CONI
SCUOLA DELLO SPORT
MARCHE

L'allenamento neuromuscolare della forza
Prevenzione e sviluppo di forza-velocità
Ancona, 21 settembre 2019

Force-Velocity-Power individual profile
for jump-sprint performance and injury management

Pr J-B Morin

UNIVERSITÉ CÔTE D'AZUR

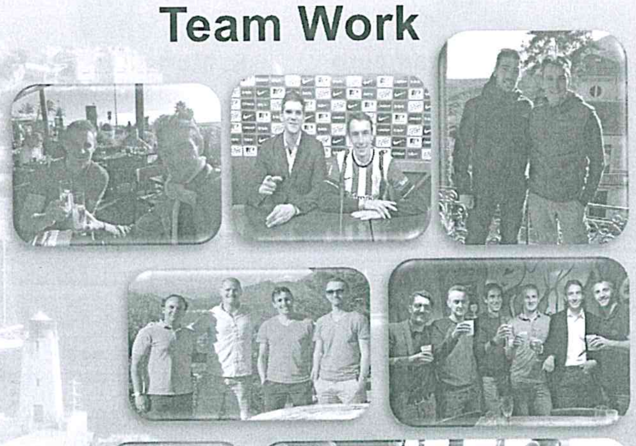
SPORTS PERFORMANCE RESEARCH INSTITUTE, NEW ZEALAND
AN INSTITUTE OF AUT UNIVERSITY

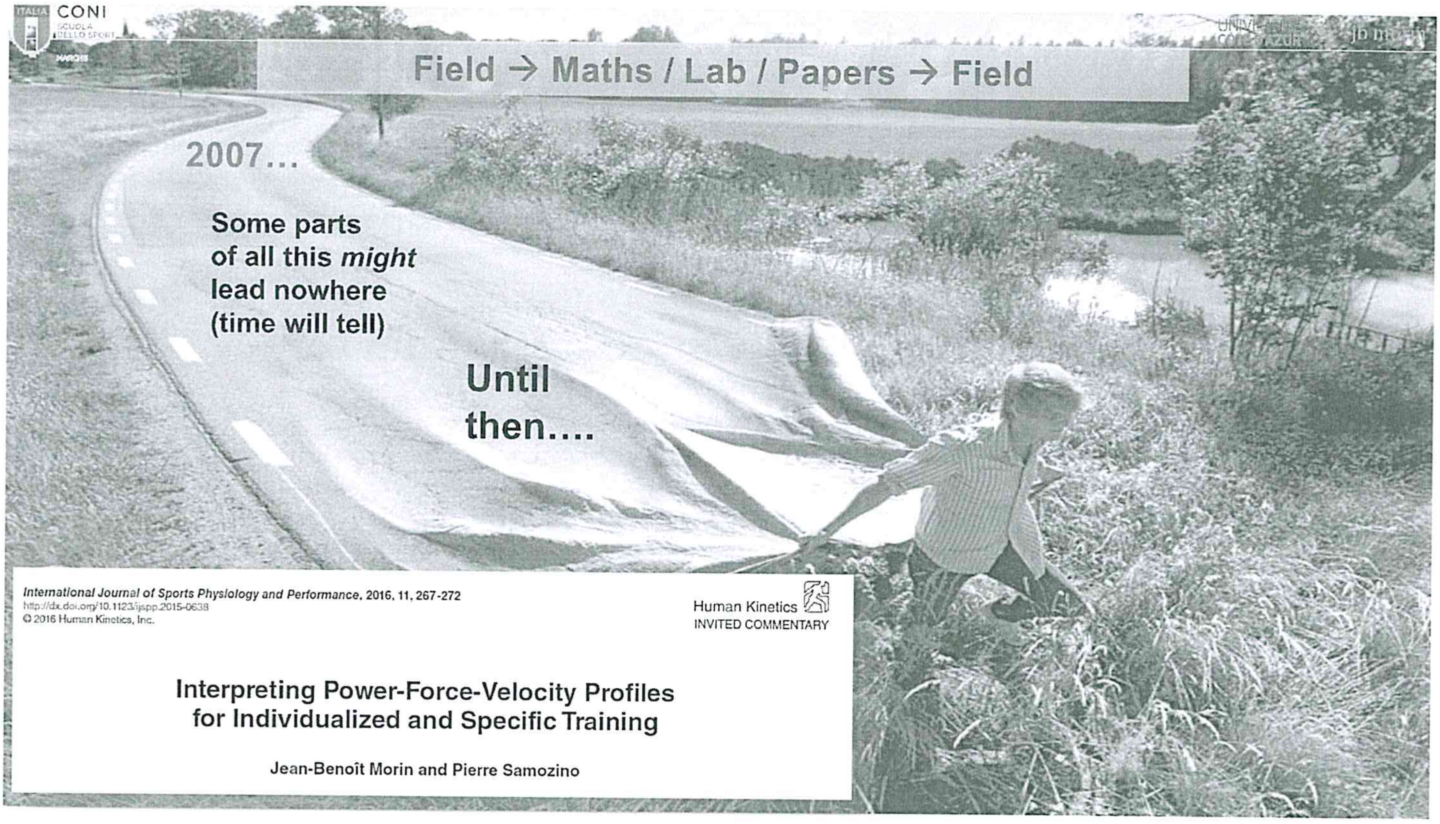
jbmorin.net @jb_morin

Team Work

Teammates & Inputs

- **P. Samozino**, Chambery FR
- **J. Mendiguchia**, Baranain SP
- **P. Jimenez-Reyes**, Madrid SP
- **M. Brughelli**, Auckland NZ
- **M. Cross**, Auckland NZ
- **Y. LeMeur**, Monaco
- **G. Rabita**, Paris FR
- **S. Brown**, Auckland NZ
- **S. Dorel**, Nantes FR
- **J. Slawinski**, Paris FR
- **A. Couturier**, Paris FR
- **C. Balsalobre-Fernandez**, Mardid SP
- **P. diPrampero**, Udine IT
- **B. Contreras**, Phoenix AZ
- **G. Petrakos**, Dublin IRL
- **J. Lahti**, Nice FR
- **1080 Motion**, SW





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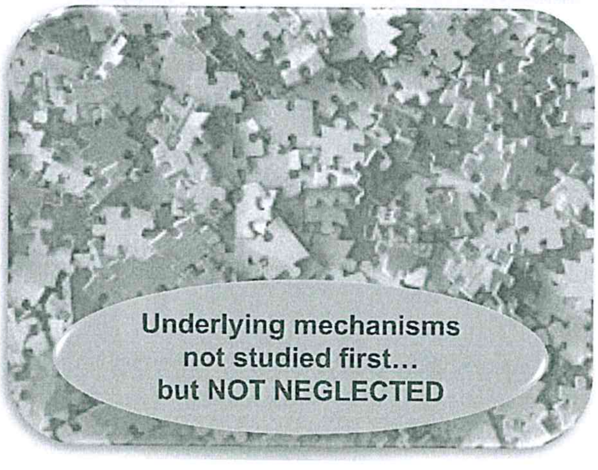
MACROSCOPIC APPROACH: BIG PICTURE FIRST

Pietro E. di Prampero
Università Degli Studi di Udine (Italy)

R. McNeill Alexander
(1934-2006)
University of Leeds (UK)



THE ROYAL SOCIETY — *Published online 6 August 2003*

Modelling approaches in biomechanics

R. McN. Alexander

School of Biology, University of Leeds, Leeds LS2 9JT, UK (r.m.alexander@leeds.ac.uk)

Conceptual, physical and mathematical models have all proved useful in biomechanics. Conceptual models, which have been used only occasionally, clarify a point without having to be constructed physically or analysed mathematically. Some physical models are designed to demonstrate a proposed mechanism, for example the folding mechanisms of insect wings. Others have been used to check the conclusions of mathematical modelling. However, others facilitate observations that would be difficult to make on real organisms, for example on the flow of air around the wings of small insects. Mathematical models have been used more often than physical ones. Some of them are predictive, designed for example to calculate the effects of anatomical changes on jumping performance, or the pattern of flow in a 3D assembly of semicircular canals. Others seek an optimum, for example the best possible technique for a high jump. A few have been used in inverse optimization studies, which search for variables that are optimized by observed patterns of behaviour. Mathematical models range from the extreme simplicity of some models of walking and running, to the complexity of models that represent numerous body segments and muscles, or elaborate bone shapes. The simpler the model, the clearer it is which of its features is essential to the calculated effect.

