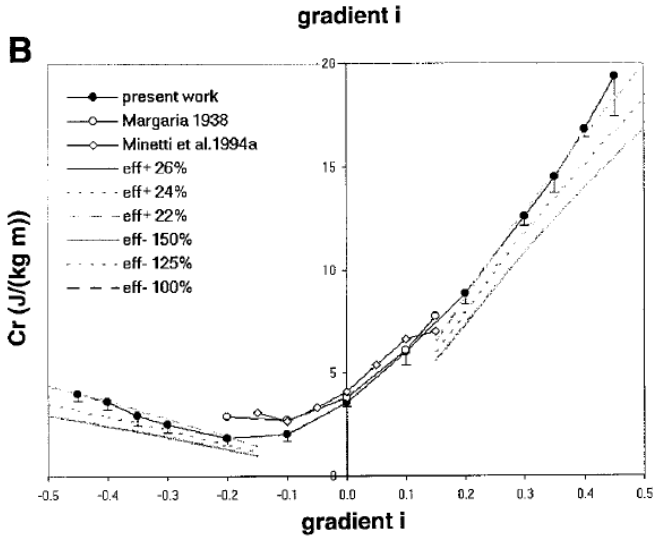
$$25\sqrt{2}\sigma \cong 35\sigma \quad [9]$$

and that $a(n)$ is affected by a noise with SD equal to:

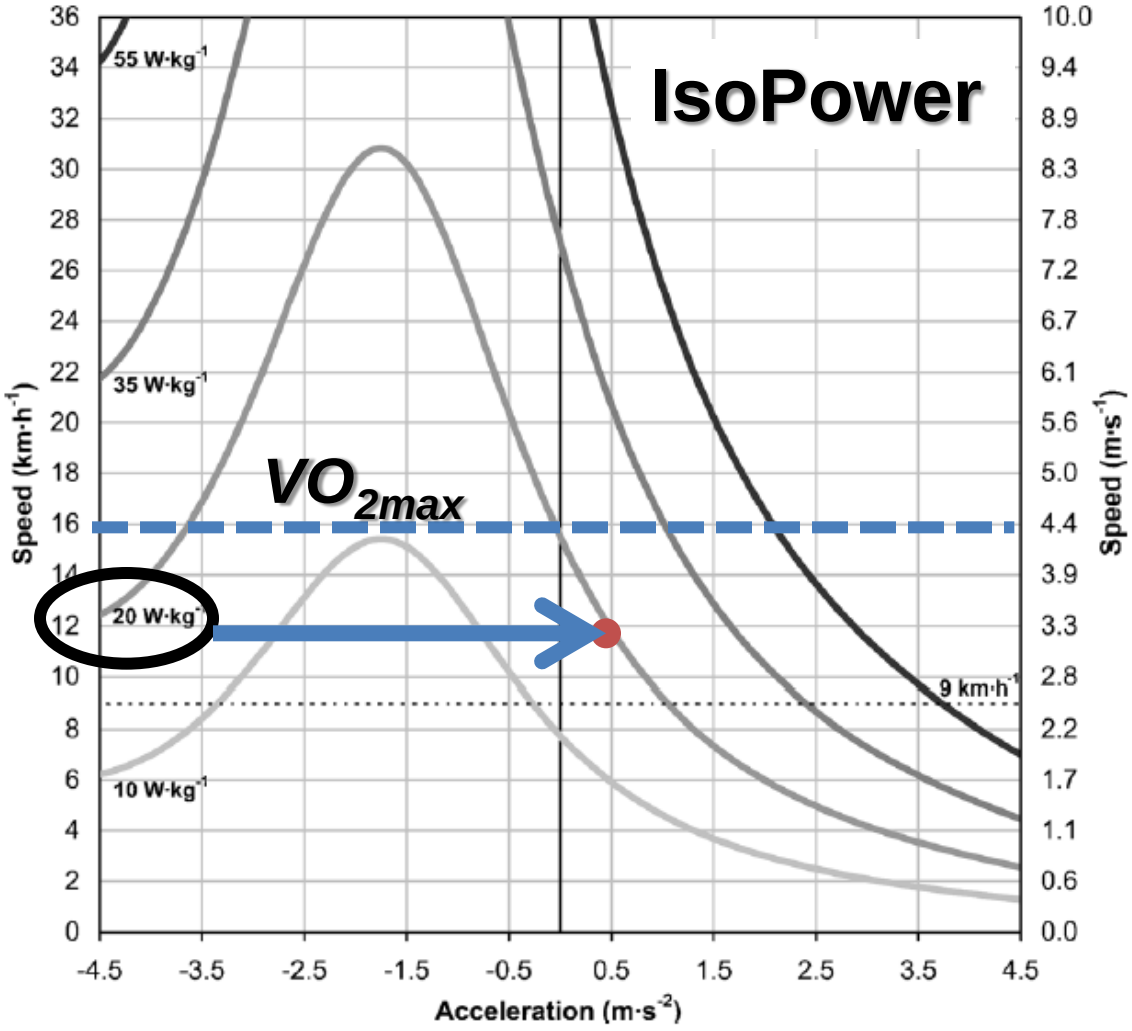
$$(25\sqrt{2})^2\sigma = 1250\sigma \quad [10]$$

Therefore, to make the estimates of $v(n)$ and $a(n)$ more reliable, the position data were filtered with the equation:

$$\hat{d}(n) = \sum_{k=0}^{186} h(k)d(n-k) \quad [11]$$



External Load Metrics



External Load: Metabolic Power

Aerobic Fitness Ecological Validity in Elite Soccer Players: A Metabolic Power Approach

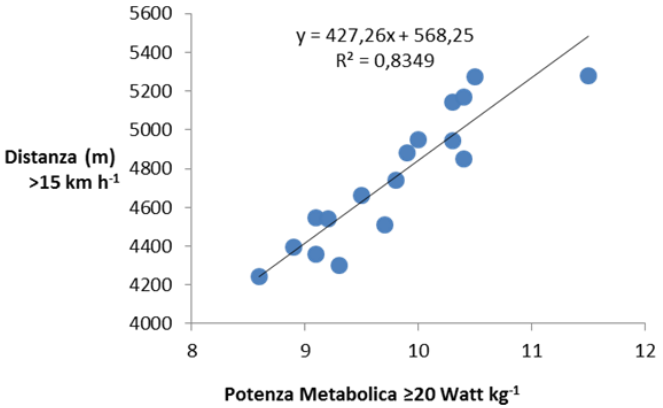
Vincenzo Manzi,[1] Franco Impellizzeri,[2] and Carlo Castagna[1]

[1]*Technical Department, Football Training and Biomechanics Laboratory, Italian Football Association (FIGC), Florence, Italy; and* [2]*Neuromuscular Research Laboratory, Schulthess Clinic, Zurich, Switzerland*

Table 2. Correlation matrix of the resulting associations among aerobic fitness and the metabolic power categori considered.*

Variables ($W \cdot kg^{-1}$)	$\dot{V}O_2max$	$\dot{V}O_2VT$	$\%\dot{V}O_2VT$	Maximal Aerobic Speed	V_{L4}
>20	0.68† (0.30–0.88)	0.83‡ (0.58–0.94)	0.62† (0.20–0.85)	0.72§ (0.36–0.89)	0.73‡ (0.58–0.94)
>35	0.63† (0.22–0.85)	0.79‡ (0.50–0.92)	0.64† (0.23–0.86)	0.64† (0.23–0.86)	0.67† (0.50–0.92)
>55	0.55§ (0.10–0.81)	0.72† (0.37–0.89)	0.65† (0.24–0.86)	0.52§ (0.05–0.80)	0.56§ (0.37–0.89)

*Data are reported as coefficient of correlation and 95% confidence intervals.
†$p < 0.01$.
‡$p < 0.001$.
§$p < 0.05$.



