MONITORING ATHLETES

MONITORING OF FATIGUE IN PROFESSIONAL SPORTS: WELCOME TO THE REAL-WORLD

Mathieu Lacome

AGENDA

1 PLAYERS MONITORING

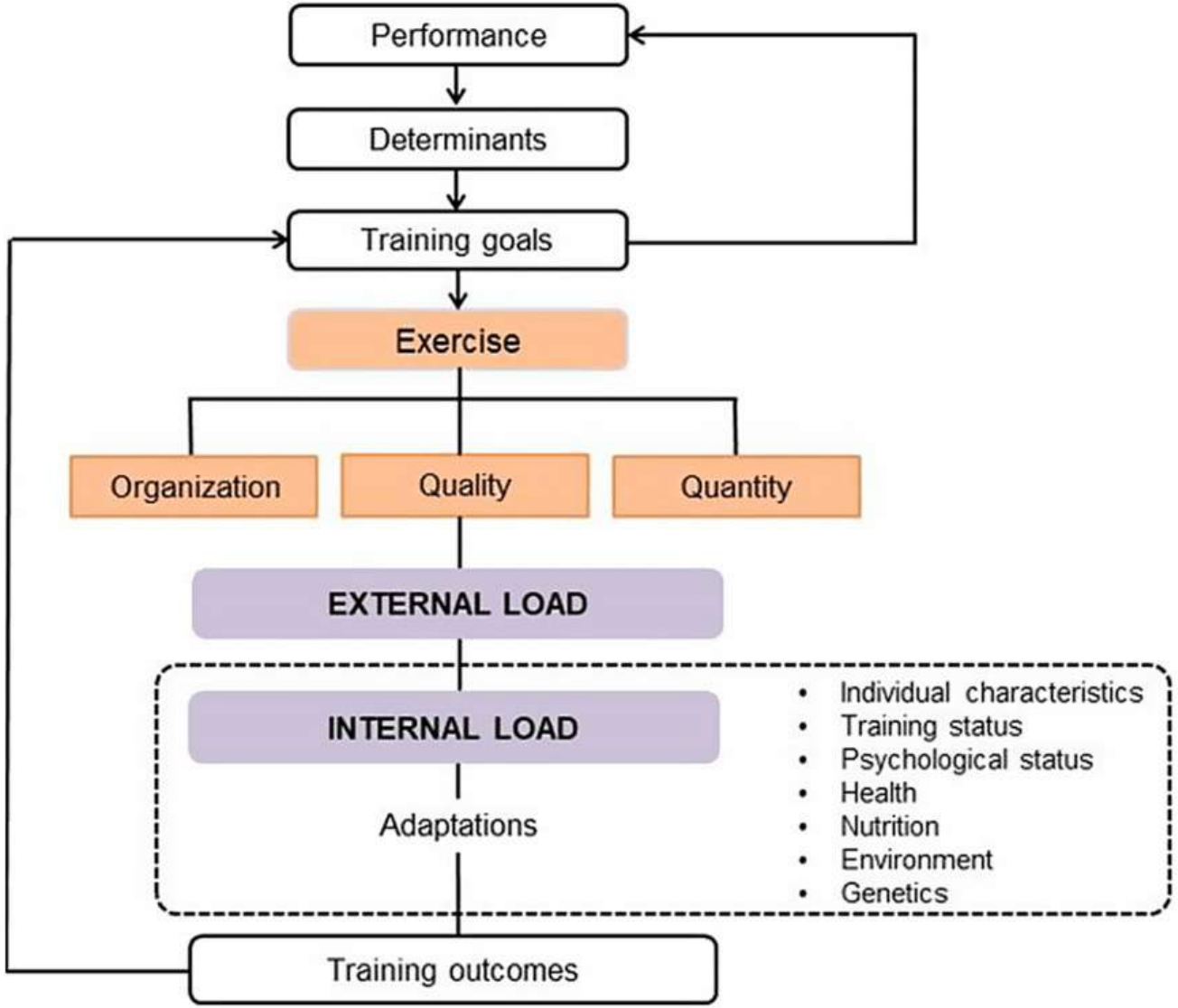
2 WHAT'S NEXT?

3 ARE WE DONE?

PLAYERS MONITORING

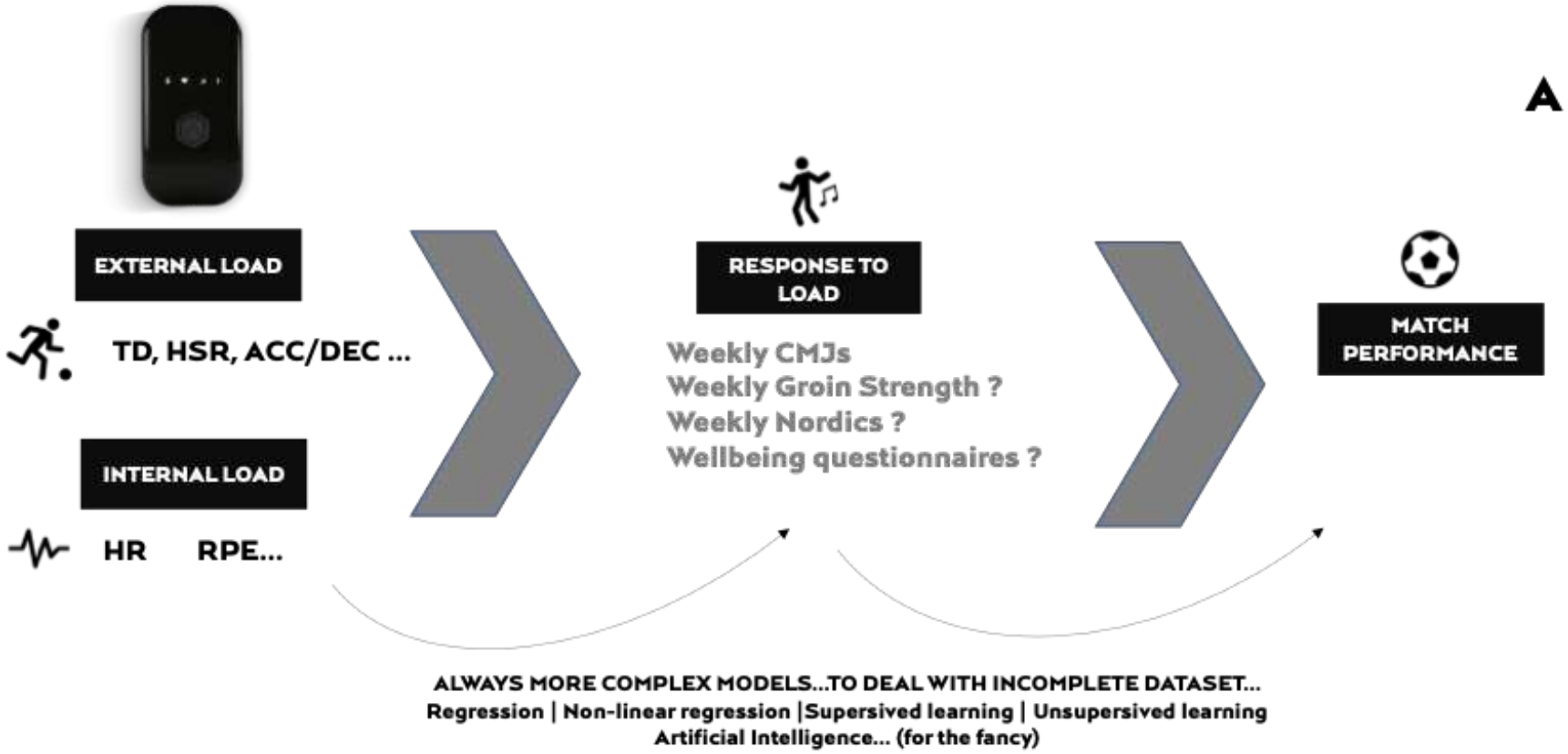
TRADITIONAL PRACTICES

MONITORING LOADS & RESPONSES



IMPELLIZZERI ET AL. 2019

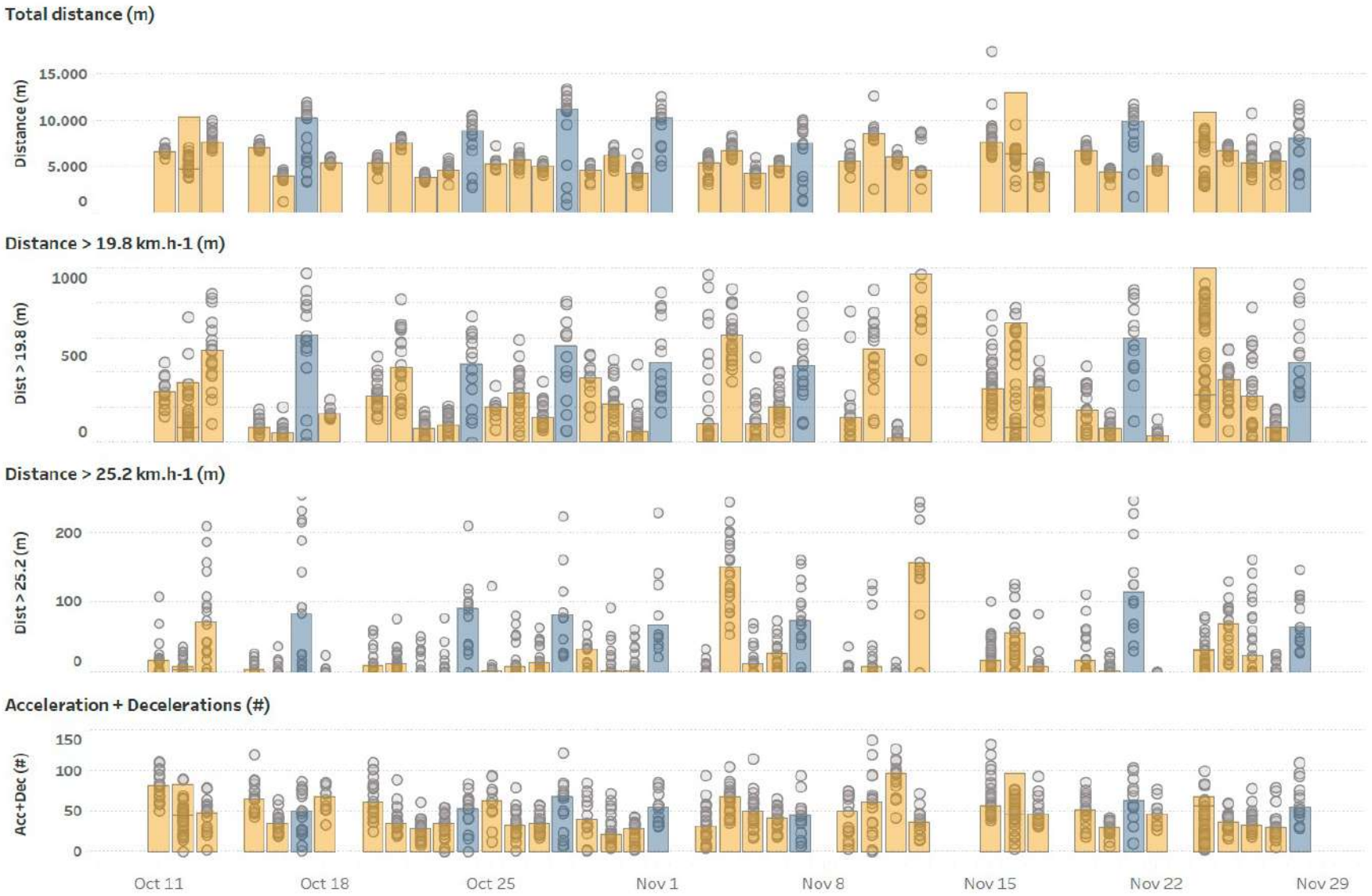
MONITORING LOADS & RESPONSES



Schematic representation of the training load management process – A. the main focus is to collect external load and sometimes collect response to load with the use of CMJ, Groin squeeze test and wellbeing questionnaire on a weekly basis. In this case, most of the time, practitionners try to develop more robust and complex model to infer on relationships between training load and players' performance. This can't be fully satisfying.