The simpler the model, the clearer it is which of its features is essential to the calculated effect *(performance)*

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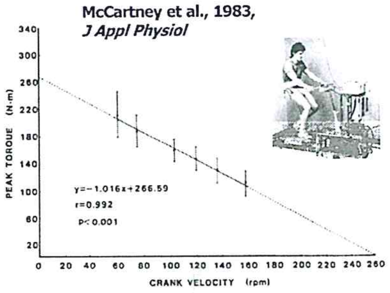
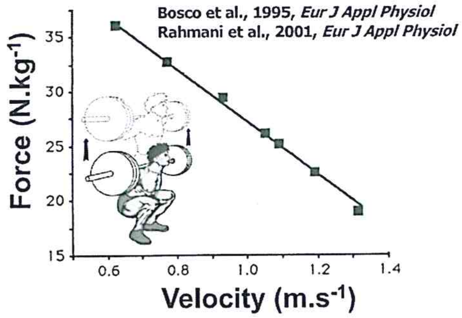
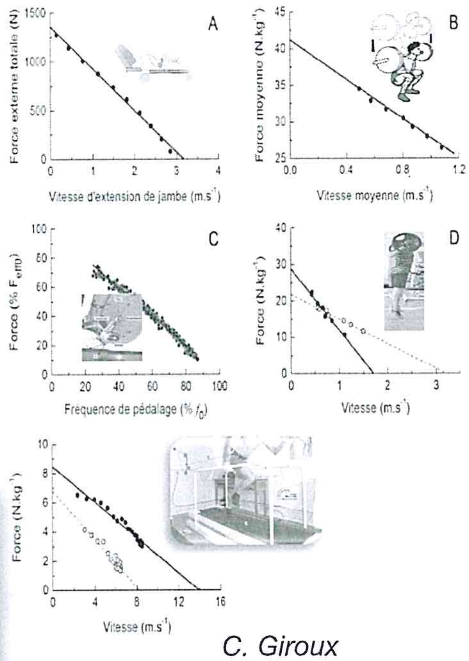
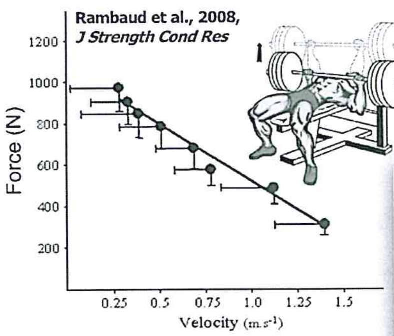
MULTIJOINT EXERCISES: LINEAR F-V RELATIONSHIP

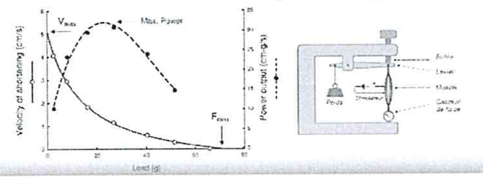






C. Giroux
PhD Thesis, 2014





J Appl Physiol 112: 1975–1983, 2012.
First published March 22, 2012; doi:10.1152/japplphysiol.00787.2011.

Why is the force-velocity relationship in leg press tasks quasi-linear rather than hyperbolic?

Maarten F. Bobbert
Research Institute MOVE, Faculty of Human Movement Sciences, VU University Amsterdam, Amsterdam, The Netherlands

Submitted 27 June 2011; accepted in final form 17 March 2012

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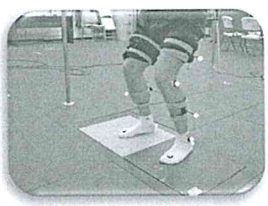
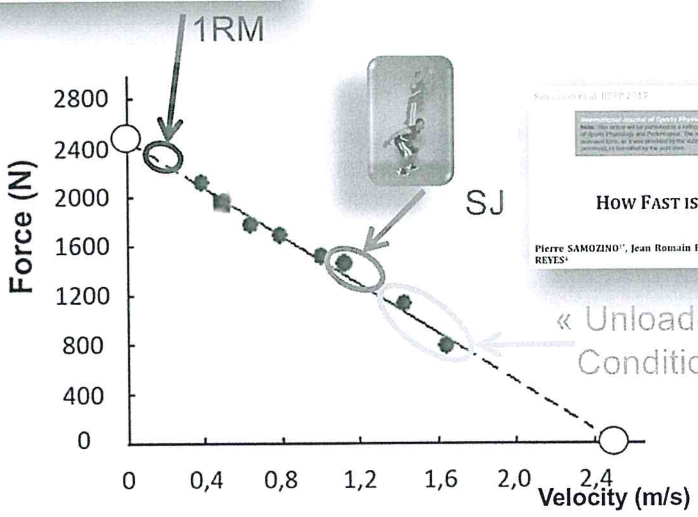
Orthopedics & Biomechanics — Thieme

Where does the One-Repetition Maximum Exist on the Force-Velocity Relationship in Squat?

Authors
Jean Romain Rivière[1], Jérémy Rossi[2], Pedro Jimenez-Reyes[3], Jean-Benoit Morin[4], Pierre Samozino[1]

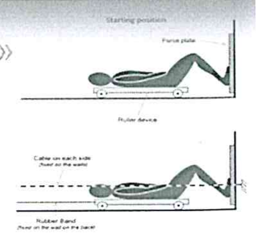




Human Kinetics
ORIGINAL INVESTIGATION

HOW FAST IS A HORIZONTAL SQUAT JUMP?

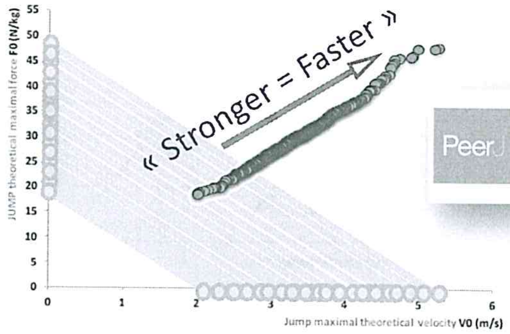
Pierre SAMOZINO[1], Jean Romain RIVIERE[1], Jérémy ROSSI[2], Jean-Benoit MORIN[3], Pedro JIMENEZ-REYES[4]



NOT the reality

Red: F_0-V_0 correlation
Blue: Individual FV profiles

The reality

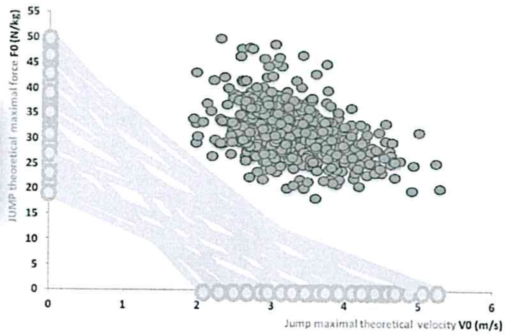


Jimenez-Reyes et al.
Peer J, 2018

PeerJ

Relationship between vertical and horizontal force-velocity-power profiles in various sports and levels of practice

Pedro Jimenez-Reyes, Pierre Samozino, Amador Garcia-Ramos, Victor Cuadrado-Peñafiel, Matt Brughelli and Jean-Benoit Morin



« Strong » at Low Velocity ≠ « Strong » at High Velocity

More maximal force ≠ More maximal velocity

14 sports >500 athletes Leisure to elite level

*No correlation overall, same sub-group outcome for each level and each sport, **SAME RESULTS FOR SPRINTING***

« Vertical » FVP Profile

Sports Medicine
https://doi.org/10.1007/s40279-019-01073-1

CURRENT OPINION

Check for updates

When Jump Height is not a Good Indicator of Lower Limb Maximal Power Output: Theoretical Demonstration, Experimental Evidence and Practical Solutions

Jean-Benoit Morin[1,3] · Pedro Jiménez-Reyes[2] · Matt Brughelli[3] · Pierre Samozino[4]

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OK, How can we do with field devices??

15'

- Scales
- 3-5 go
- Jump

Journal of Biomechanics 41 (2008) 2940–2945

ELSEVIER

A simple method for measuring ... power output ... squat jump

Pierre Samozino ... Frédérique Hintzy, Alain Belli

Exercise Physiology Laboratory ... Bellevue—Médecine du Sport et Myologie, 42055 Saint-Etienne

$$\bar{F} = mg\left(\frac{h}{h_{PO}} + 1\right)$$

$$\bar{v} = \sqrt{\frac{gh}{2}}$$

$$\bar{P} = mg\left(\frac{h}{h_{PO}} + 1\right)\sqrt{\frac{gh}{2}}$$

Mass + Load
Jump height
Push-off distanc

APPROVED

Validity and reliability SJ and CMJ

Samozino et al, 2008, J Biomech
Palmieri et al, 2014, CMBBE
Giroux et al, 2015, IJSM
Jimenez et al, 2017, IJSPP

Amador García Ramos @amagr

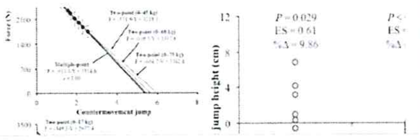
« 2 loads »

50 free copies of our last article in @sportsbiomechj with @alex_pc1992 and #SlobodanJaric "Optimisation of applied loads when using the two-point method for assessing the force-velocity relationship during vertical jumps".