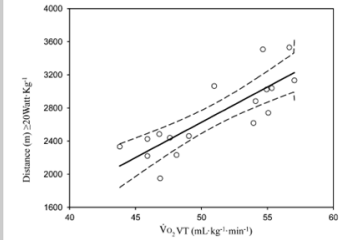


Figure 2. Scatter plot of the resulting relationship between distance covered at metabolic power ≥20 $W \cdot kg^{-1}$ and $\dot{V}O_2VT$; $r = 0.83$ (95% confidence interval, 0.58–0.94); $p < 0.0001$.

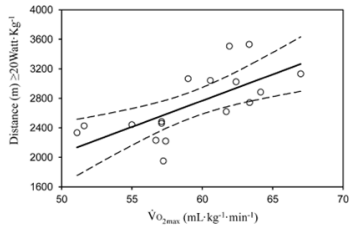
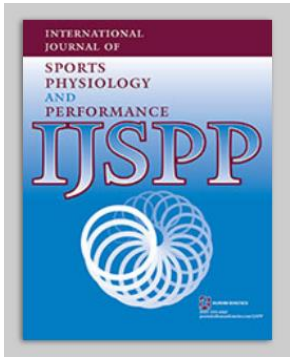


Figure 1. Scatter plot of the resulting relationship between distance covered at metabolic power ≥20 $W \cdot kg^{-1}$ and $\dot{V}O_2max$; $r = 0.68$ (95% confidence interval, 0.30–0.88); $p = 0.0024$.

Speed vs Metabolic Power



Ahead of Print

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ORIGINAL INVESTIGATION

The Evaluation of the Match External Load in Soccer: Methods Comparison

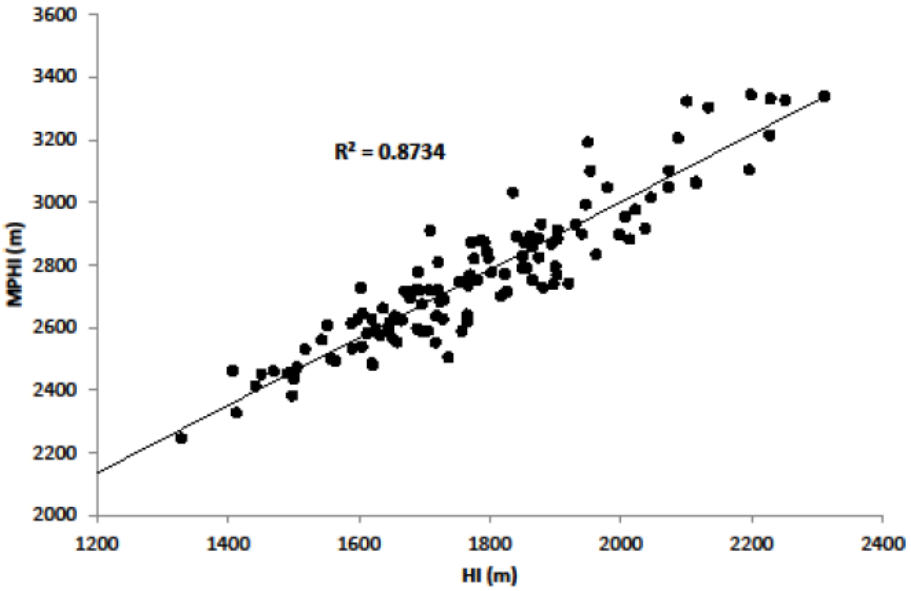
Authors: Carlo Castagna[12*] Matthew Varley[3] Susana Cristina Póvoas Araújo[4] Stefano D'Ottavio[2]

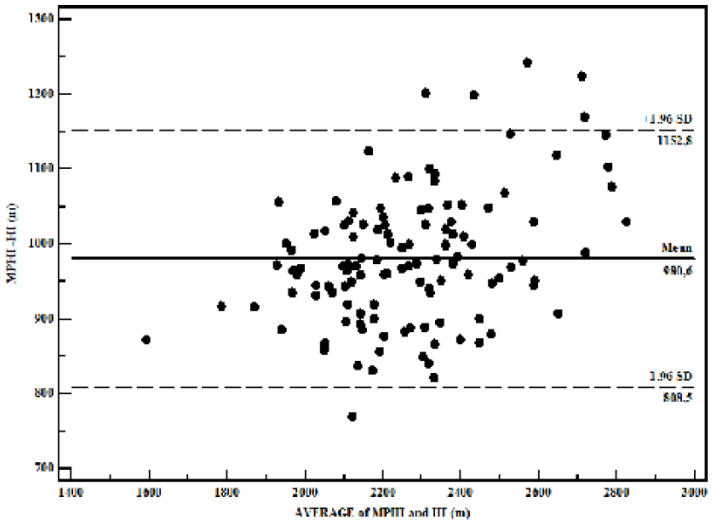
AFFILIATIONS

[1]Fitness training and biomechanics laboratory, Italian Football Federation (FIGC), Technical Department, Coverciano (Florence), Italy. [2]University of Rome Tor Vergata, Rome, Italy. [3]College of Sport and Exercise Science, Victoria University, Footscray PO Box 14428, Melbourne VIC 8001, Australia. [4]Research Center in Sports Sciences, Health Sciences and Human Development, CIDESD, University Institute of Maia, ISMAI, Maia, Portugal. *Contact Details for the Corresponding Author: Carlo Castagna PhD, via Sparapani 30, 60131, Ancona, Italy; tel: +39 071-2866532, @mail: castagnac@libero.it

Volume: 0 **Issue:** 0 **Pages:** 1-25

	TD	HI	VHI	MPHI	Σ
Premier League	5	3	1	3	7
BUNDESLIGA	1	1	2	1	4
LIGUE 1	3	2	3	2	7
LaLiga	4	5	5	5	15
SERIE A	2	4	4	4	12





External Load: Metabolic Power

Il Carico Interno ed Esterno nel controllo del 3v3: Studio di un caso.