MONITORING LOADS

WEEK TO WEEK CHANGES



w20
36,421 m
24% vs usual

w20
2,021 m
48% vs usual

w20
135.3 m
48% vs usual

w20
 # 96.50
48% vs usual

MONITORING LOADS

ACUTE : CHRONIC RATIOS

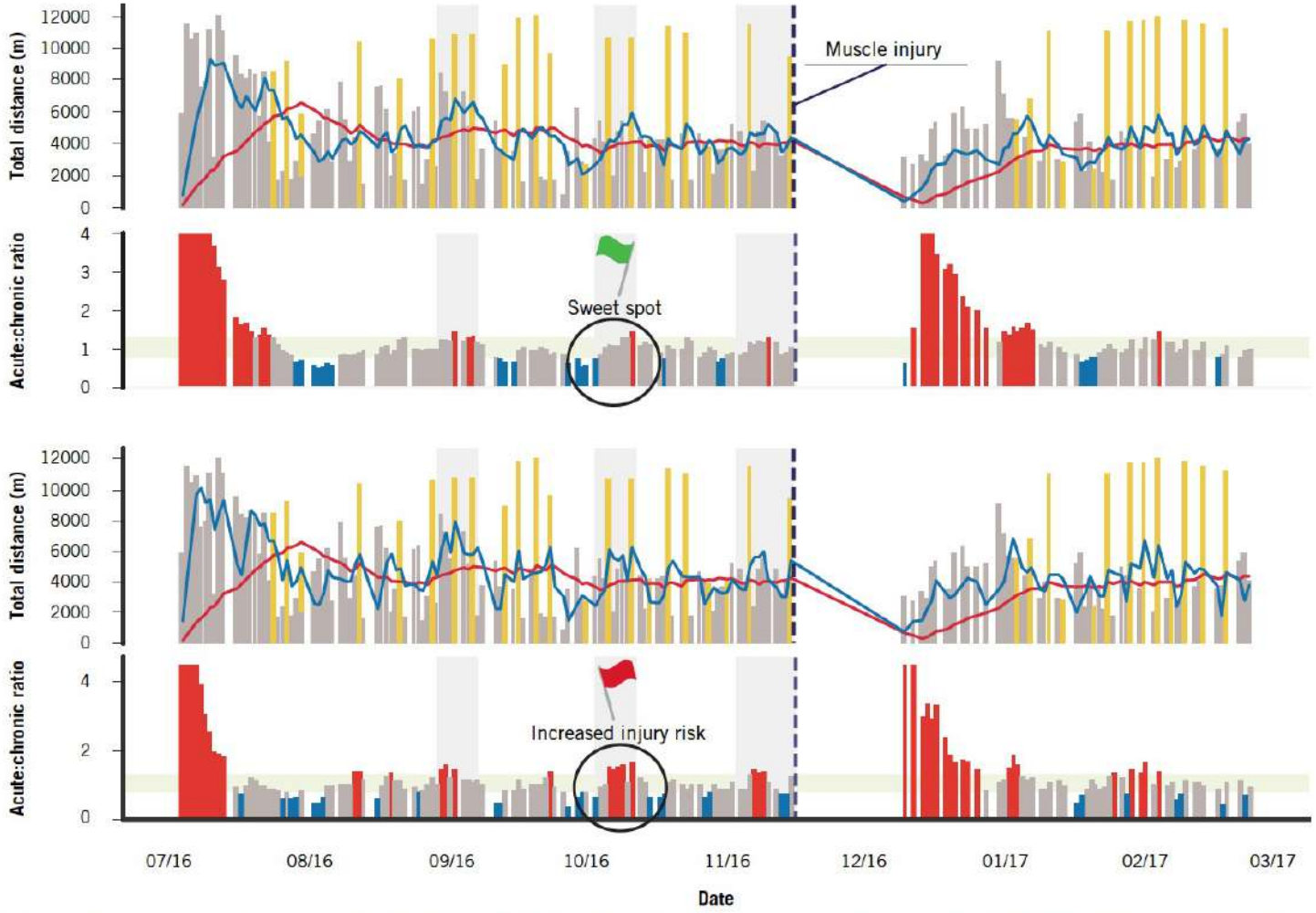


Figure 1: Change in total distance (m) for an elite football player over 7 months. Acute (blue line) and chronic (red line) loads are calculated using 7- and 28-day periods (upper panel) and 4- and 18-day periods (lower panel). Light grey zones represent international breaks when workloads are estimated based on data obtained from national team sports science support. Total distance graphs: grey bars=training sessions; yellow bars=matches. Acute:Chronic ratio graphs: bars are coloured blue and red, with blue representing unloading (acute<chronic load) and red representing loading periods (acute>chronic load), the green zone represents the theoretical sweet spot (0.8 to 1.5). Created in Tableau (v10.4).

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& RESPONSES

WELLBEING
[1-5 SCALES]

CK
[BLOOD]

NEUROMUSCULAR TESTING
[CMJs]

WATTBIKES
[SPRINTS]

LACOME ET AL. 2018
BERTRAND ET AL. 2017

THE PROBLEM

[1] STAFF NUMBER

[2] PLAYER BUY-IN

[3] TIME NEEDED TO COMPLETE

[4] … OVERALL STAFF BUY-IN


PROBLEM
OPPORTUNITY

SO WHAT'S NEXT?

WHERE ARE WE TRYING TO GO NOW?

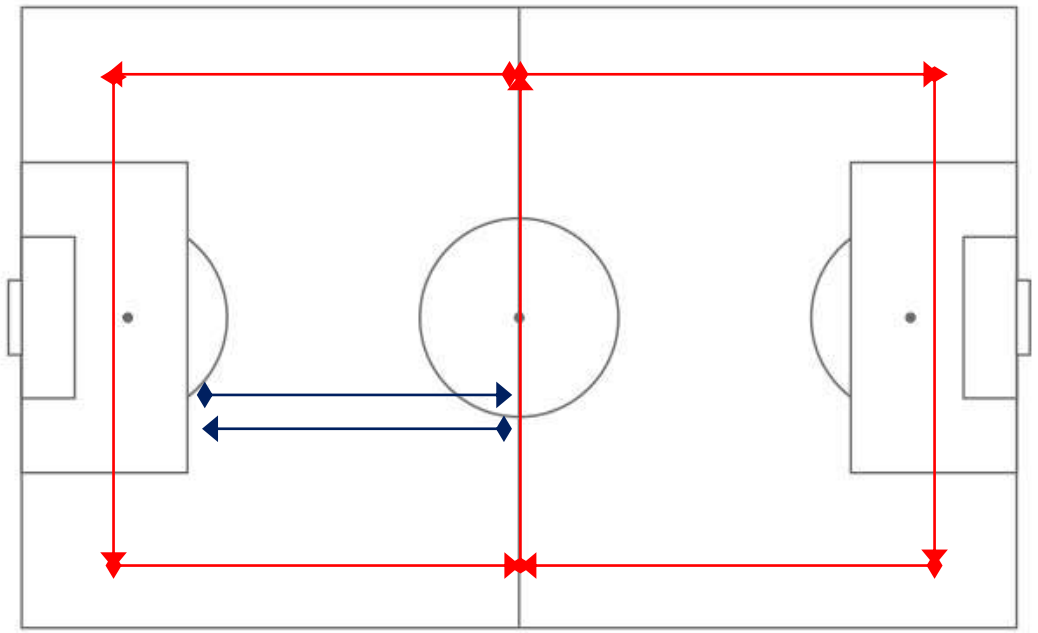
PERFORMANCE PERSONAS

WHAT PRACTITIONERS' ISSUES AND CONSTRAINTS ARE ?

1. TIME – SHORT & EFFICIENT TESTING
2. LACK OF RESOURCES – FEW TO NO ADDITIONAL SETUP
3. LACK KNOWLEDGE
4. « RISKS » MANAGEMENT & JOB-PROTECTION – UNRISKY SITUATIONS

FITNESS MONITORING

4’ SUB-MAXIMAL RUNS.
HR during the last 1-min – Run @ 12 km.h-1



ANALYSIS

Average Heart rate recording during the last 1’
Weighted by outdoor temperature

Avg. HR is an indice of overall player fitness.
Shown to be related to vLa4

DURATION: 4’
FREQUENCY: WEEKLY TO MONTHLY

FITNESS MONITORING

4’ SUB-MAXIMAL RUNS.

HR during the last 1-min – Run @ 12 km.h-1

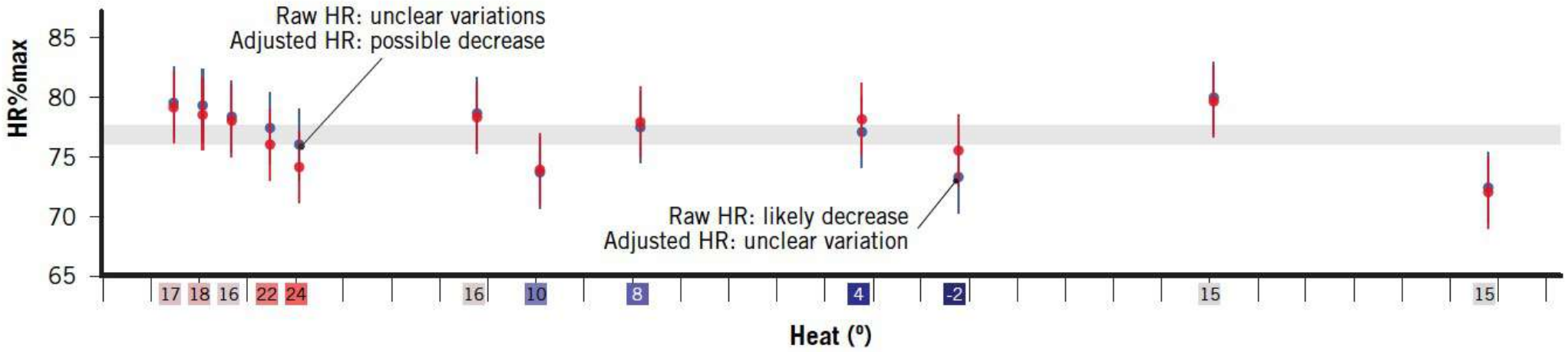


Figure 4: Upper panel: relationships between heart rate (HR) response during a 4-minute submaximal monitoring run and heat index (index that combines air temperature and relative humidity in an attempt to determine the human-perceived equivalent temperature in °C) (left) and relationships between leg stiffness (K) and pitch hardness measured with a Clegg Hammer (kN) (right). Regression coefficients (r) are presented as mean [±90% confidence limits]. Lower panel: intra-player changes in HR response (unadjusted (blue) and adjusted based on heat index (red)) to the 4-minute submaximal monitoring run (grey area represents the season mean ±1%). During the 5th run, the unadjusted HR value suggests unclear variation in fitness while the adjusted HR based on the heat index (+24°C) suggests a possible improvement (decreased HR). During the 10th run, the temperature was -2°C; unadjusted data suggest likely increased fitness while the variation may in fact be unclear when considering adjusted HR. Created with Tableau 10.2.