Unloaded jump + 10 cm jump ✓

tandfonline.com/eprint/N886xhh...

Traduire le Tweet



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You need something to *accurately* measure Jump Height !!

@MyJumpApp

Journal of Sports Sciences, 2014
http://dx.doi.org/10.1080/02640414.2014.996184

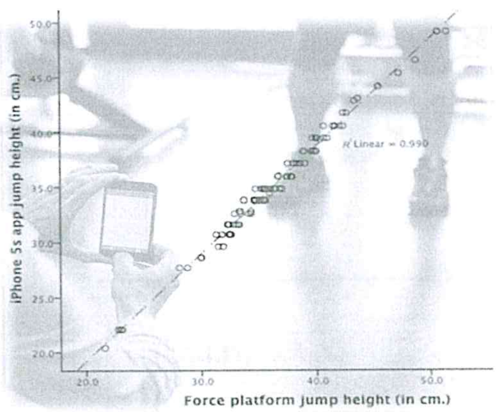
Routledge

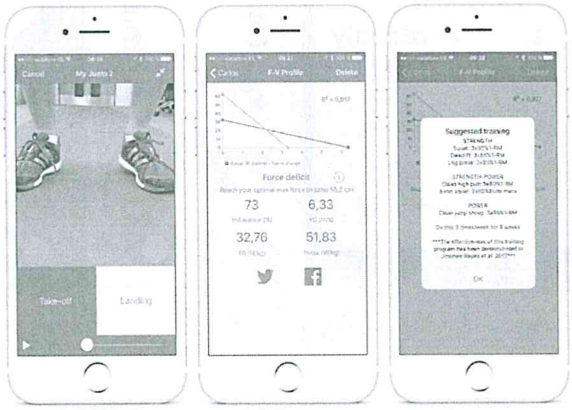
The validity and reliability of an iPhone app for measuring vertical jump performance

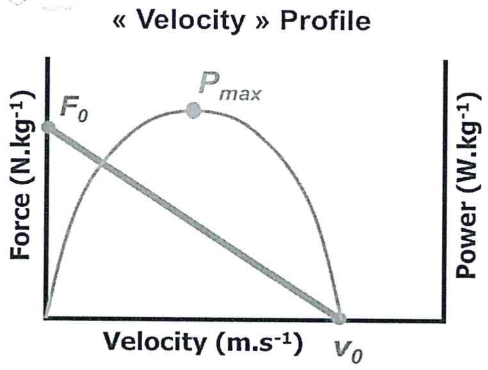
CARLOS BALSALOBRE-FERNÁNDEZ[1], MARK GLAISTER[2] & RICHARD ANTHONY LOCKEY[2]

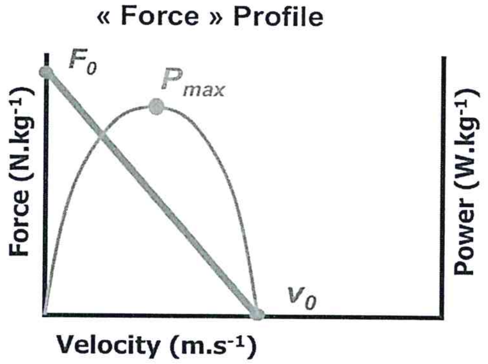
Carlos Balsalobre
UA Madrid

Confirmed in 5+ studies !









Athlete 1

Athlete 2

For a same given P_{max},

Many F-V profiles possible....

Which one(s) maximize Jumping Performance ??

All athletes need WATTS

In terms of F and V...who needs WHAT?


Journal of Theoretical Biology

Contents lists available at ScienceDirect

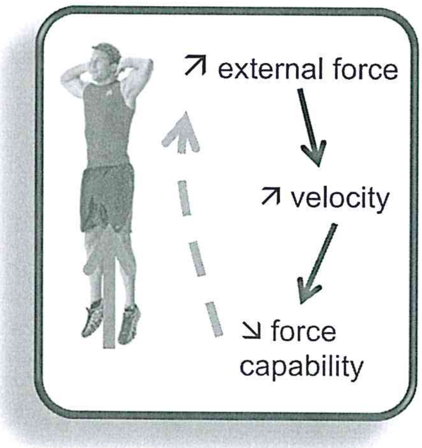
Journal of Theoretical Biology

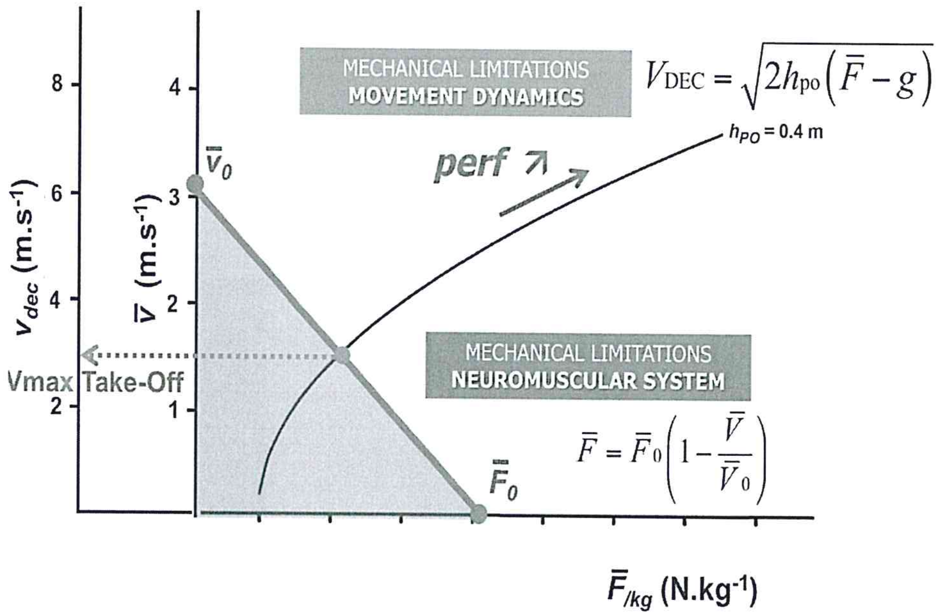
journal homepage: www.elsevier.com/locate/yjtbi

Jumping ability: A theoretical integrative approach

Pierre Samozino, Jean-Benoît Morin, Frédérique Hintzy, Alain Belli

A Macroscopic Biomechanical Model





A Macroscopic Biomechanical Model

Samozino et al, 2012, MSSE

Optimal Force–Velocity Profile in Ballistic Movements—*Altius*: *Citius* or *Fortius*?

PIERRE SAMOZINO[1], ENRICO REJC[2], PIETRO ENRICO DI PRAMPERO[2], ALAIN BELLI[3], and JEAN-BENOÎT MORIN[3]

[1]Laboratory of Exercise Physiology (EA4338), University of Savoy, Le Bourget du Lac, FRANCE; [2]Department of Biomedical Sciences and Technologies, University of Udine, Udine, ITALY; and [3]Laboratory of Exercise Physiology (EA4338), University of Lyon, Saint Etienne, FRANCE

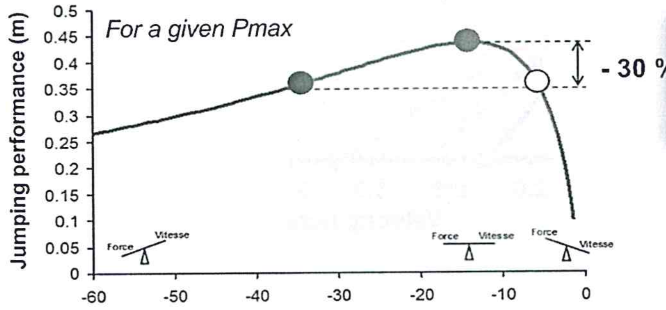
$$v_{TO_{max}} = h_{PO}\left(\sqrt{\frac{S_{Fv}^2}{4} + \frac{2}{h_{PO}}\left(2\sqrt{-\bar{P}_{max} S_{Fv}} - g\sin\alpha\right)} + \frac{S_{Fv}}{2}\right)$$

Best Performance | **Pmax**, **F-v Profile**, **Lower limb extension range**

Validity ?? ✓ *Prediction errors : 4-6%*

Interest ??