Carlo Castagna, Vincenzo Manzi 2013

RISULTATI

- Distanza 721±60 metri
- PM 11.2±1.1 Watt·kg^{-1}
- VO_2 47.2±8.1 ml·kg^{-1}·min^{-1} (80±10%)
- Stima VO_2 33±3 ml·kg^{-1}·min^{-1} (56±7.4%)
- Lattato 3.7±2.4 mmol·l^{-1}

Metabolic Power Validity

Measured and Estimated Energy Cost of Constant and Shuttle Running in Soccer Players

TOM GERARDUS ANTONIA STEVENS[1], CORNELIS JOHANNES DE RUITER[1], DAVID VAN MAURIK[1], CHRIS JOANNES WILHELMUS VAN LIEROP[1], GEERT JOZEF PETER SAVELSBERGH[1,2], and PETER JAN BEEK[1,3]

[1]Research Institute MOVE, Faculty of Human Movement Sciences, VU University Amsterdam, THE NETHERLANDS; [2]Academy of Physical Education, Amsterdam University of Applied Sciences, THE NETHERLANDS; [3]School of Sport & Education, Brunel University, Uxbridge, Middlesex, UNITED KINGDOM

APPLIED SCIENCES

- Actual energy cost of constant running was significantly overestimated by MP approach....
- Actual energy cost of shuttle running was significantly underestimated.

Metabolic Power Validity

Monitoring Locomotor Load in Soccer: Is Metabolic Power, Powerful?

Authors: M. Buchheit[1], C. Manouvrier[2], J. Cassirame[3], J.-B. Morin[4]

Affiliations:
[1] Paris Saint Germain FC, Performance, Saint-Germain-en-Laye, France
[2] Olympic de Marseille Fooball Club, Physical Performance, Marseille, France
[3] Laboratory of Sport Sciences, Université de Franche-Comté, UFR STAPS Besançon, Besançon, France
[4] Faculty of Sport Sciences, Université de Nice Sophia Antipolis, NICE, France

- MP largely underestimates the energy demands of soccer-specific drills, especially during the recovery phases.
- **The poor reliability of MP > 20 W.kg $^{-1}$ questions its value for monitoring purposes in soccer.**
- Actual energy cost of shuttle running was significantly underestimated.

Metabolic Power Validity

PLOS ONE

RESEARCH ARTICLE

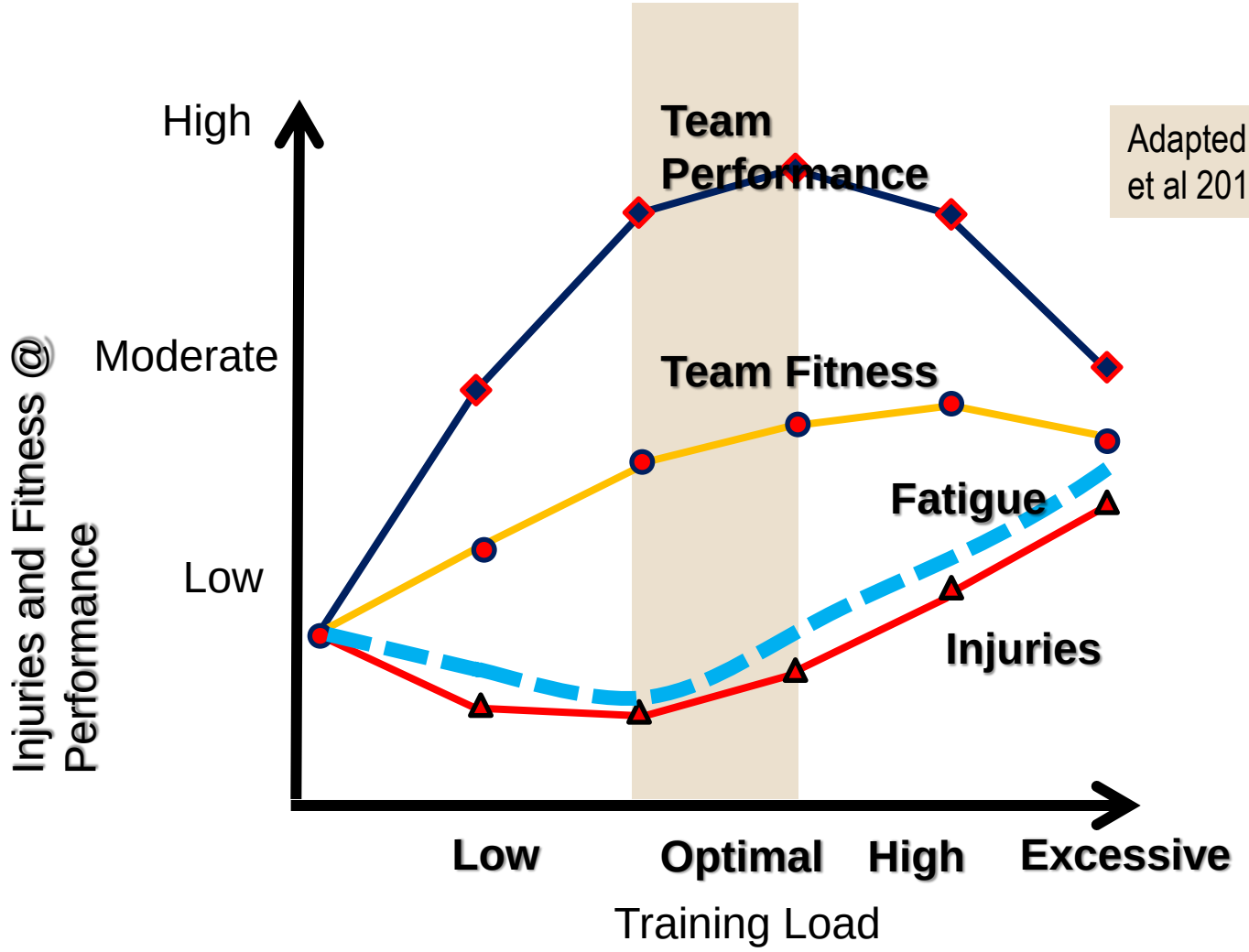
Metabolic Power Requirement of Change of Direction Speed in Young Soccer Players: Not All Is What It Seems

Karim Hader[1,2☯]*, Alberto Mendez-Villanueva[3‡], Dino Palazzi[3‡], Saïd Ahmaidi[1], Martin Buchheit[4,5,6☯]

1 Laboratory of Exercise Physiology and Rehabilitation, EA 3300, Faculty of Sport Sciences, University of Picardie, Jules Verne, 80025 Amiens, France, 2 National Sports Medicine Programme, Excellence in Football Project, Aspetar-Orthopaedic and Sports Medicine Hospital, Doha, Qatar, 3 Sport Science Department, Aspire Academy, Doha, Qatar, 4 Sport Science Department, Myorobie Association, Montvalezan, France, 5 Performance Department, Paris Saint Germain Football Club, Saint-Germain-en-Laye, France, 6 Institute of Sport, Exercise and Active Living, College of Sport and Exercise Science, Victoria University, Melbourne, Australia