LACOME ET AL. 2018

FITNESS MONITORING

4’ RUN vs COGNONI or $[La]_4$ analysis

International Journal of Sports Physiology and Performance, (Ahead of Print)
https://doi.org/10.1123/ijspp.2019-0911

Human Kinetics
ORIGINAL INVESTIGATION

Monitoring Cardiorespiratory Fitness in Professional Soccer Players: Is It Worth the Prick?

Martin Buchheit, Ben M. Simpson, and Mathieu Lacome

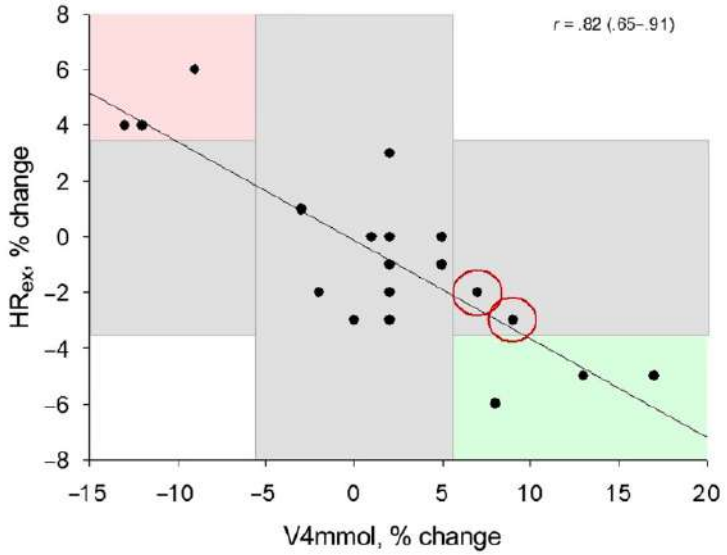


Figure 2 — Percentage change in HR_{ex} at 12 km/h and the speed at V4mmol for the 22 test comparisons. Gray areas (in online version; all but upper left corner and lower right corner) represent unclear changes (2 × typical error). The red zone (color in online but gray in print; upper left corner) represents an impaired fitness, and the green area (color in online but gray in print; lower right corner) represents an improved fitness based on both variables. Note that 2 points (<10% of the observations, circles, players 4 and 14) were suggestive of a clearly improved V4mmol despite unclear change in HR_{ex}. HR_{ex}, indicates exercise heart rate; V4mmol, speed associated with 4 mmol/L of blood lactate.

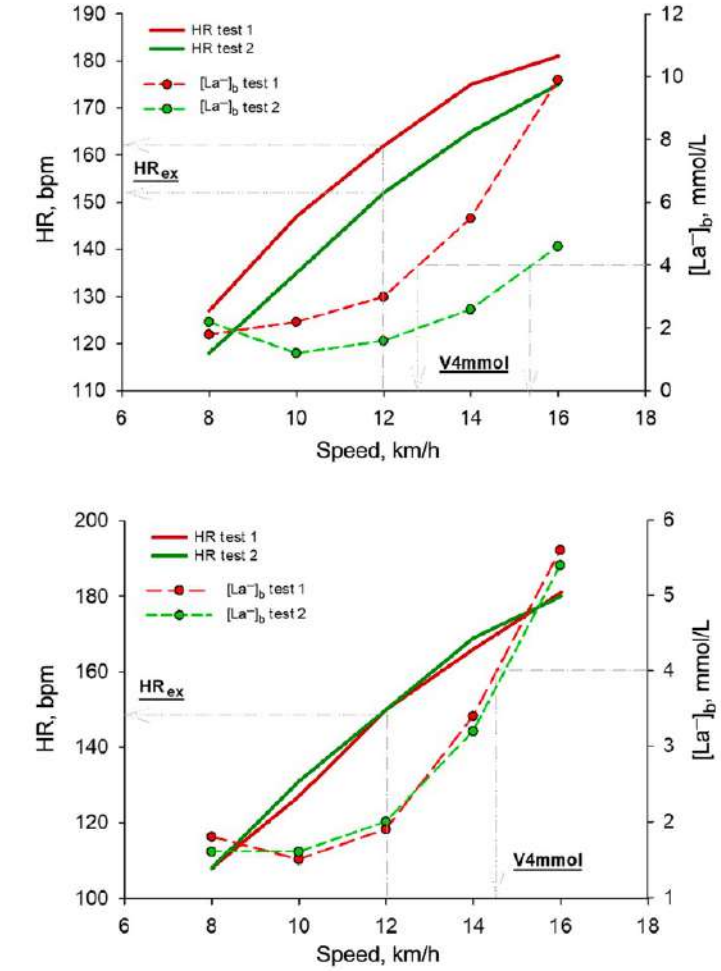


Figure 1 — Typical HR and $[La^-]_b$ patterns during 2 incremental tests performed at the start of 2 consecutive seasons in 2 representative players. Upper panel: Clear decrease in HR_{ex} of 5% and clear increase in V4mmol of 17%. Lower panel: No change in HR_{ex} and unclear increase in V4mmol of 2%. The method to derive the HR reached at 12 km/h and the speed at 4 mmol/L is also shown. HR indicates heart rate; HR_{ex}, exercise HR; $[La^-]_b$, blood lactate; V4mmol, speed associated with 4 mmol/L of blood lactate.

FITNESS MONITORING

SMALL SIDED GAMES ARE DONE DAILY IN MODERN FOOTBALL

FITNESS MONITORING

> Int J Sports Physiol Perform. 2018 Nov 1;13(10):1273-1280. doi: 10.1123/ijspp.2018-0026.
Epub 2018 Nov 20.

Monitoring Players' Readiness Using Predicted Heart-Rate Responses to Soccer Drills

Mathieu Lacome, Ben Simpson, Nick Broad, Martin Buchheit

PMID: 29688115 DOI: 10.1123/ijspp.2018-0026

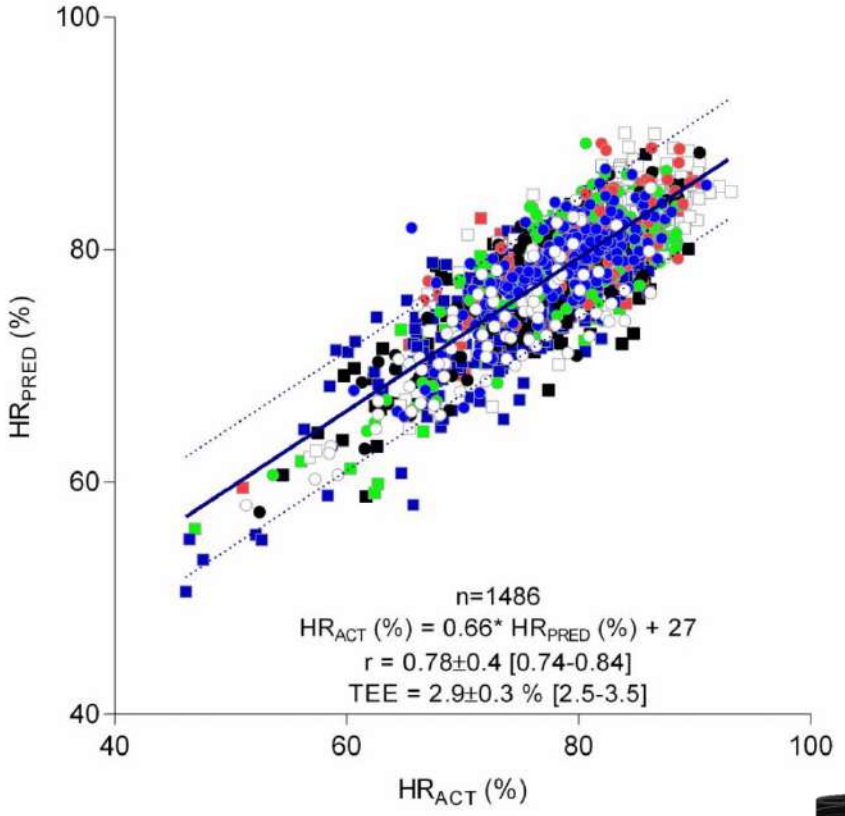


Figure 1 Relationship between predicted HR from GPS data and actual HR.

Data are presented as mean±standard deviation [range]. Blue ligne and dashed lines: Linear fit with 90% confidence intervals. TEE: Standard error of the estimate. HR_{PRED}: Predicted heart rate. HR_{ACT}: Actual heart rate. Colors and shapes are set for each player.