Optimal Fv profile



← « force » profile **FV Profile** « velocity » profile →

Int J Sports Med 2014; 35: 505–510

Force-Velocity Profile: Imbalance Determination and Effect on Lower Limb Ballistic Performance

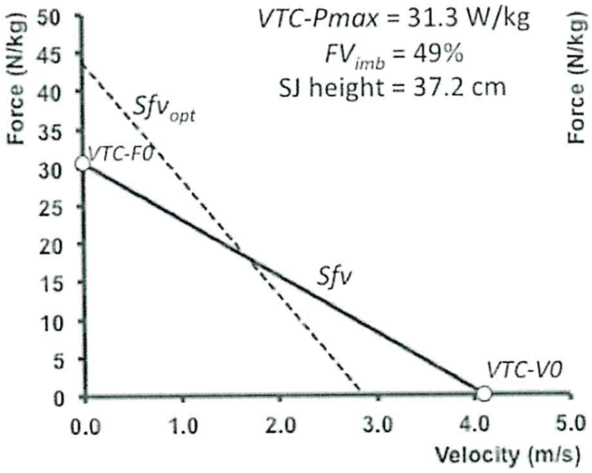
Improve performance with

- ✓ ↗ Pmax
- ✓ ↙ FV imbalance

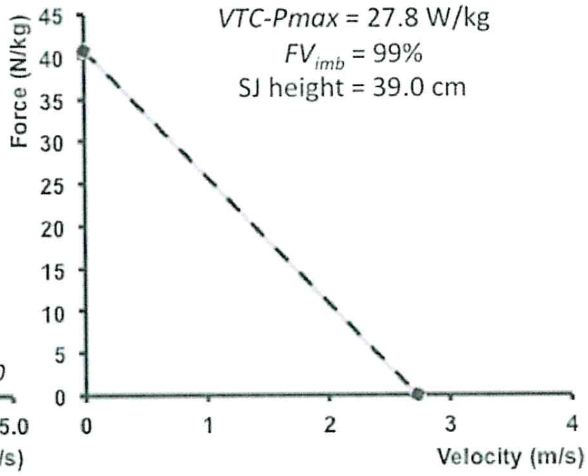
Samozino et al, 2010, J Theor Biol
Samozino et al, 2014, IJSM

Typical Examples

Athlete A
VTC-Pmax = 31.3 W/kg
FV_{imb} = 49%
SJ height = 37.2 cm

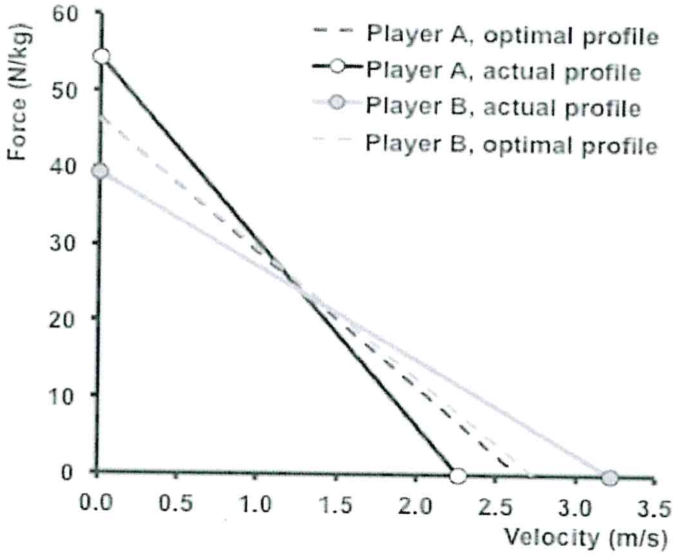


Athlete B
VTC-Pmax = 27.8 W/kg
FV_{imb} = 99%
SJ height = 39.0 cm



B is less powerful….but has better individual FV balance
→ **better SJ performance**

TYPICAL EXAMPLES



Player A
VTC-Pmax = 30.7 W/kg
FV_{imb} = 137%
SJ height = 34.8 cm

Player B
VTC-Pmax = 31.6 W/kg
FV_{imb} = 72%
SJ height = 37.2 cm

Training should be individualized according to FV imbalance
→ better performance for ***BOTH players***

Date	01/05/15
Time	

NAME	
Firstname	

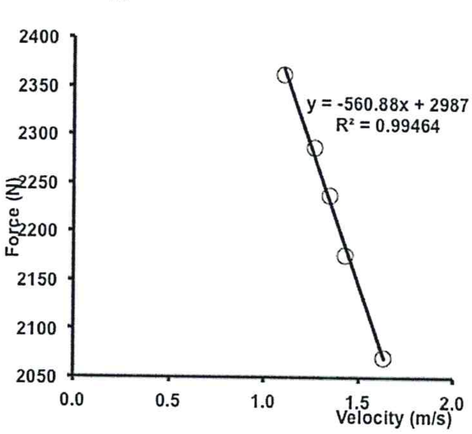
Body Mass (kg) :	102
Lower limb length (m) :	1.34
Hi (m) :	0.83
Hpo (m) :	0.51

Université Nice Sophia Antipolis

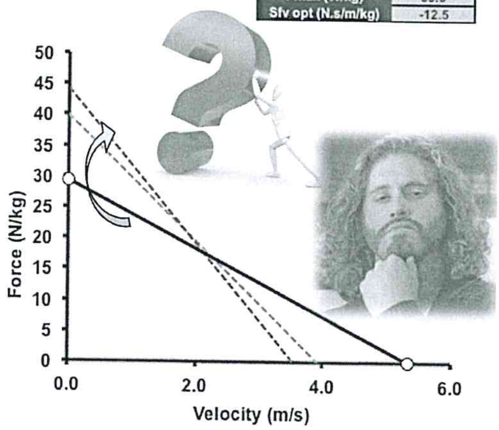
Condition (% BW)	Additional Mass (kg)	Total Mass (kg)	H1 (m)	H2 (m)	H3 (m)	Hmax (m)	F (N)	V (m.s-1)	P (W)
	0	102.0	0.545			0.545	2069.9	1.64	3384
	20	122.0	0.417			0.417	2175.4	1.43	3111
	30	132.0	0.371			0.371	2236.9	1.35	3018
	40	142.0	0.327			0.327	2286.2	1.27	2895
	50	152.0							
	60	162.0	0.248			0.248	2362.0	1.10	2605

r^2	0.99
r	-1.00
Fo (N)	2987
Fo (N/kg)	29.3
Sfv (N.s/m)	-561
Sfv (N.s/m/kg)	-5.50
Vo	5.33
Pmax (W)	3977
Pmax (W/kg)	39.0
Sfv opt (N.s/m/kg)	-12.5

102



Fo (N/kg)	29.3
Vo	5.33
Pmax (W/kg)	39.0
Sfv (N.s/m/kg)	-5.50
	F-v Profile = 54% of the optimal FORCE is to be developped
	F-v Profile = 44% of the optimal FORCE is to be developped



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« Optimized » Training

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PILOT TRAINING STUDY

→**9 weeks** (mistake #1)
→**OPTIMIZED (46) vs NON-OPTIMIZED (18)**

Pedro JIMENEZ-REYES
URJC, Madrid

Experimental group:

22 force deficit
18 velocity deficit
6 well-balanced

frontiers in Physiology

ORIGINAL RESEARCH
published: 09 January 2017
doi: 10.3389/fphys.2016.00677

Effectiveness of an Individualized Training Based on Force-Velocity Profiling during Jumping

*Pedro Jiménez-Reyes[1], Pierre Samozino[2], Matt Brughelli[3] and Jean-Benoît Morin[3,4]**

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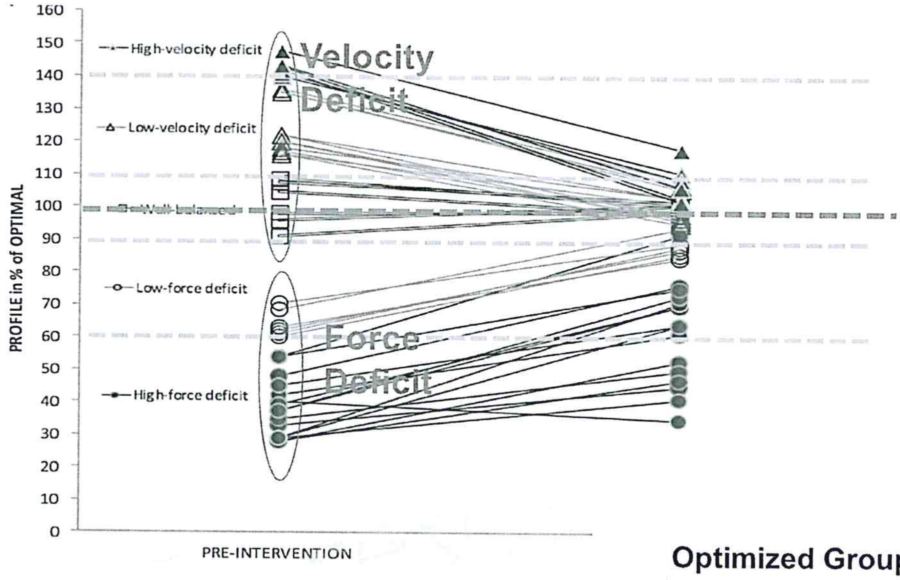
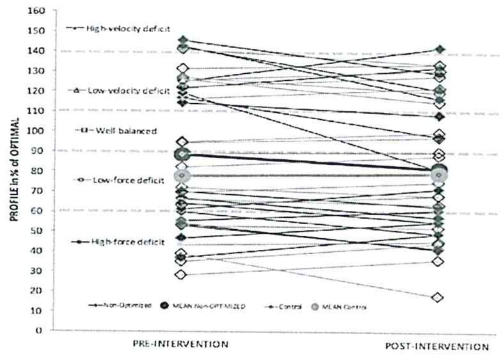
Optimized Training