- These results also highlight the dissociation between metabolic and muscle activity demands during COD-sprints, which **questions the use of metabolic power as a single measure of running load in soccer.**

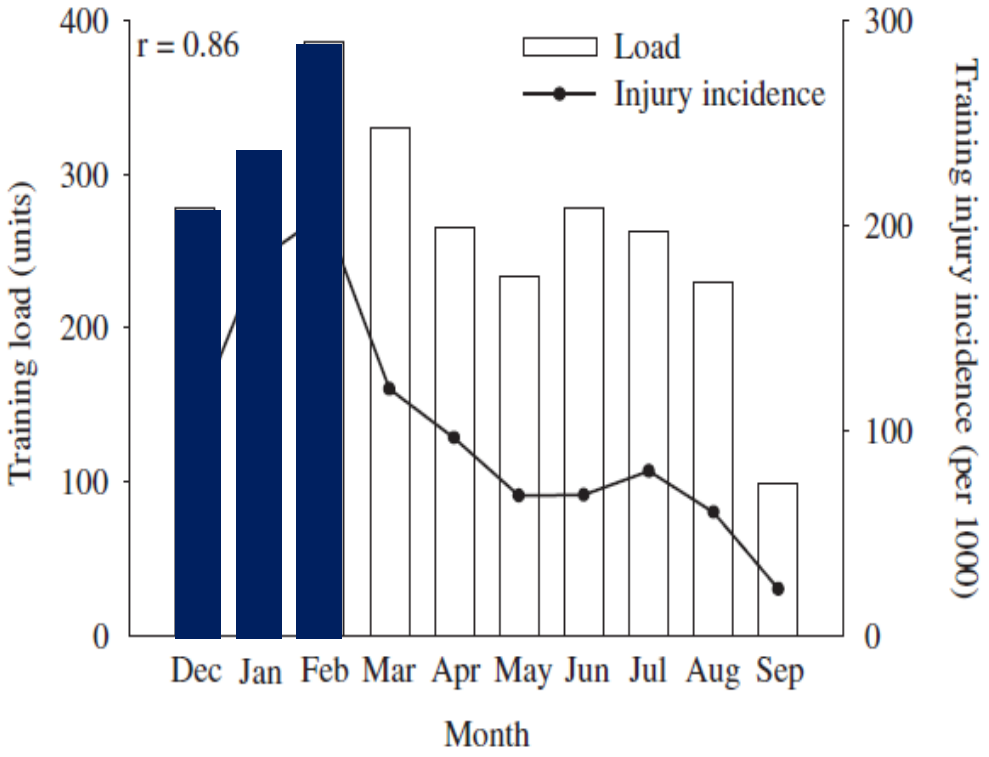
Training Load Dynamic

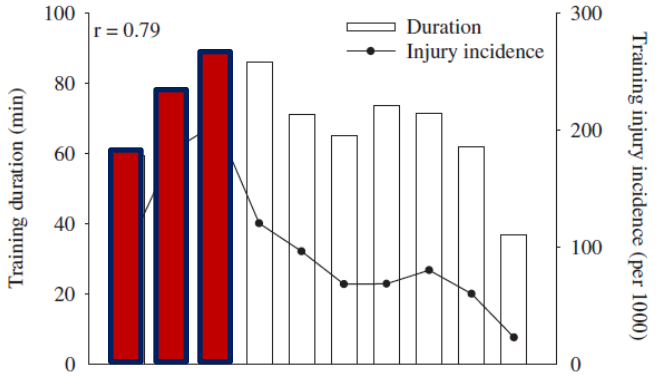


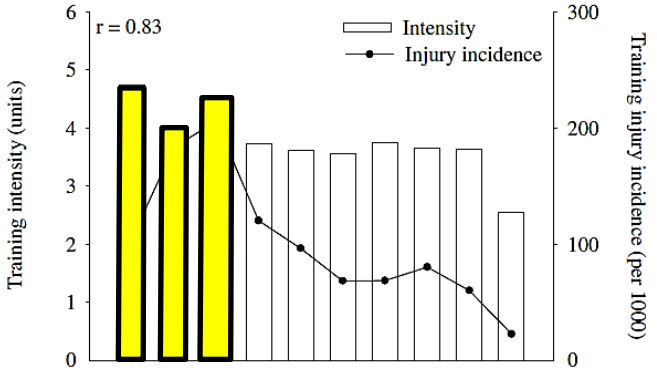