FITNESS MONITORING

LESS RELIABLE BUT MORE DATA POINT

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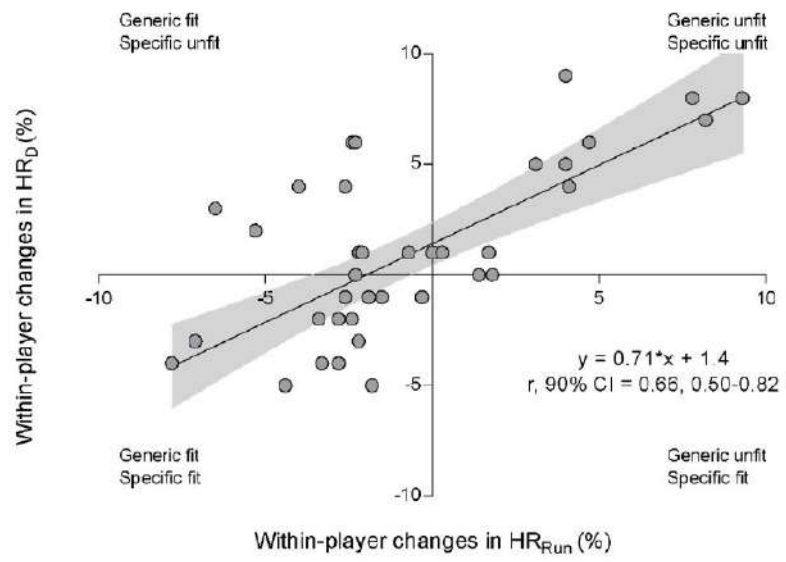
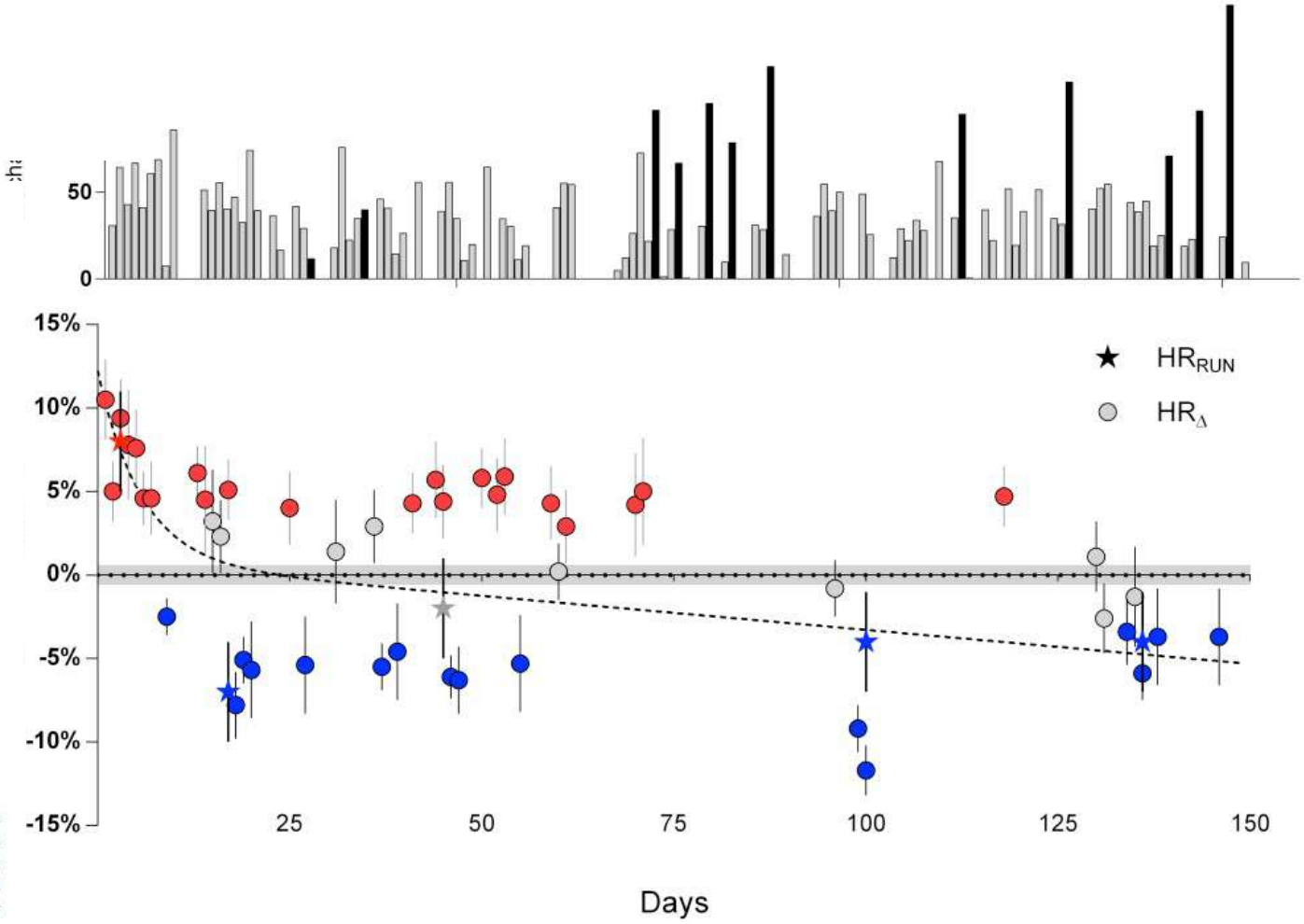


Figure 4: Relationship between within-player changes in HR_Δ and HR_{RUN} in elite soccer players.

HR_{RUN} : Heart rate during the last 1-min of the 4-min standardised submaximal running protocol. HR_Δ: difference between predicted HR from the GPS variables and the actual HR response. Y and X axes cut out the figure into 4 quadrans. Players in the upper-right quadran present both greater HR_Δ and HR_{RUN} values, suggesting that they lack both generic and specific fitness. In the bottom-left quadran, players present both lower HR_Δ and HR_{RUN} values, suggesting that these players gained both generic and specific fitness. Finally, some players in the upper-left quadran report greater HR_Δ values but lower HR_{RUN} values, suggestive of generic fitness but a lack of specific fitness. Note that there are no data point in the lower-right quadran, which would imply an unexpected (less probable) scenario: players unfit at the general level but showing specific fitness.



FITNESS MONITORING

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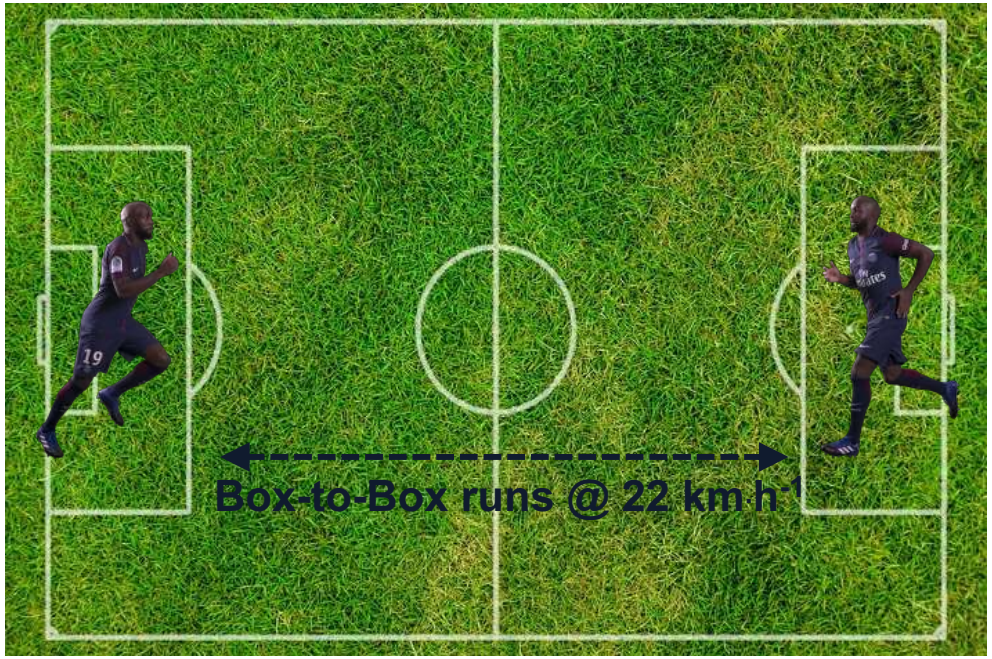
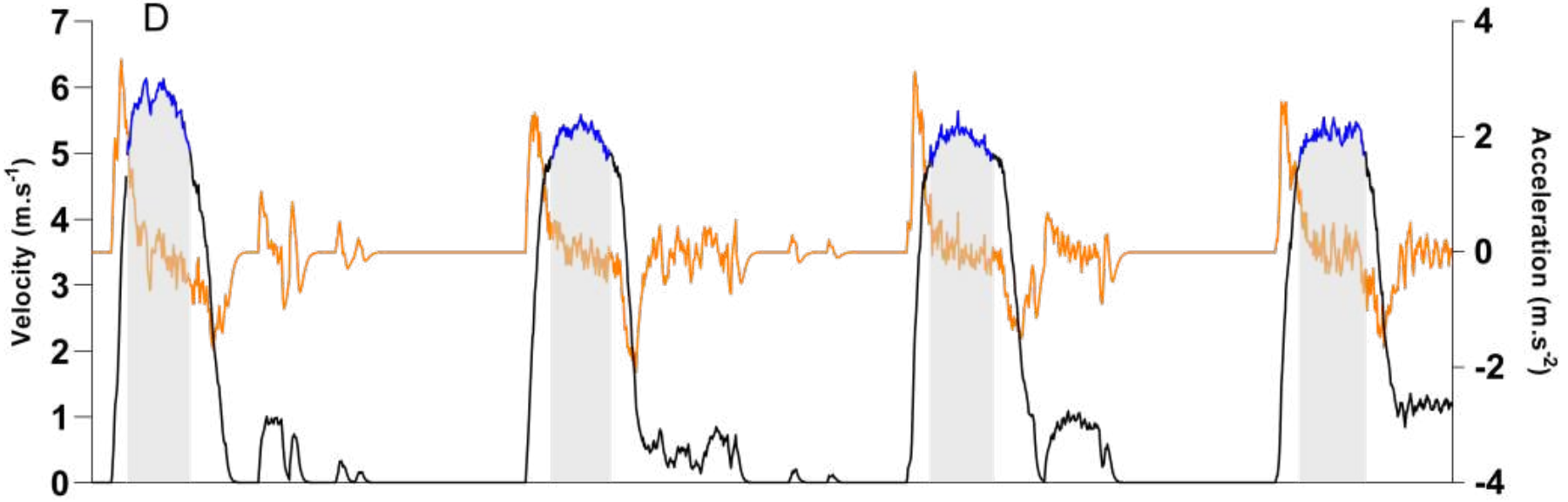
LIMITATIONS

SIMPLE SET-WISE INDIVIDUAL REGRESSIONS
NO EFFECT OF TIME OF DRILLS TAKEN INTO ACCOUNT (SLOW VO2 COMPONENT…)
SMALL SAMPLE OF DATA
NO iTRIMP POSSIBILITIES – ONLY AVG. HR

OPPORTUNITY FOR COLLABORATION?