NON-Optimized



JUMP HEIGHT

Optimized Group
46/46 subjects increased above SWC
12.7 ± 7.4 %

Non-Optimized Group
7/18 subjects increased above SWC
2.3 ± 4.7 %

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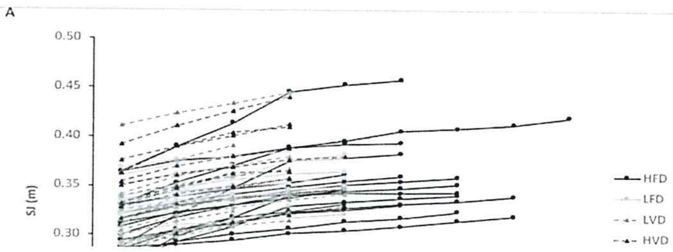
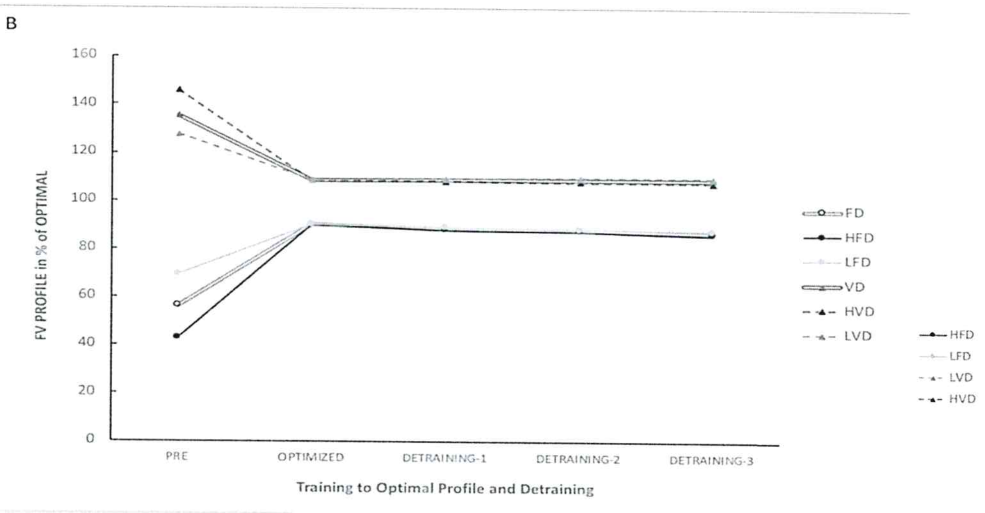
Replication - Improvement
REALLY individualized
Training and Detraining kinetics

HOT OFF THE PRESS

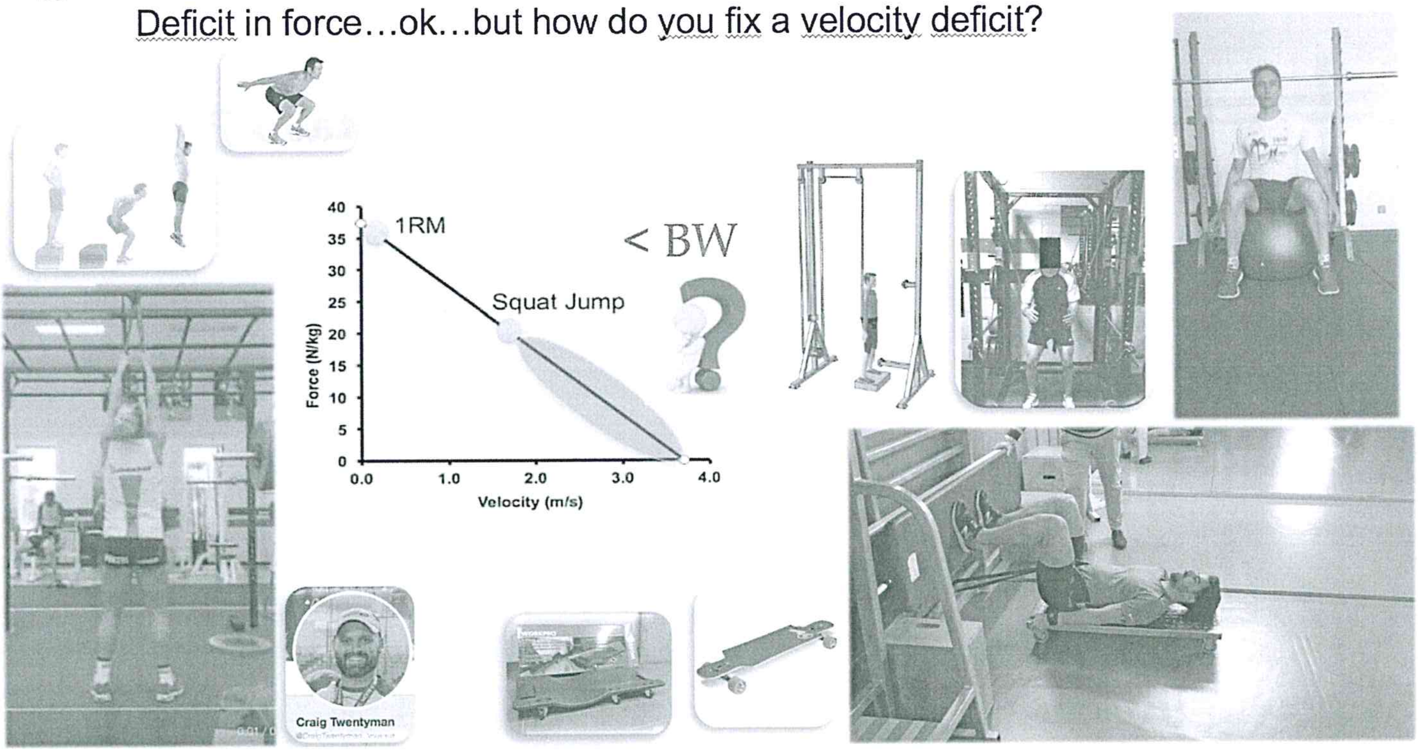


PLOS | ONE



Weeks to Optimal Profile

Deficit in force…ok…but how do you fix a velocity deficit?



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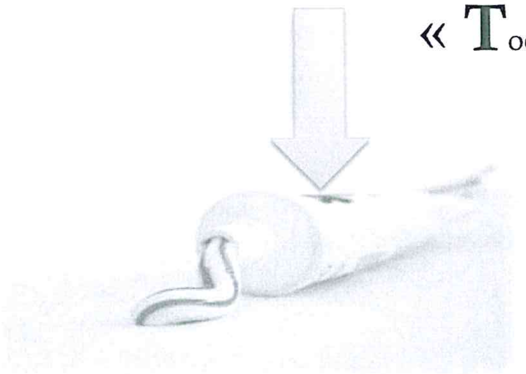
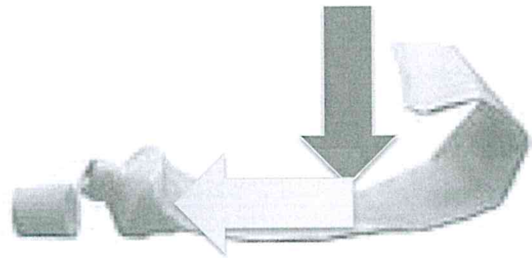
SUMMARY…

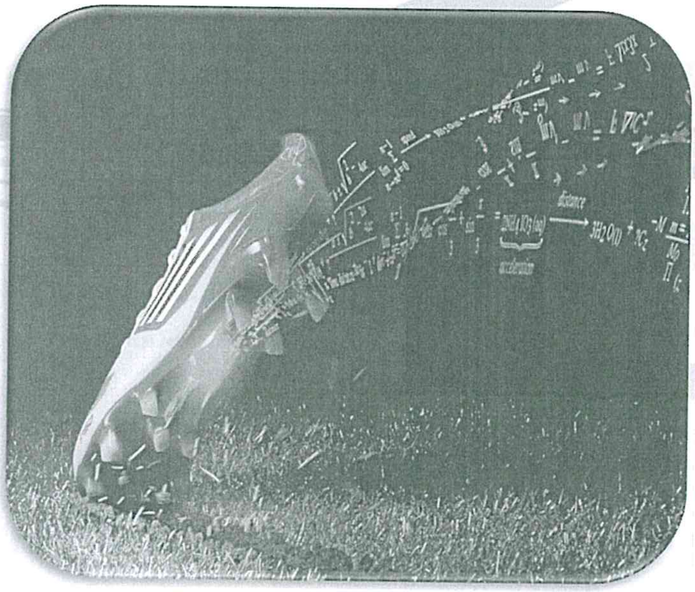
« Toothpaste Tube Theory »