Adapted from Gabbett et al 2015 BJSM

Training Load Dynamic

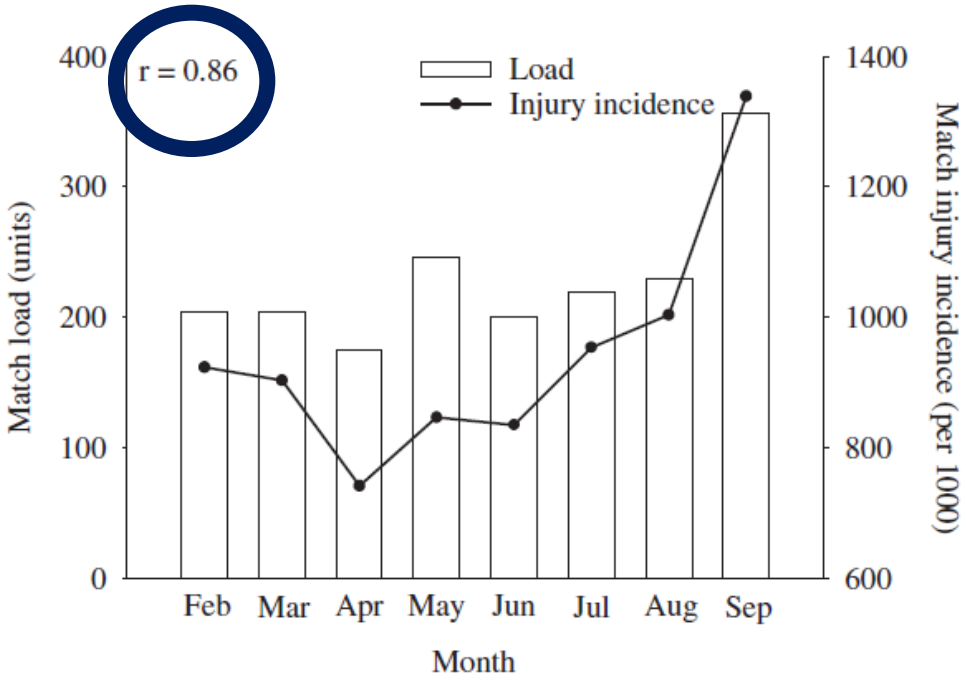
Gabbett et al 2004 JSS



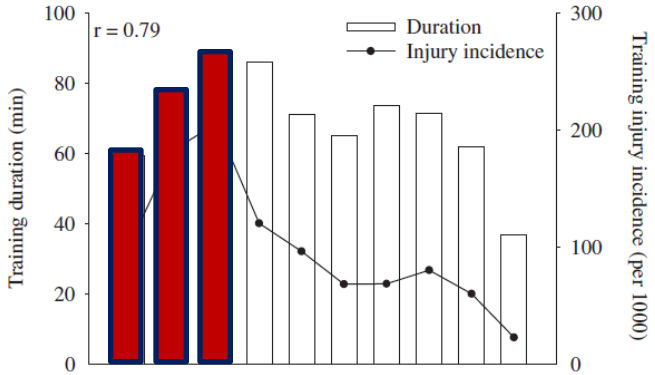


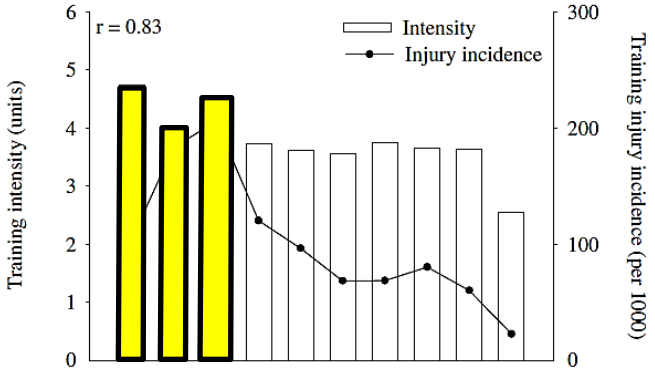


Training Load Dynamic

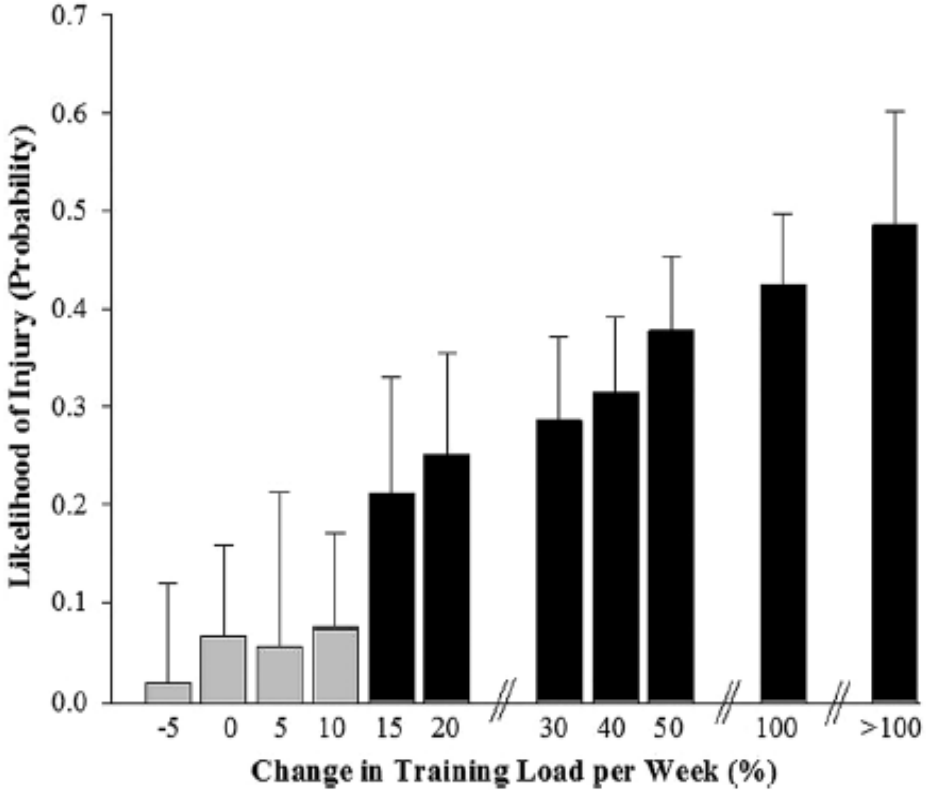


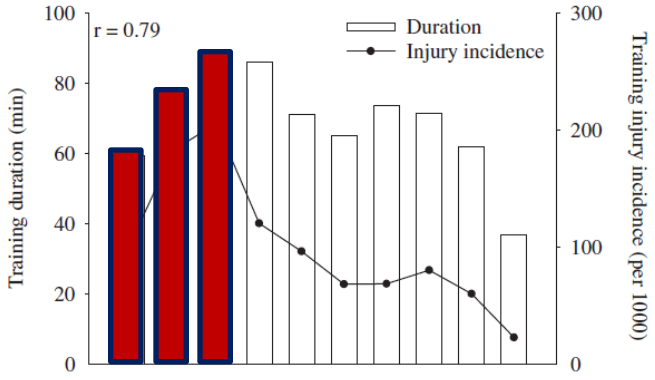
Gabbett et al 2004 JSS

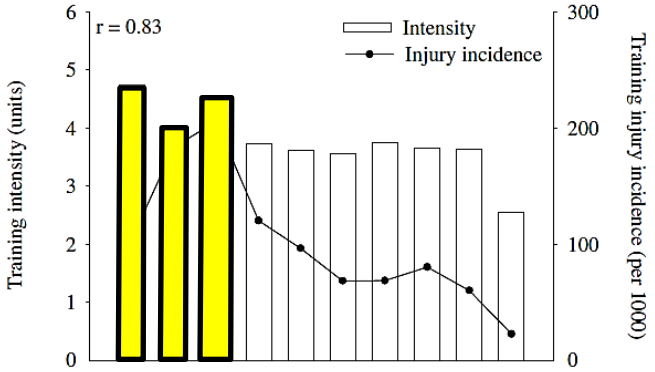