BOX TO BOX RUNS





LEDUC ET AL. 2020

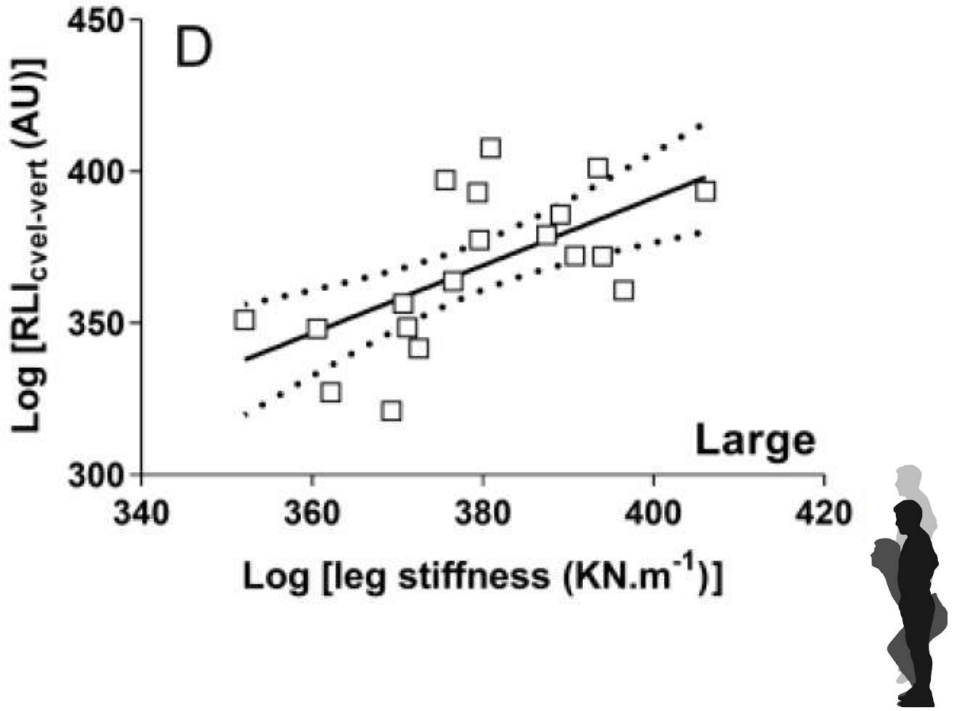
BOX TO BOX RUNS

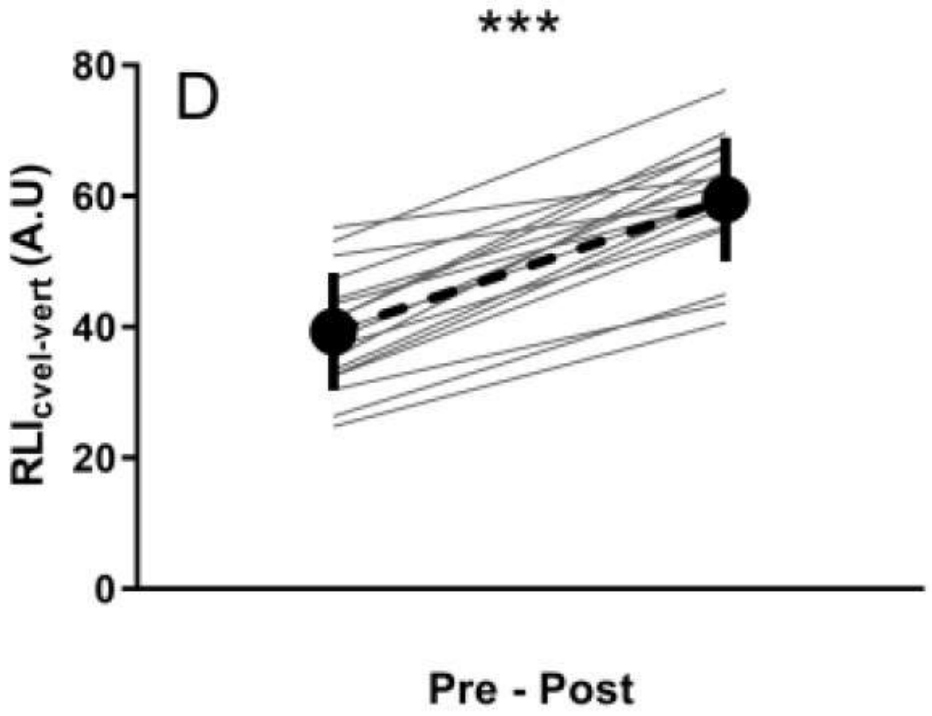
> Int J Sports Physiol Perform. 2020 Jul 8;1-7. doi: 10.1123/ijspp.2019-0319. Online ahead of print.

Convergent Validity, Reliability, and Sensitivity of a Running Test to Monitor Neuromuscular Fatigue

Cédric Leduc, Jason Tee, Mathieu Lacome, Jonathon Weakley, Jeremy Cheradame, Carlos Ramirez, Ben Jones

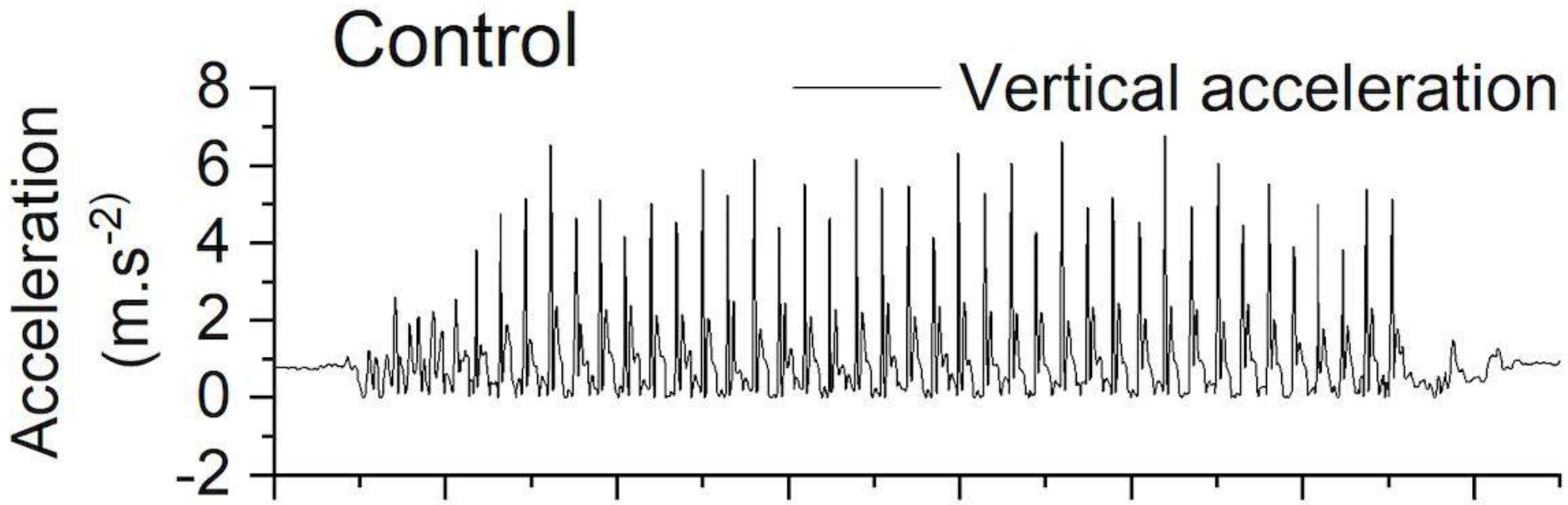
PMID: 32663385 DOI: 10.1123/ijspp.2019-0319





BOX TO BOX RUNS

FREE BONUS WITH BOX TO BOX MONITORING



ACCELEROMETER DATA @ 200 HZ

BOX TO BOX RUNS

FREE BONUS WITH BOX TO BOX MONITORING

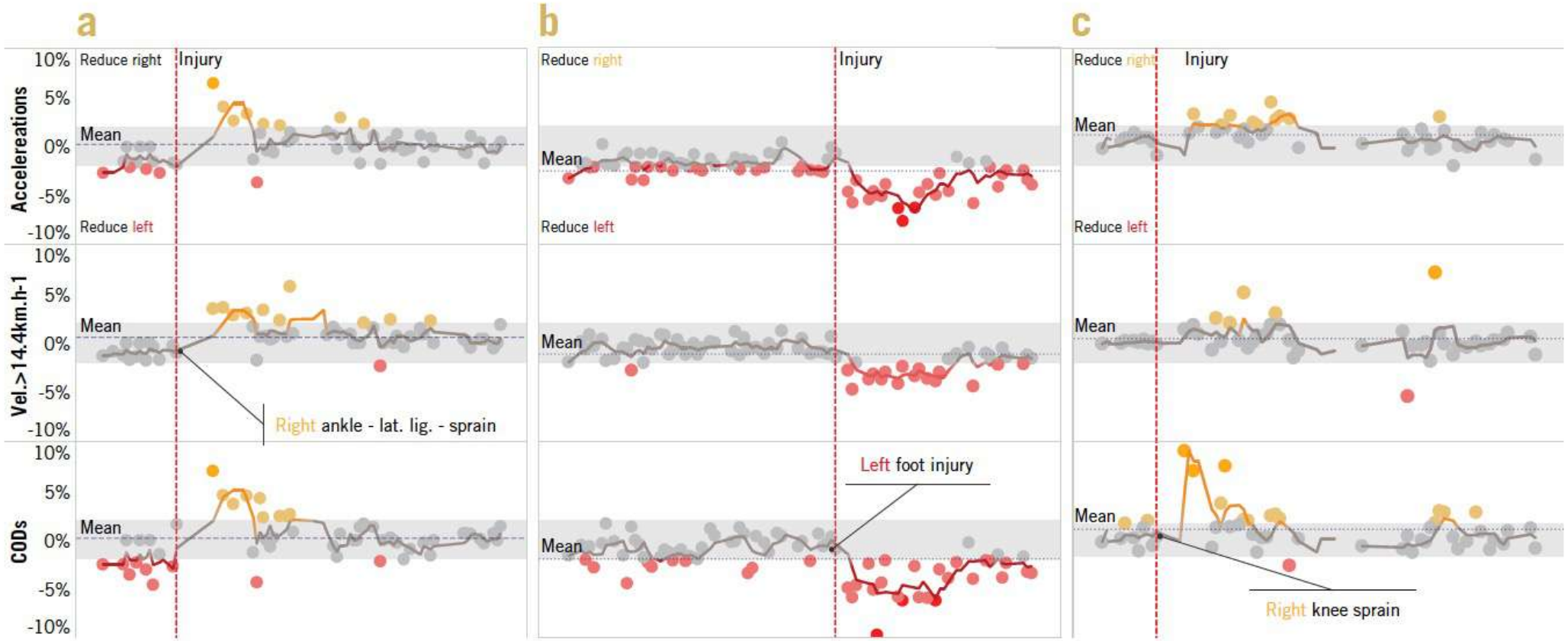


Figure 6: Examples of force load symmetries in three players before their injury and during the return to play period following (a) inferior tibiofibular ligament sprain – right ankle, (b) left foot sprain and (c) medial collateral ligament sprain – right knee. The symmetry is calculated from the force load of all foot impacts during (from top to bottom): accelerations, running phase above 14.4 km/h and changes of directions. Orange circles=right-leg force deficit >2%; red circles=left-leg force deficit >2%; red dashed lines=injury date. Created in Tableau Software 10.2.

LACOME ET AL. 2018

MUSCLE STATUS?

European Journal of
Investigation in Health, Psychology and Education

MDPI

Brief Report

Association between Change in Regional Phase Angle and Jump Performance: A Pilot Study in Serie A Soccer Players

Tindaro Bongiovanni [1,2,*], Athos Trecroci [2], Alessio Rossi [3], Fedon Marcello Iaia [2], Giulio Pasta [4] and Francesco Campa [5]

[1] Department of Health, Nutrition and Exercise Physiology, Parma Calcio, 1913 Parma, Italy
[2] Department of Biomedical Sciences for Health, Università degli Studi di Milano, 20129 Milano, Italy;

International Journal of
Environmental Research and Public Health

MDPI

Article

Phase Angle Is Related to 10 m and 30 m Sprint Time and Repeated-Sprint Ability in Young Male Soccer Players

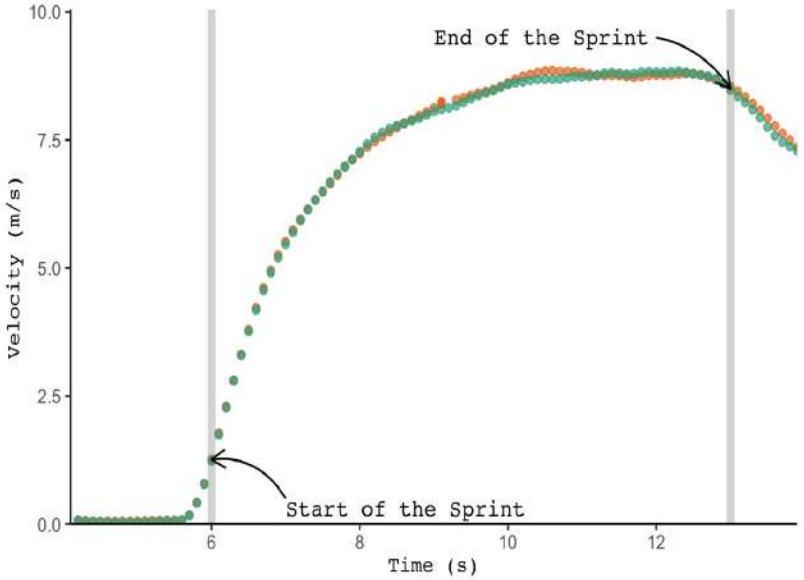
Priscila Custódio Martins [1,*], Anderson Santiago Teixeira [2,3], Luiz Guilherme ANTONACCI Guglielmo [2], Juliana Sabino Francisco [1], Diego Augusto Santos Silva [1], Fábio Yuzo Nakamura [4] and Luiz Rodrigo Augustemak de Lima [5]