Don't do the same better
Do something ELSE

« Horizontal » Profile



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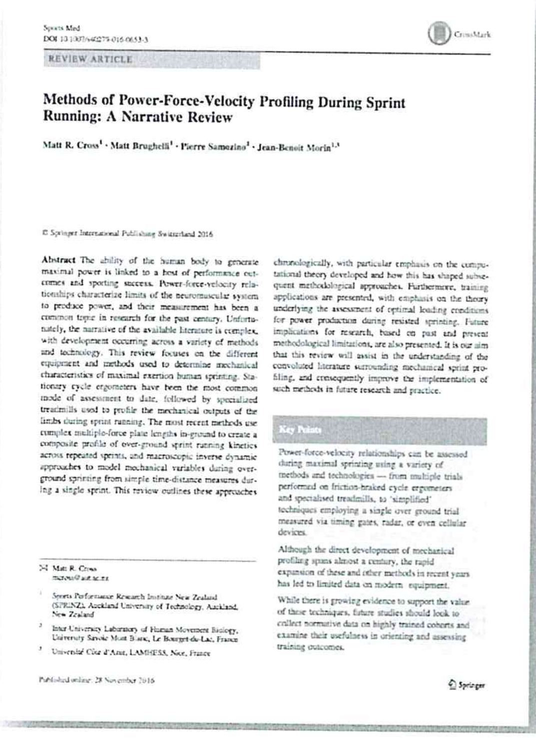

Sports Med
DOI 10.1007/s40279-016-0653-3

REVIEW ARTICLE

Methods of Power-Force-Velocity Profiling During Sprint Running: A Narrative Review

Matt R. Cross[1] · Matt Brughelli[1] · Pierre Samozino[2] · Jean-Benoit Morin[1,3]

Abstract The ability of the human body to generate maximal power is linked to a host of performance outcomes and sporting success. Power-force-velocity relationships characterize limits of the neuromuscular system to produce power, and their measurement has been a common topic in research for the past century. Unfortunately, the narrative of the available literature is complex, with development occurring across a variety of methods and technology. This review focuses on the different equipment and methods used to determine mechanical characteristics of maximal exertion human sprinting. Stationary cycle ergometers have been the most common mode of assessment to date, followed by specialized treadmills used to profile the mechanical outputs of the limbs during sprint running. The most recent methods use complex multiple-force plate lengths in-ground to create a composite profile of over-ground sprint running kinetics across repeated sprints, and macroscopic inverse dynamic approaches to model mechanical variables during over-ground sprinting from simple time-distance measures during a single sprint. This review outlines these approaches chronologically, with particular emphasis on the computational theory developed and how this has shaped subsequent methodological approaches. Furthermore, training applications are presented, with emphasis on the theory underlying the assessment of optimal loading conditions for power production during resisted sprinting. Future implications for research, based on past and present methodological limitations, are also presented. It is our aim that this review will assist in the understanding of the convoluted literature surrounding mechanical sprint profiling, and consequently improve the implementation of such methods in future research and practice.

Key Points

Power-force-velocity relationships can be assessed during maximal sprinting using a variety of methods and technologies — from multiple trials performed on friction-braked cycle ergometers and specialised treadmills, to 'simplified' techniques employing a single over ground trial measured via timing gates, radar, or even cellular devices.

Although the direct development of mechanical profiling spans almost a century, the rapid expansion of these and other methods in recent years has led to limited data on modern equipment.

While there is growing evidence to support the value of these techniques, future studies should look to collect normative data on highly trained cohorts and examine their usefulness in orienting and assessing training outcomes.

✉ Matt R. Cross
mcross@aut.ac.nz

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Published online: 28 November 2016

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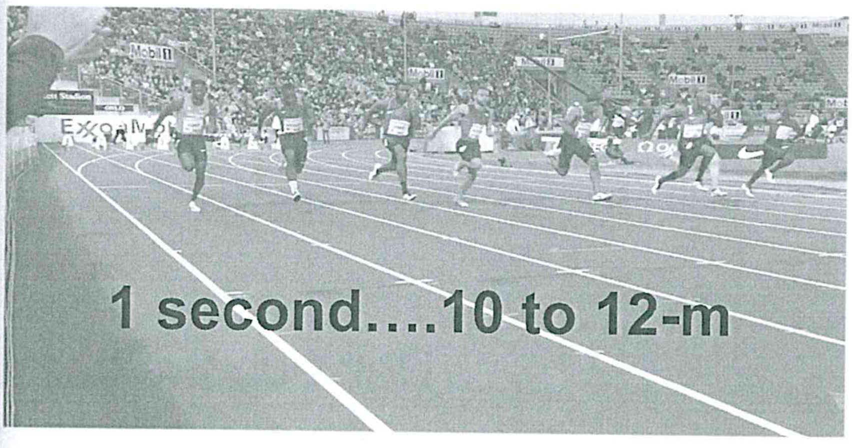
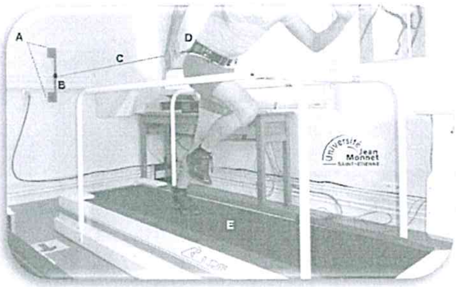
AUT, Auckland)
@MattCrossNZ

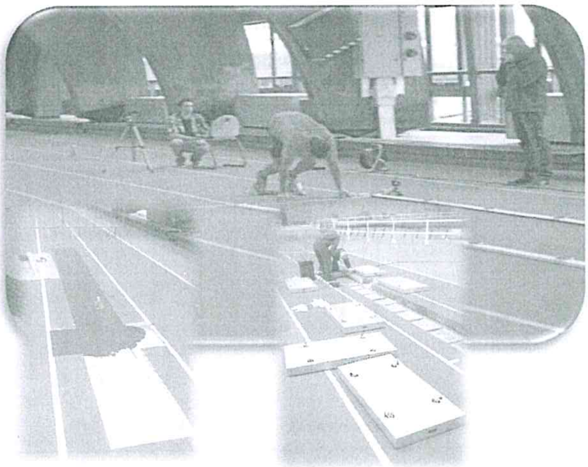


Two (im)possibilities



INSTRUMENTED SPRINT TREADMILL
St-Etienne, France
Doha, Qatar

FORCE PLATES
INSEP, Paris, France (7m)
Kanoya, Japan (50m+)



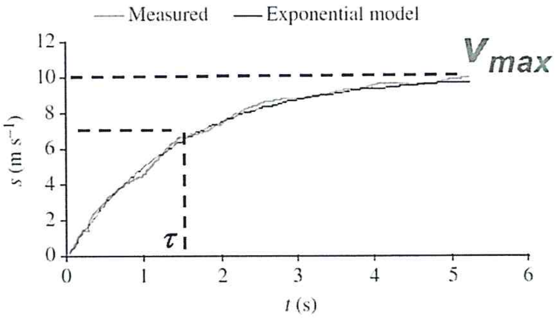
OK, How can we do with field devices??

2016: P. Samozino

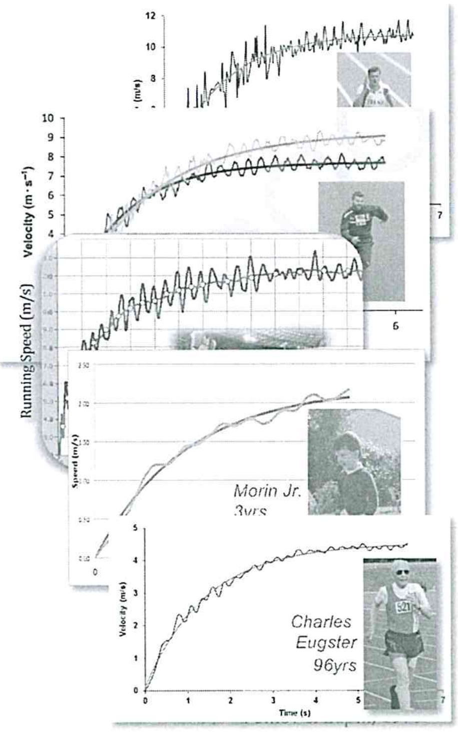
Scand J Med Sci Sports 2015: ••: ••–••
doi: 10.1111/sms.12490
© 2015 John Wiley & Sons A/S. Published by John Wiley & Sons Ltd
SCANDINAVIAN JOURNAL OF MEDICINE & SCIENCE IN SPORTS