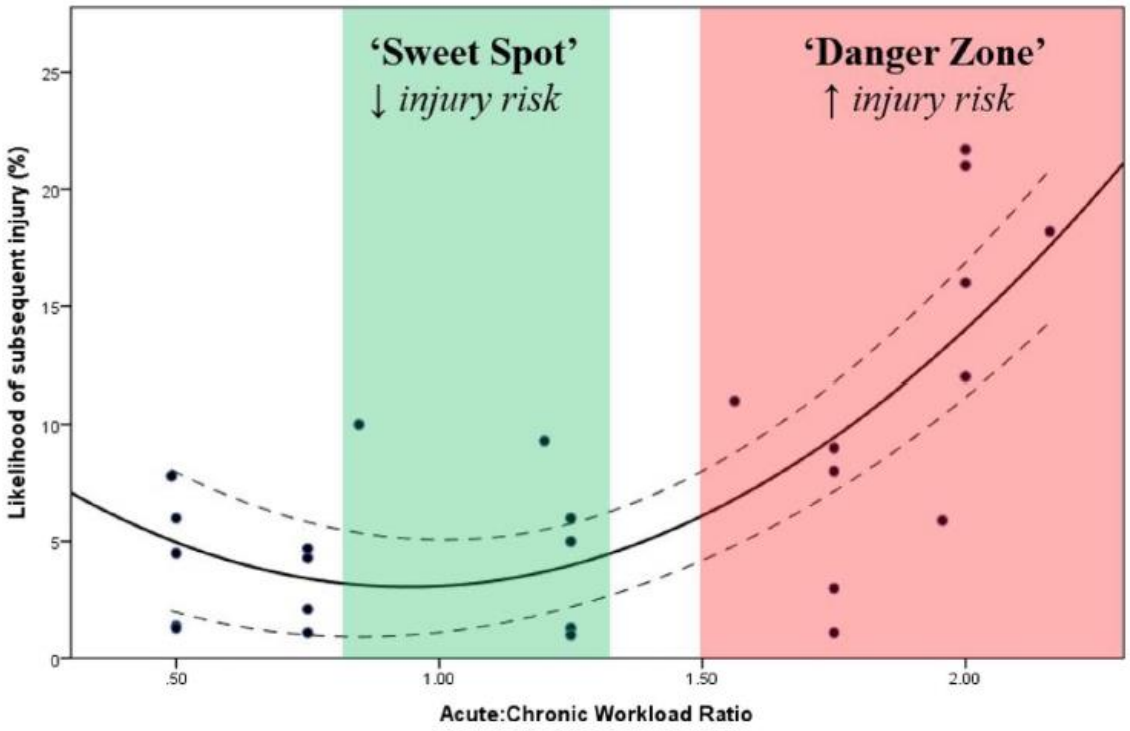
Training Load Dynamic



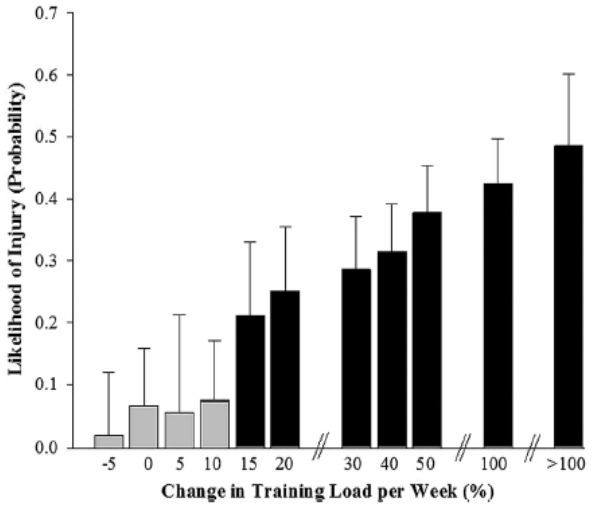




Training Load Dynamic

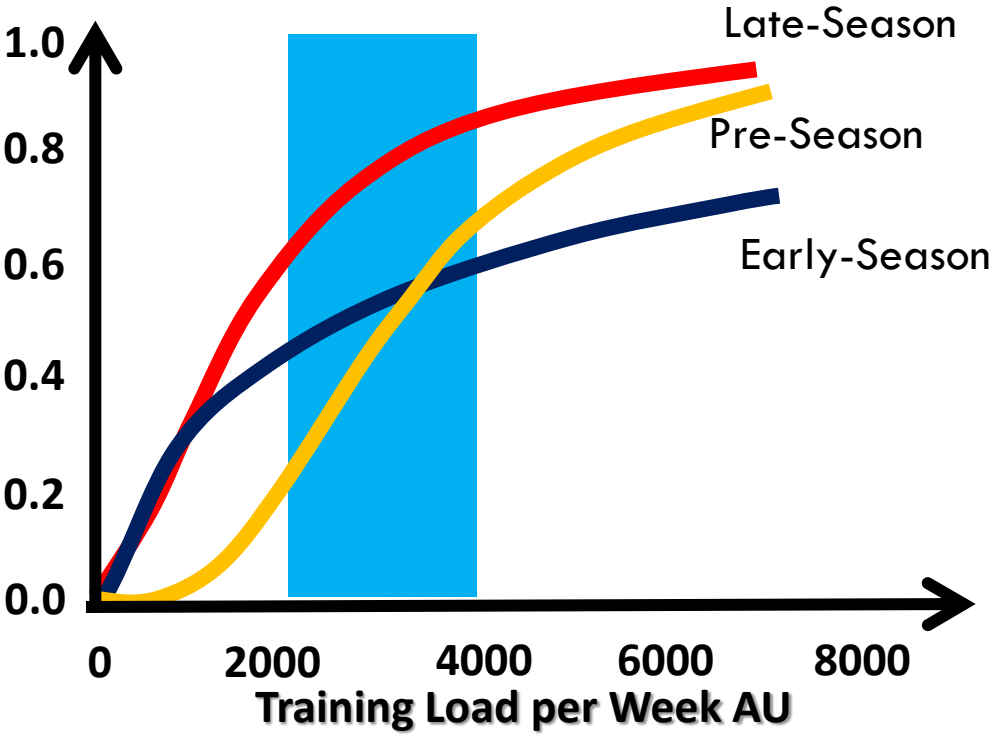


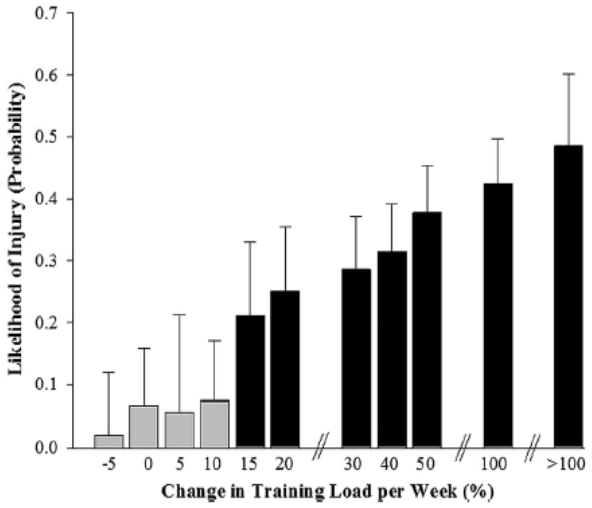
Gabbett et al 2015 BJSM



- **Acute/Chronic Load Ratio=** $\frac{\text{S-RPE 1 week}}{\text{3-6 weeks S-RPE}}$
- **Sweet Spot ACLR =0.8–1.3**