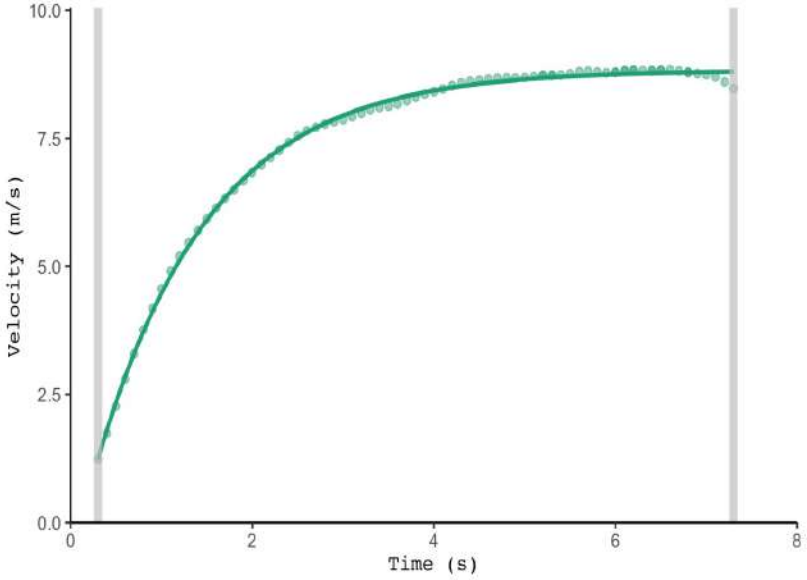
[1] Research Center in Kinanthropometry and Human Performance, Sports Center, Federal University of Santa Catarina, Florianopolis 88040-900, SC, Brazil; julianasabinofrancisco@outlook.com (J.S.F.); diegoaugustoss@yahoo.com.br (D.A.S.S.)
[2] Physical Effort Laboratory, Sports Center, Federal University of Santa Catarina, Florianópolis 88040-900, SC, Brazil; anderson.santeixeira@gmail.com (A.S.T.); luiz.guilherme@ufsc.br (L.G.A.G.)

IN PARTICULAR, BODY FLUID DISTRIBUTIONS AND CELLULAR HEALTH ARE REFLECTED IN THE BIOELECTRIC PHASE ANGLE (PHA), AN EASY TO OBTAIN BIOELECTRICAL VALUE [7]. IT HAS BEEN SHOWN THAT PHA IS HIGHER IN SOCCER PLAYERS THAN GENERAL POPULATION, WHILE DIFFERENCES BETWEEN ATHLETES AND CONTROLS SEEM TO VARY ACCORDING TO THE SPORT/PHYSICAL ACTIVITY MODALITY [7].

FORCE – VELOCITY PROFYLING

FORCE – VELOCITY PROFYLING

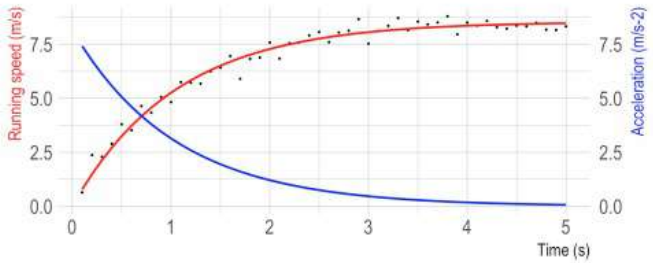




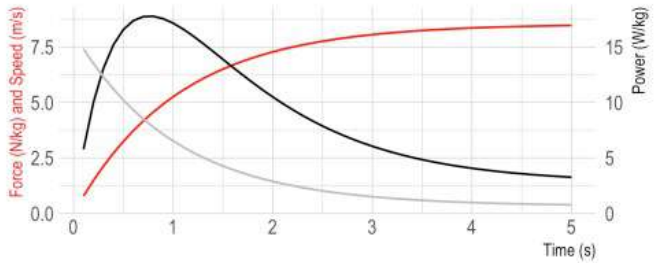
SS_SB_A_2.csv | A | FORCE-VELOCITY-POWER profile

	File	Sprint_no	Athlete	Bodyweight	F0_N	F0_N.kg.1	V0_m.s.1	Pmax_W	Pmax_W.kg.1	FV.profile_slope	RF.max
B_A_2.csv	SS_SB_A_2.csv	1	A	75	605	8.1	8.9	1342	17.9	-0.91	0.53

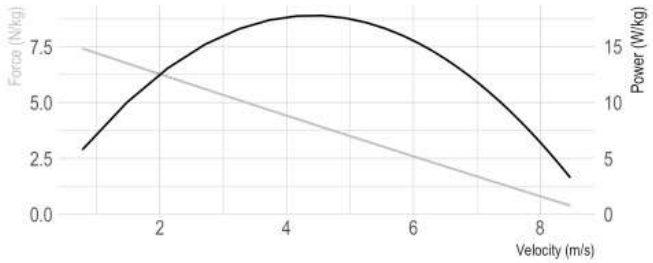
Force & Speed Profile



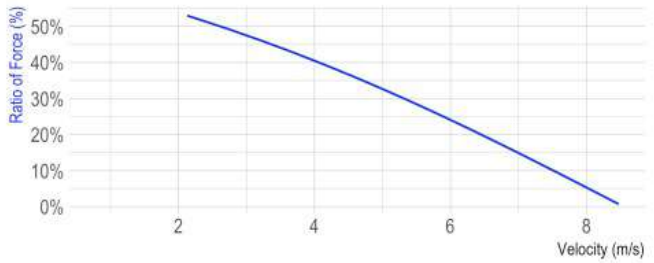
Force & Power Profile



Field Sprint Force-Velocity-Power Profile



Horizontal force–velocity profiles



Full detail of method: Samozino et al. (2015) and Morin and Samozino (2016) - Produce by HelpMyResearch team (2020)

ACC-SPEED IN-SITU MONITORING

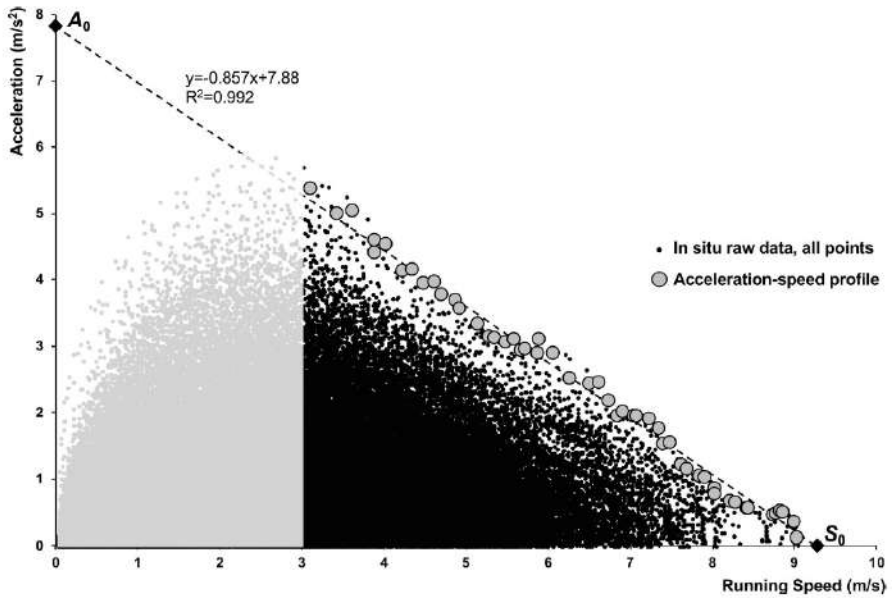


Fig. 1. Typical example of an individual acceleration-speed profile obtained from the data of 8 training sessions spanned over 2 consecutive weeks in a professional football player. From the total > 700.000 raw points, 51 points were selected (see methods) to compute the acceleration-speed linear profile. The dashed line shows the linear profile, from which theoretical maximal acceleration (A_0 = 7.88 m/s² in this example) and speed (S_0 = 9.19 m/s) were determined. Raw data below the 3 m/s speed threshold were partially masked for clarity.

DURATION: NONE - INVISIBLE
FREQUENCY: WEEKLY

PROTOCOL

Post processing of ALL GPS data from last 7 days (game included)

ANALYSIS

Using R software.

Extraction of best acceleration per speed increment
Straight line interpolation of A0, V0 and the slope.

V_0

⟶ *Peak theoretical speed capacity*

A_0

⟶ *Maximal acceleration (indirectly force) capabilities in the antero-posterior direction.*
Decreased are potentially linked to hamstring injury risk – to be confirmed.

& RESPONSES V2

WELLBEING
[15s]

BIO. IMPED.
[1min]

BOX TO BOX
[2min30]
weekly

HR Readiness v2
[0 min]
In-Situ FVP
[0 min]

HR runs
[5min]
Every 3-4 weeks

Potential Parma Calcio 1913 Monitoring

Test	***Wellness TQR***	***In-Situ Monitoring***	***Box-to-Box runs***	***Submaximal fitness***	***Gym VBT | Force***	***Sleep Monitoring***
Testing Time	***-*** ***30s***	***-*** ***Invisible***	***+*** ***2'30s***	***+*** ***4'***	***+*** ***30s***	***++*** ***Continuous***
Staff burden	***++*** ***Manual collection***	***-*** ***Invisible***	***-*** ***Easy setup***	***+*** ***Track setup***	***++*** ***30' total***	***-*** ***Invisible***
Type	***Subjective Global***	***Neuro***	***Neuro Disbalances***	***Fitness***	***Neuro*** *Disbalances*	***Sleep***
Frequency	***Daily/ Weekly***	***Daily/ Weekly***	***Weekly***	***Monthly***	***Weekly***	***On-demand***
Recommendations						

 ***Phase 1 ASAP***

 ***Phase 2 -***

 ***Phase 3 When ready***

ARE WE DONE?

DO WE NEED TO STOP AFTER DATA COLLECTION?

IMPORTANCE OF GOOD STATS

% changes are not good…

AVERAGE CHANGE IN CMJ PERFORMANCE IS 5% APPROX.
AVERAGE CHANGE IN [CK] POST MATCH CAN BE UP TO 30%…

TE: Typical error.
SWC: Smallest worthwile change
MDC: Minimum detectable change.