A simple method for measuring power, force, velocity properties, and mechanical effectiveness in sprint running

P. Samozino[1], G. Rabita[2], S. Dorel[3], J. Slawinski[4], N. Peyrot[5], E. Saez de Villarreal[6], J.-B. Morin[7]



$$v(t) = v_{max} \cdot (1 - e^{(-t/\tau)})$$



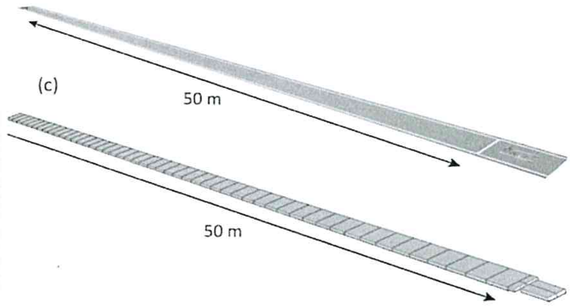
di Prampero et al., 2015

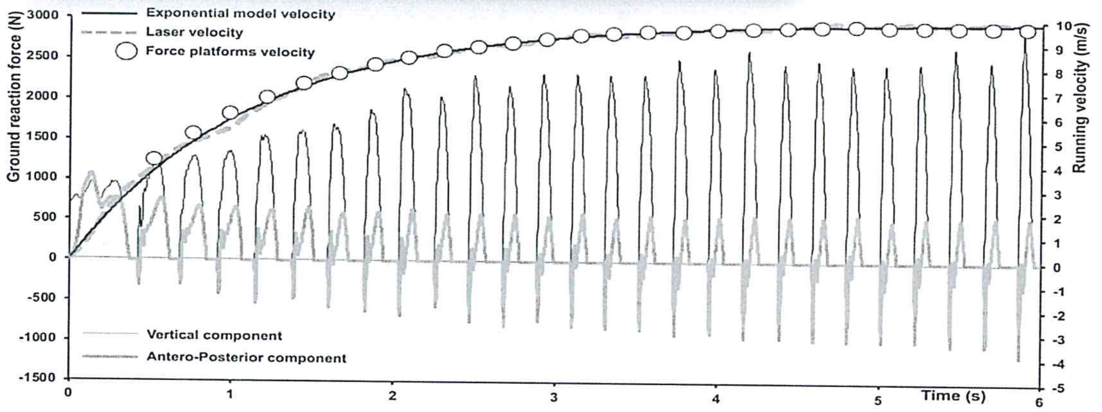
2016 AND 2019: VALIDATION AGAINST FORCE PLATES

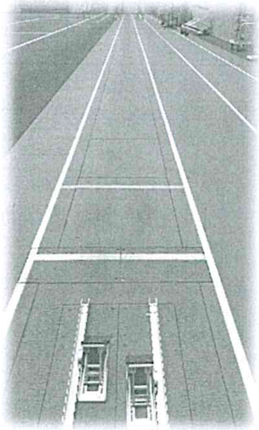
Contents lists available at ScienceDirect
Journal of Biomechanics
journal homepage: www.elsevier.com/locate/jbiomech www.JBiomech.com

A simple method for computing sprint acceleration kinetics from running velocity data: Replication study with improved design

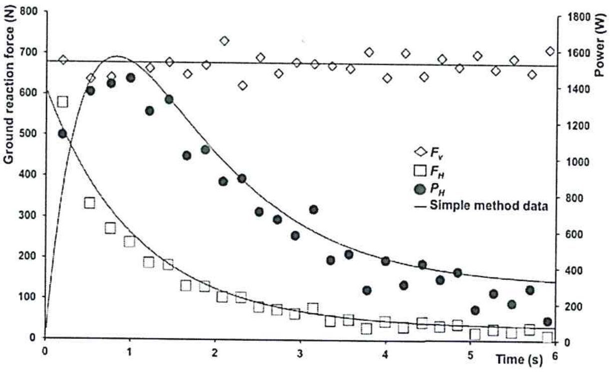
Jean-Benoit Morin[a,d,*], Pierre Samozino[b], Munenori Murata[c], Matt R Cross[b,d], Ryu Nagahara[c]

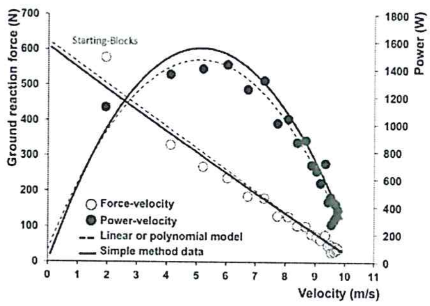






2016 AND 2019: VALIDATION AGAINST FORCE PLATES





- ✓ Simple inputs (body mass, running velocity)
- ✓ High reliability
- ✓ In practice…1 acceleration up to Vmax

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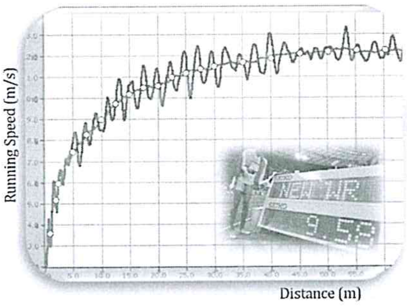
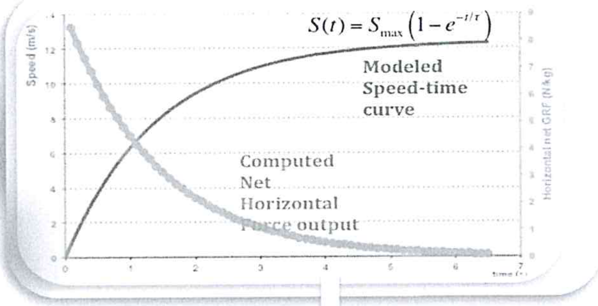
FORCE-VELOCITY-POWER outputs of Usain Bolt's World Record

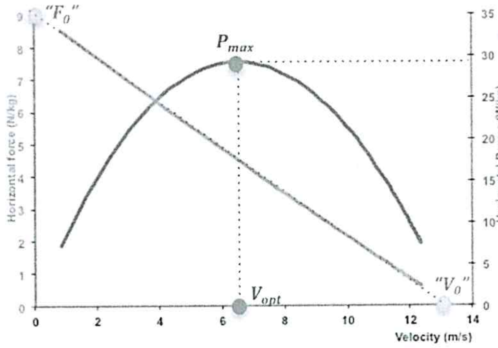


Field Measurements
In competition conditions

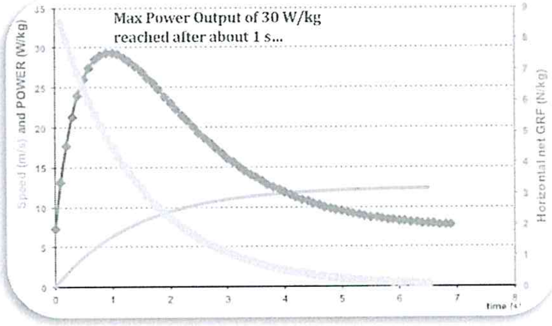
Computing



Specific, Field Sprint Force-Velocity-Power profile



Power = Force x Speed...



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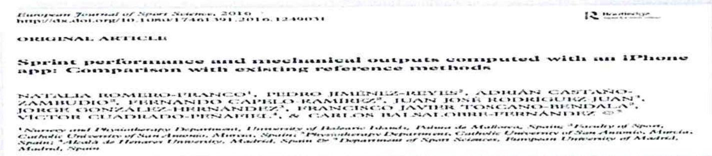
SIMPLER THAN SIMPLE...