Training Load Dynamic





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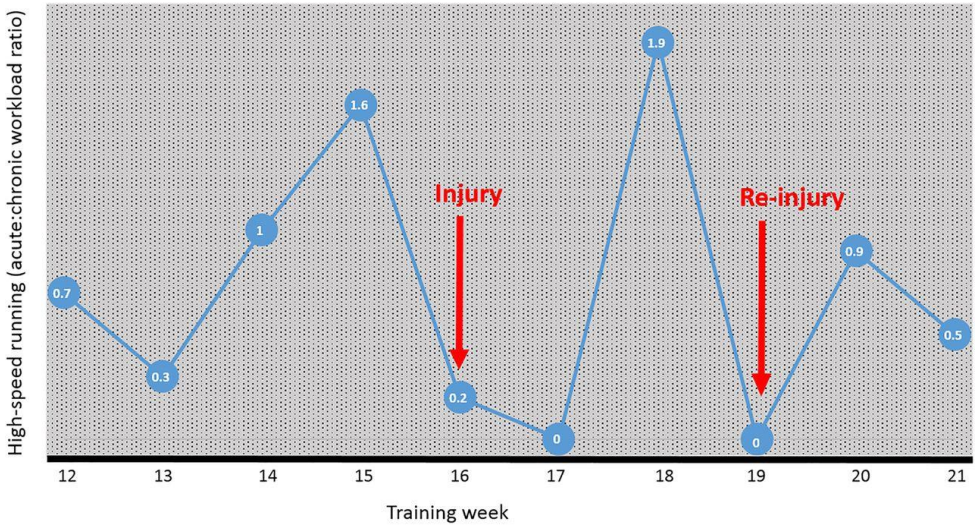
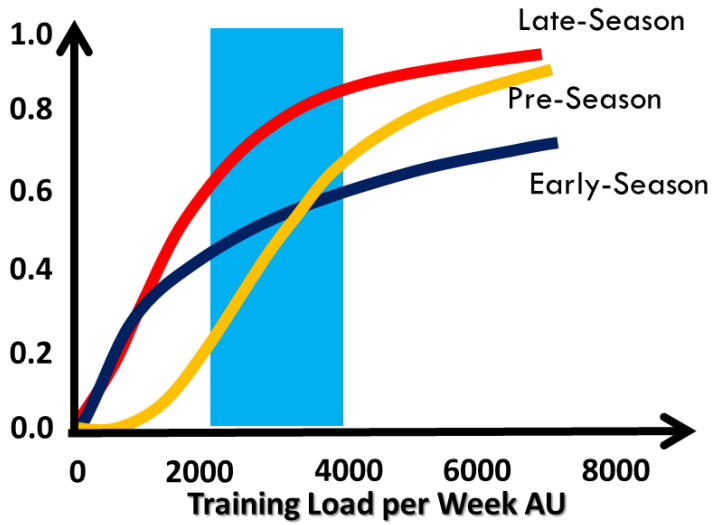
Training Load Dynamic





Peter Blanch, and Tim J Gabbett Br J Sports Med 2016;50:471-475

- **Acute/Chronic Load Ratio= $\frac{\text{S-RPE 1 week}}{\text{3-6 weeks S-RPE}}$**
- **Sweet Spot ACLR =0.8–1.3**

Training Load Dynamic

Training-Injury Prevention Paradox

- Athletes accustomed to high training loads have fewer injuries than athletes training at lower workloads.
- Well-developed physical qualities are associated with a reduced risk of injury.
- Under-training may increase injury risk

Train Harder & Smarter

Training Load Dynamic

Training-Injury Prevention Paradox

- Excessive and rapid increases in training loads are likely responsible for a large proportion of non-contact, soft-tissue injuries.

Train Harder & Smarter

Training Load Dynamic

Editorial

Mathematical coupling causes spurious correlation within the conventional acute-to-chronic workload ratio calculations

Lorenzo Lolli,[1] Alan M Batterham,[1] Richard Hawkins,[2] David M Kelly,[2,3] Anthony J Strudwick,[2] Robin Thorpe,[2,3] Warren Gregson,[3] Greg Atkinson[1]

preceding 7-day loads, respectively.[1 4] Given the conceptual definition of acute and chronic load variables,[4] we hypothesised that 'mathematical coupling' might exist, leading to a spurious correlation between acute and chronic training load estimates.[3]

To test our hypothesis with adequate statistical precision, we generated data to simulate four 7-day periods of high-speed distance data reported in a recent study involving elite Australian footballers[2] for a hypothetical squad of 1000 players (online supplementary file 1). Each of the four sets

Br J Sports Med. 2017 Nov 3. pii: bjsports-2017-098110. doi: 10.1136/bjsports-2017-098110. [Epub ahead of print]

Acute/Chronic Load

Formula:

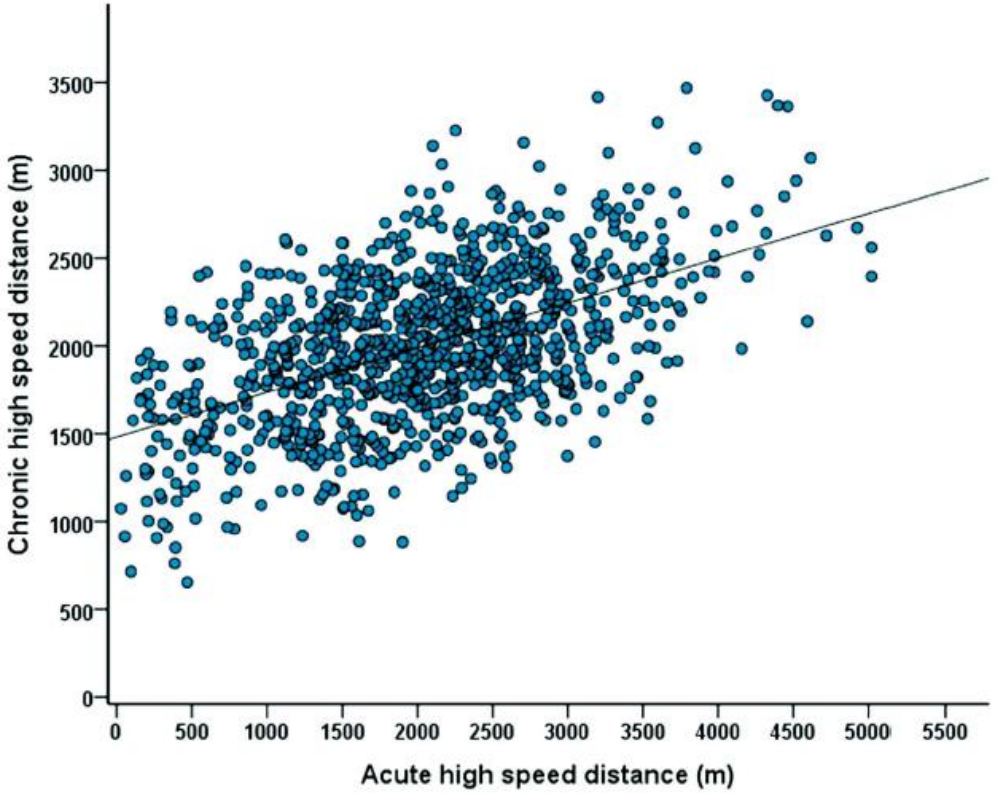
Lolli et al Br J Sports Med. 2017

$$ACWR = \frac{A}{0.25(W1 + W2 + W3 + A)}$$

Mathematical coupling in the AC WR calculation

Legend

W1= week 1
W2= week 2
W3= week 3
A= week 4



Training Load Dynamic

Lolli et al Br J Sports Med. 2017

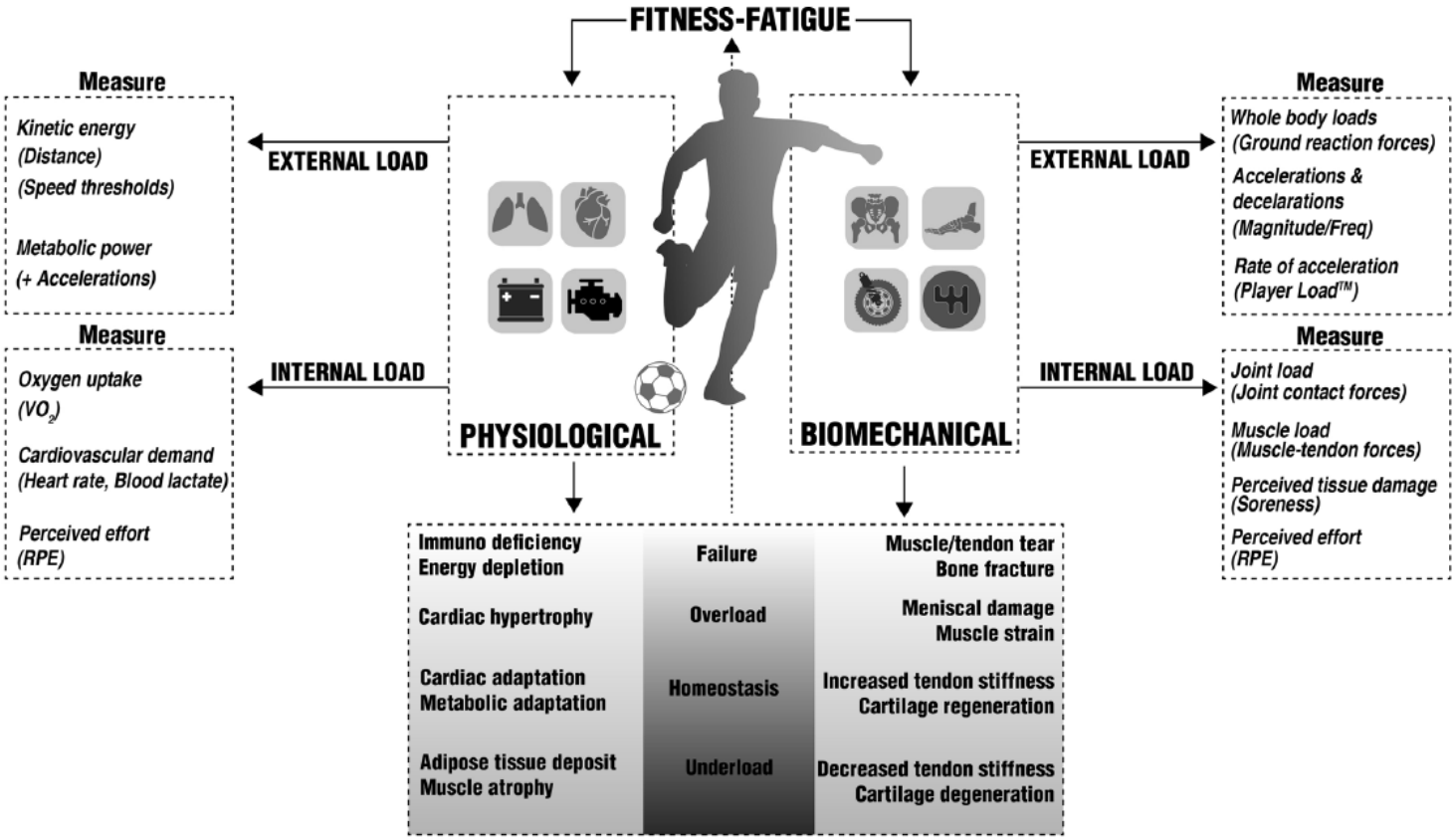
Conclusions

Collectively, our findings have demonstrated that the numerator and **denominator** *in the ACWR are mathematically coupled* and, therefore, spuriously correlated. The simplest solution is **not** to **include acute load periods in the calculation of chronic load** if the training load–injury aetiological relationship, grounded on the magnitude of the ACWR, is to be examined accurately.

Formula:

$$ACWR = \frac{A}{0.25(W1 + W2 + W3)}$$

Load Monitoring in Football:



Vanrenterghem et al 2017

Training Load Dynamic

Sports Med (2017) 47:533–544
DOI 10.1007/s40279-016-0591-0

SYSTEMATIC REVIEW

Relationships Between Training Load Indicators and Training Outcomes in Professional Soccer

Arne Jaspers[1] · Michel S. Brink[2] · Steven G. M. Probst[1] · Wouter G. P. Frencken[2,3] · Werner F. Helsen[1]

Key Points

Inconsistent findings exist regarding relationships between external load indicators and changes in sprint and jump performance in professional senior soccer.

There is moderate evidence for relationships between heart rate-based training load and changes in aerobic fitness during pre-season.

Despite the availability of external and internal load indicators, evidence regarding their relevance in relation to injury or illness is scarce.

Inconsistent Findings
External Load vs Physical Performance Changes

Moderate Evidence
HR based methods vs Aerobic Fitness Pre-Season

Scarce Evidence
I-TL Ex-TL vs Injuries

Training Load Dynamic

Sports Med
https://doi.org/10.1007/s40279-017-0830-z

SYSTEMATIC REVIEW

The Relationships Between Internal and External Measures of Training Load and Intensity in Team Sports: A Meta-Analysis

Shaun J. McLaren[1,2] · Tom W. Macpherson[1] · Aaron J. Coutts[3] · Christopher Hurst[1,5] · Iain R. Spears[4] · Matthew Weston[1]

Key Points

Total running distance has the strongest association with session ratings of perceived exertion (sRPE), sRPE training load (sRPE-TL) and heart-rate-derived training impulse (TRIMP) during team-sport training and competition.

External load relationships appear stronger with sRPE-TL than with TRIMP.

Internal–external load relationships differ depending on the mode of training.

Strongest Associations
TD and S-RPE, S-RPE and TRIMP

Strogest Associations
External Load vs S-RPE

Mode of Training dependent

Conclusion

- One Size doesn't fit all
- Internal Load
- External Load
- Validity
- Reliability

Training Load Control in Football

תודה

Carlo Castagna PhD

UNIVERSITA' degli STUDI di ROMA TOR VERGATA

SETTORE TECNICO FIGC.IT

Laboratorio di Metodologia e Biomeccanica Applicata al Calcio
Coverciano **(Firenze)**