PLEASE DO NOT BASE YOUR ACTION ON QUESTIONABLE STATS…

IMPORTANCE OF DATAVIZ

IF YOUR ROLE IS TO CONVEY INFORMATION…

Monit HR%	Monit HR%	Avg. Run HR	Last Run HR
1	77	77	
8	74 ▼	78	79
26	76	80	83
2	77	80	83
14	80 ▼	84	81
3	76	76	73
4	82	85	85
7	71 ▼	75	76
1	82	82	
22	85	87	90
9	73 ▼	78	75
32	81	82	83
2	83	83	84
1	66	66	
23	82	80	84
2	78	79	80
33	80	79	82
2	78	78	78
23	81 ▼	86	83
44	75	72	78
2	75	76	77

Monitoring - Run
Last 1min HR (%max)

Imbal.	Avg. Imb	Last Imb
0.4%	0.4%	
1.7%	0.1%	0.2%
1.0%	0.0%	-0.1%
1.3%	1.3%	
-1.9%	-0.7%	-1.2%
0.4%	-0.9%	-1.6%
1.3%	-0.7%	-1.1%
-1.5%	-1.8%	-2.1%
1.7%	1.7%	
0.8%	-0.2%	-0.9%
0.4%	-2.0%	-1.7%
-0.6%	-1.5%	-0.6%
-0.4%	-0.7%	-1.1%
3.2%	3.2%	
-0.9%	-1.5%	-1.0%
-1.3%	-1.3%	
2.1%	1.7%	0.2%
1.1%	1.1%	
1.1%	0.1%	0.1%
3.4%	0.0%	0.3%
-1.4%	-1.6%	

Monitoring - Box 2 Box
Imbalances > 14.4 km.h-1

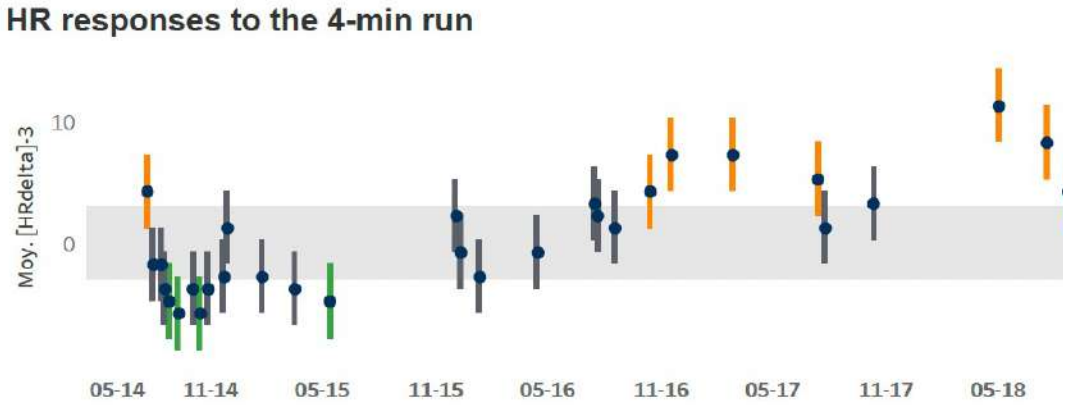
Imbal.	Avg. Imb.	Last Imb.
2.0%	2.0%	
3.6%	0.8%	0.2%
1.9%	0.4%	1.0%
1.9%	1.9%	
-3.3%	-1.4%	-1.9%
1.6%	-0.2%	-1.0%
1.6%	-0.1%	-1.0%
-4.3%	-2.4%	-1.9%
4.0%	4.0%	
2.0%	-0.3%	-0.3%
-1.9%	-3.9%	-4.1%
0.9%	-0.9%	1.4%
-1.2%	-1.1%	-1.0%
6.2%	6.2%	
-0.8%	-1.2%	1.8%
0.1%	0.1%	
0.2%	1.7%	0.0%
2.0%	2.0%	
1.3%	0.6%	0.7%
5.2% ▲	0.1%	0.1%
1.8%	-0.2%	

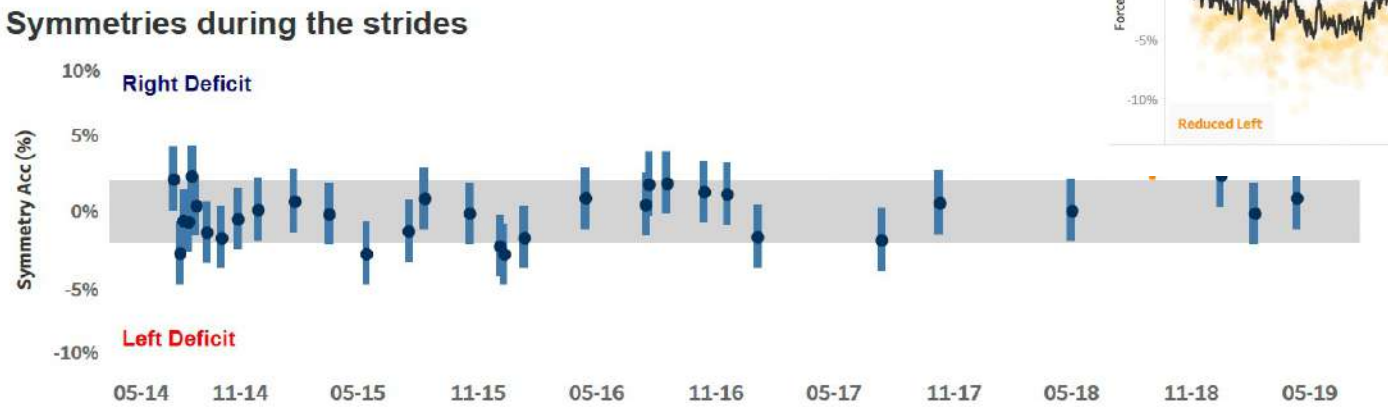
Monitoring - Box 2 Box
Imbalances Acc.

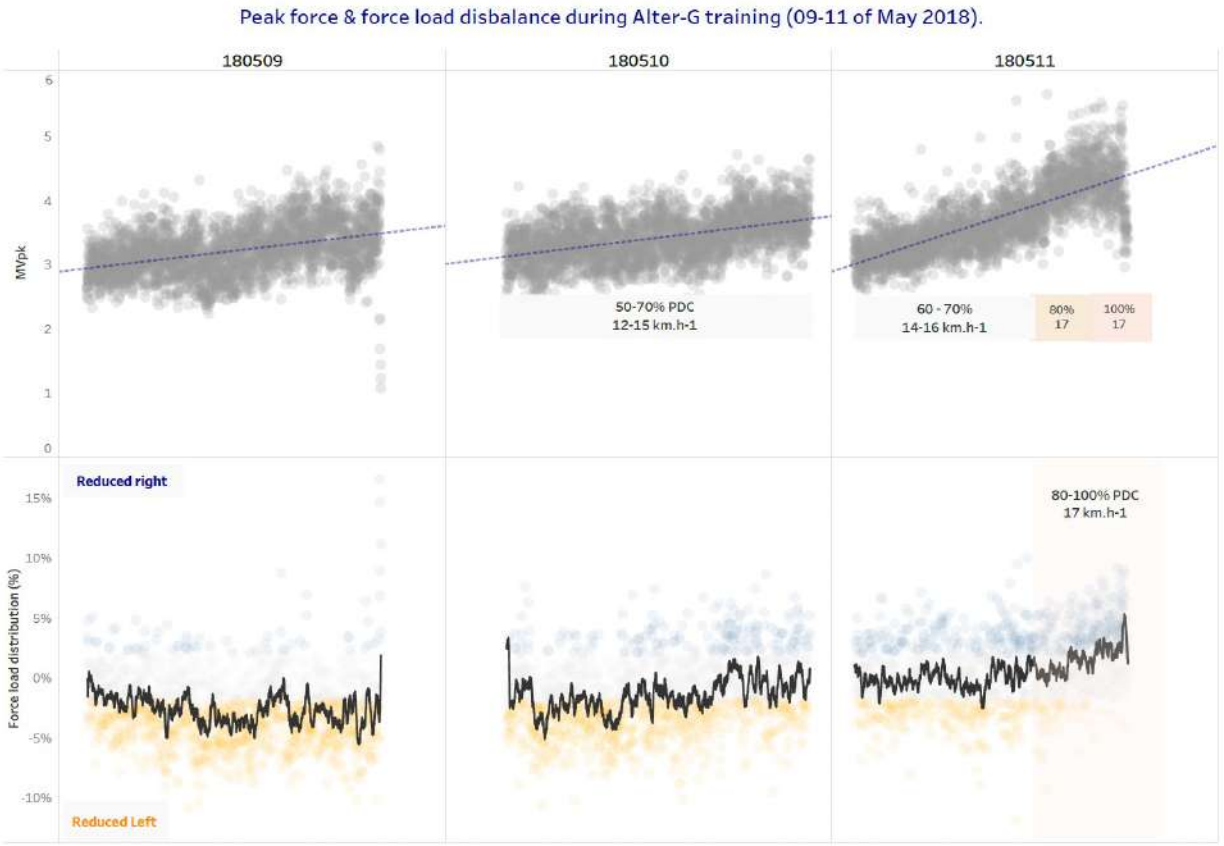
-ve numbers - Left reduced | +ve numbers - Right reduced

IMPORTANCE OF DATAVIZ

IF YOUR ROLE IS TO CONVEY INFORMATION…







THANK YOU

INVISIBLE MONITORING.

Mathieu Lacome | mathlacome.com | @mathlacome

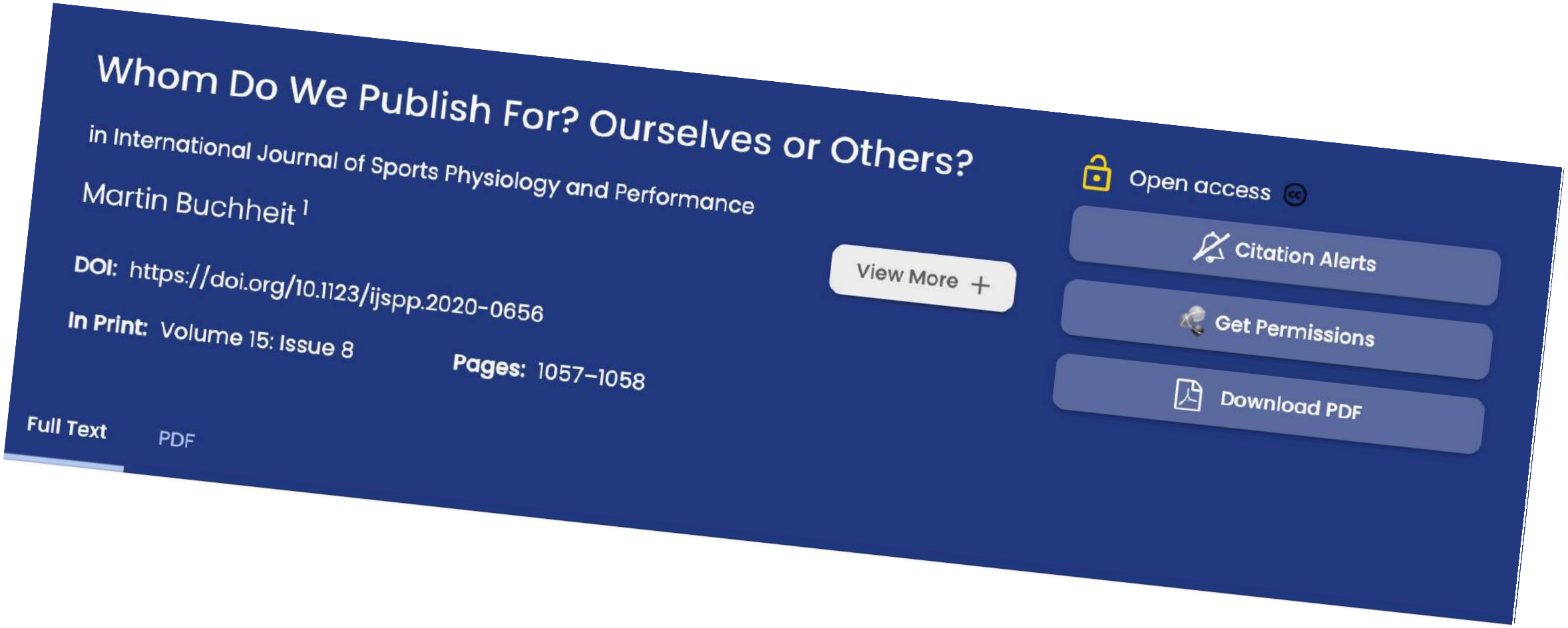
DIVING INTO INNOVATION CONCEPTS

EMPATHIE

NEEDS

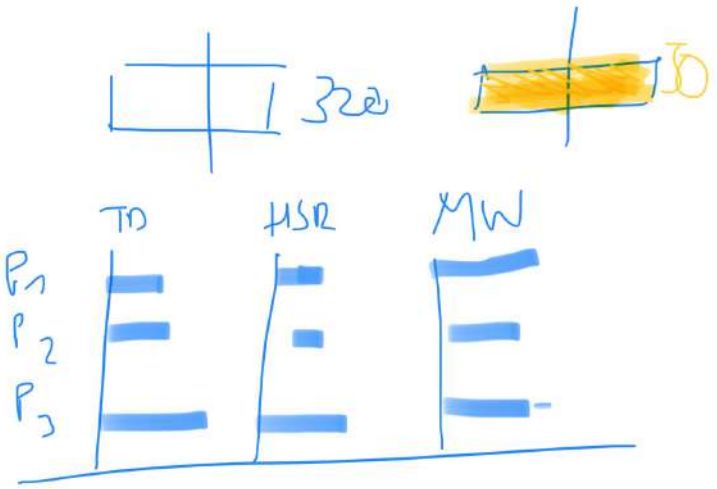
JOBS-TO-BE-DONE

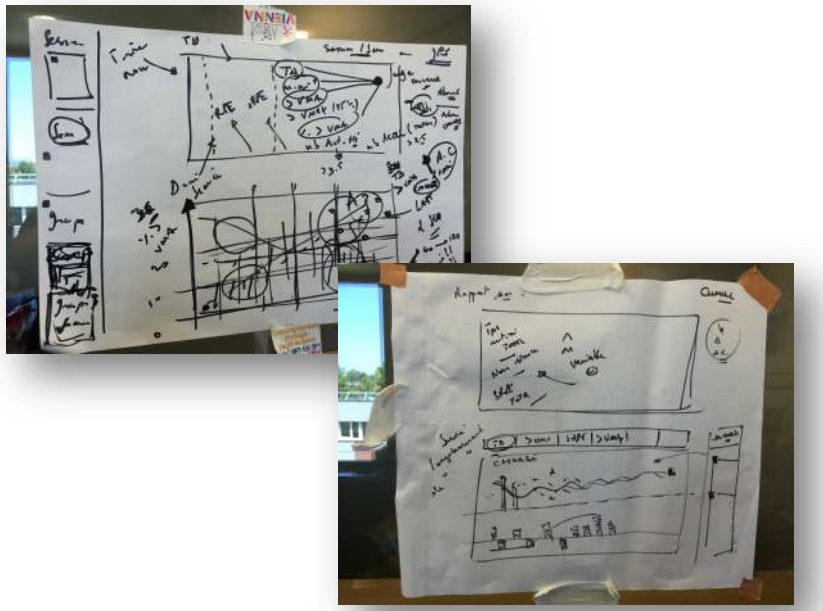
DIVING INTO INNOVATION CONCEPTS



LEAN EXECUTION

FOR DATA PROJECTS





Team session report — 10/03/2020 | 1100 H — D+6 D-1

Session duration: 69 min | RPE: 3

Last 28 days training schedule (15-02, 20-02, 25-02, 01-03, 06-03, 11-03)

Select Date: 10/03/2020 | Select Time: 1100

Color code: G, Pitch session, Today

Target choice: Game 1st Half / Session | Days From: D+6 | Days To: D-1 | Session Focus: All | Surname_Key: All | Standardised Difference (ES): -1.0 … 1.0

Volume	Total distance (m)	Distance > 19.8 km.h-1 (m)	Distance > 25.2 km.h-1 (m)	Mechanical Work (a.u)	Heart rate > 80% (min)
	4,148 vs. 4,916	205 vs. 379	30 vs. 71	30 vs. 41	vs. 21

Intensity (effective time)	Total distance (m/min)	Distance > 19.8 km.h-1 (m/min)	Distance > 25.2 km.h-1 (m/min)	Mechanical Work (a.u/min)	Heart rate (%HRmax)
	83 vs. 107	4.1 vs. 8.2	0.6 vs. 1.5	0.6 vs. 0.9	vs. 82

Drill analysis — Select drills: ~~Multiple values~~

Drill Code	Dur (min)	TD (m)	D>14.4 (m)	D>19.8 (m)	D>25.2 (m)	Vmax (km.h-1)	Mech W. (u.a)	High MechW. (u.a)	HR (%max)	RPE	TD (m.min-1)	D>19.8 (m.min-1)	MechW (u.a.min-1)
Session	69	4,148	549	205	30	27	30	11		3	83	4.1	0.6
WU_Rc_2Li-Mob+PasGo+Actv_X_X_NM	11	668	24	2	0	19	3		62%		63	0.2	0.3
Po_Ta_AtiZone-Fr_10v9_50x68_TT	7	636	104	29	2	23	6	2			94	4.2	0.9
GS_Ta_Fr_10v10+GKs_60x68_TT	7	837	159	55	7	26	8	3			112	7.3	1.0

LEAN EXECUTION

FOR RESEARCH PROJECTS

« QUICK & DIRTY » EXPERIMENTATION
OUR MVPs

SHOULD TAKE YOU MAXIMUM 1 DAY TO GET IT PLANNED, DONE, AND DATA ANALYZED

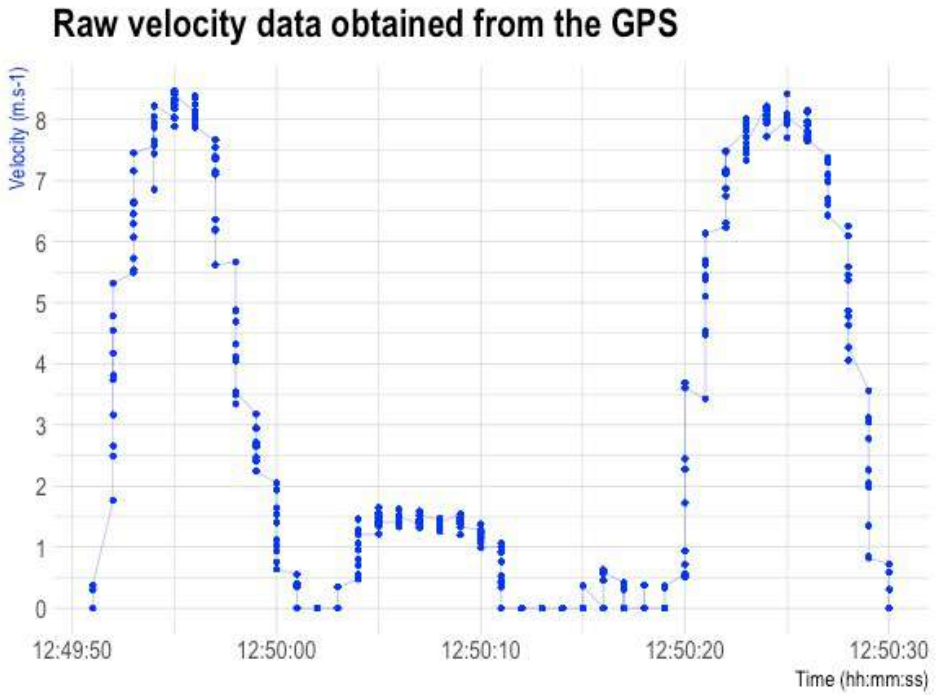
LEAN EXECUTION

FOR RESEARCH PROJECTS

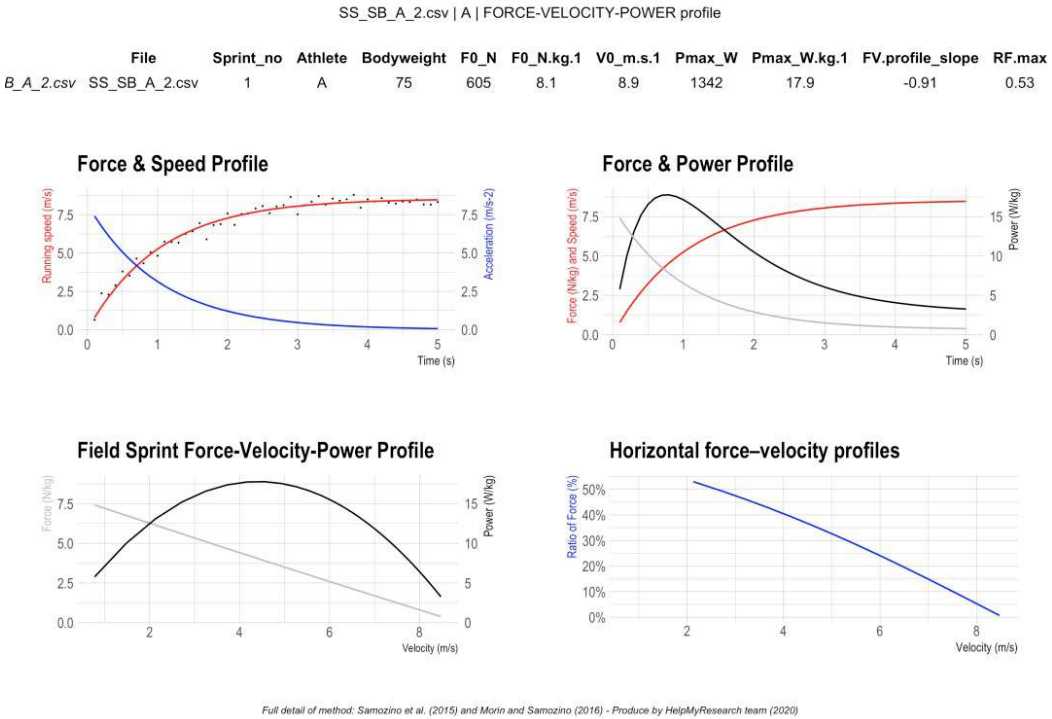
FIRST ITERATION

CALCULATING FORCE-VELOCITY PROFILE ASSESS THROUGH GPS DEVICES IN SOCCER: FROM LABOURING TO AUTOMATIC PROCESS

by mathlacome@gmail.com | Jul 20, 2020



Full set of data collected on us !



http://mathlacome.com/fvp-easy/

LEAN EXECUTION

FOR RESEARCH PROJECTS

CALCULATING FORCE-VELOCITY PROFILE ASSESS THROUGH GPS DEVICES IN SOCCER: FROM LABOURING TO AUTOMATIC PROCESS

by mathlacome@gmail.com | Jul 20, 2020

LAST ITERATION

- Data collected on elite athletes
- Code optimized thanks to feedbacks
- Publishing – diving deep in stats & writting process.