2016: P. Jiménez-Reyes

Iphone / iPad:

240 frames/s


European Journal of Sport Science, 2016
http://dx.doi.org/10.1080/17461391.2016.1249031

ORIGINAL ARTICLE

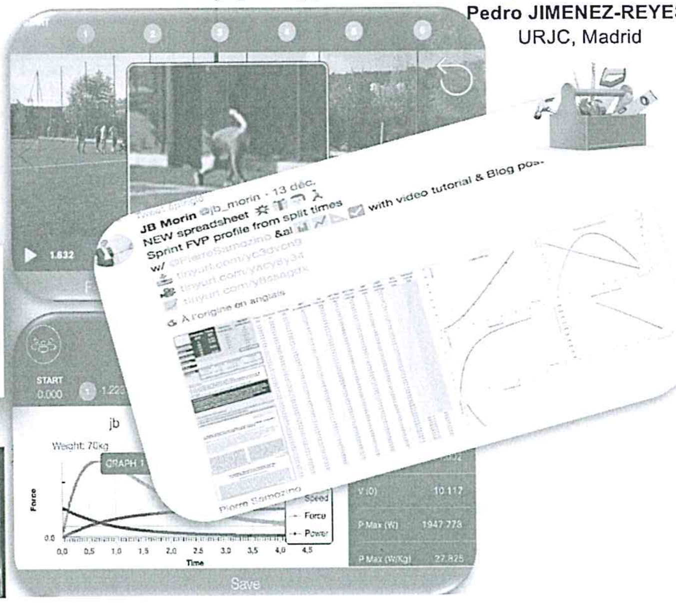
Sprint performance and mechanical outputs computed with an iPhone app: Comparison with existing reference methods

NATALIA ROMERO-FRANCO[1], PEDRO JIMÉNEZ-REYES[2], ADRIÁN CASTAÑO-ZAMBUDIO[3], FERNANDO CAPELO-RAMIREZ[3], JUAN JOSÉ RODRÍGUEZ-JUAN[3], JORGE GONZÁLEZ-HERNÁNDEZ[3], FRANCISCO JAVIER TOSCANO-BENDALA[4], VÍCTOR CUADRADO-PEÑAFIEL[4], & CARLOS BALSALOBRE-FERNÁNDEZ[5]

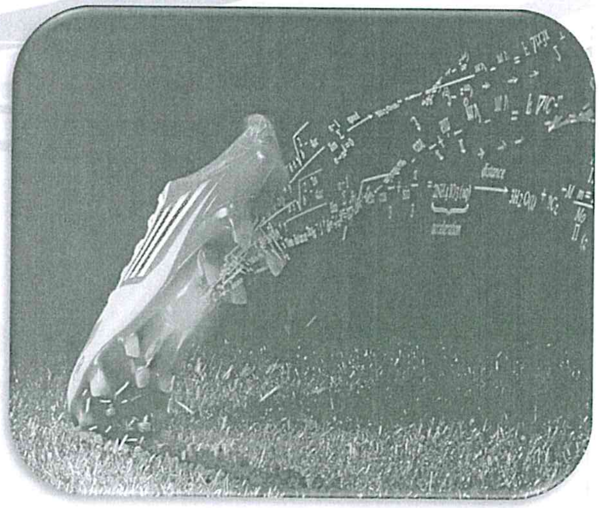
EJ Marey, 1885, 24 fps

@MySprintApp

Pedro JIMENEZ-REYES
URJC, Madrid



Applications: Training

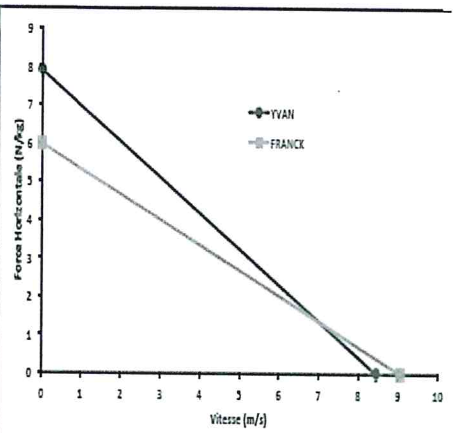


TYPICAL EXAMPLE:
Player is « slow »……but has high velocity capabilities !

40-m test :
6.21 vs **6.37** s

FFF - CEPP Novembre 2012
Dr Pierre SAMOZINO
Dr Jean-Benoit MORIN
Laboratoire de Physiologie de l'Exercice (EA4338)
CONTACT jean.benoit.morin@univ-st-etienne.fr
pierre.samozino@univ-savoie.fr

		Qualités physiques évaluées lors du 60m sans charge							
	Masse (kg)	Vmax théorique (m/s)	Fmax théorique (N)	Fmax théorique (N/kg)	Pmax (W)	Pmax (W/kg)	Profil F-v	Temps à 40 m (s)	Vmax mesurée (m/s)
YVAN	68	8.5	536	7.88	1125	16.5	-63.5	6.21	8.18
FRANCK	71	9.1	424	5.97	950	13.4	-46.9	6.37	8.64

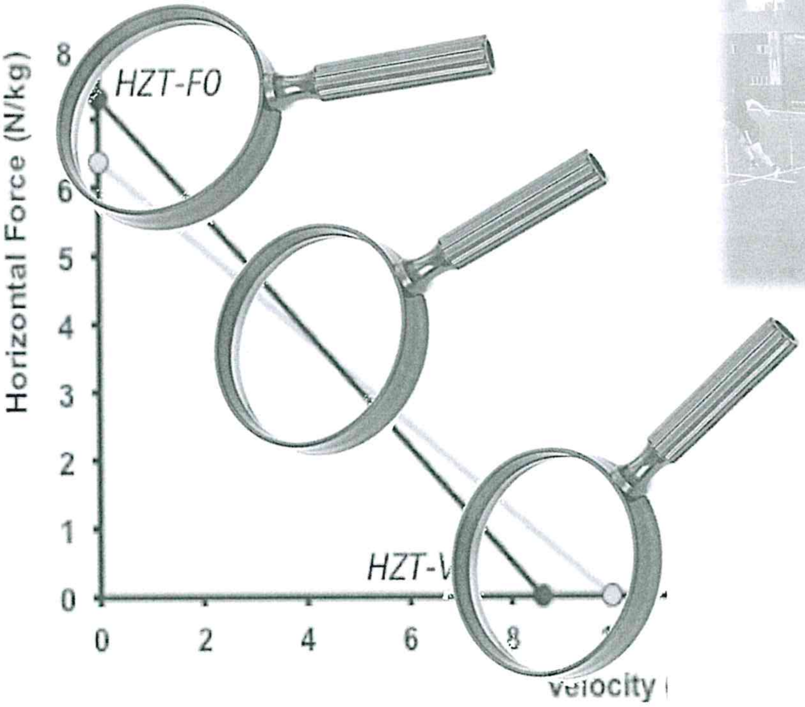


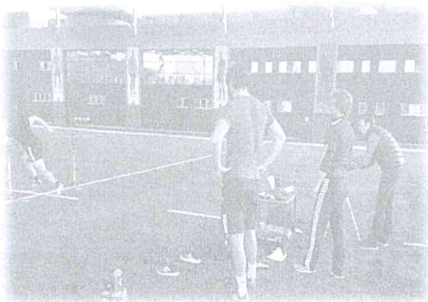
French Elite Rugby Union Team Follow-up 2017-2018

Same 30-m time, very different FVP profiles…

Height (m)	Mass (kg)	Age	30-m Time (s)	0m	5m split (s)	10m split (s)	15m split (s)	20m split (s)	25m split (s)	30m split (s)	V Max (m/s)	F0 (N)	F0 (N/Kg)	V0 (m/s)	Max (W)	P Max (W/Kg)
1,73	78,60		4,40	3,77	1,20	1,92	2,60	3,20	3,80	4,40	8,31	791,51	10,07	8,54	1689,47	21,49
1,79	78		4,42	4,21	1,34	2,05	2,68	3,28	3,86	4,42	9,05	607,33	7,79	9,40	1427,58	18,30
1,85	90,50		4,41	3,59	1,27	2,00	2,65	3,26	3,85	4,41	8,68	779,19	8,61	8,94	1741,84	19,25

Towards Individualized Sprint Training…





Training studies needed…

What training input(s) for what part(s) of the FV spectrum?

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EXPLORING: From 120%BM sleds to 10% OVERSPEED: entire spectrum !

Sports Med — SYSTEMATIC REVIEW
Resisted Sled Sprint Training to Improve Sprint Performance: A Systematic Review
George Petrakos · Jean-Benoit Morin · Brendan Egan

Journal of Sports Sciences, 2016 — Routledge
Determining friction and effective loading for sled sprinting
Matt R. Cross, Farhan Tinwala, Seth Lenetsky, Pierre Samozino, Matt Brughelli and Jean-Benoit Morin

International Journal of Sports Physiology and Performance — Human Kinetics
Optimal Loading for Maximizing Power During Sled-Resisted Sprinting
Matt R. Cross, Matt Brughelli, Pierre Samozino, Scott R. Brown, and Jean-Benoit Morin

European Journal of Applied Physiology — ORIGINAL ARTICLE
A comparison between the force-velocity relationships of unloaded and sled-resisted sprinting: single vs. multiple trial methods
Matt R. Cross · Pierre Samozino · Scott R. Brown · Jean-Benoit Morin

Work in progress

International Journal of Sports Physiology and Performance, (Ahead of Print) — Human Kinetics
Assessing Horizontal Force Production in Resisted Sprinting: Computation and Practical Interpretation
Matt R. Cross, Farhan Tinwala, Seth Lenetsky, Scott R. Brown, Matt Brughelli, Jean-Benoit Morin, and Pierre Samozino

PILOT

International Journal of Sports Physiology and Performance, 2017, 12, 840 — Human Kinetics — BRIEF REPORT
Very-Heavy Sled Training for Improving Horizontal-Force Output in Soccer Players
Jean-Benoit Morin, George Petrakos, Pedro Jiménez-Reyes, Scott R. Brown, Pierre Samozino, and Matt R. Cross

PILOT

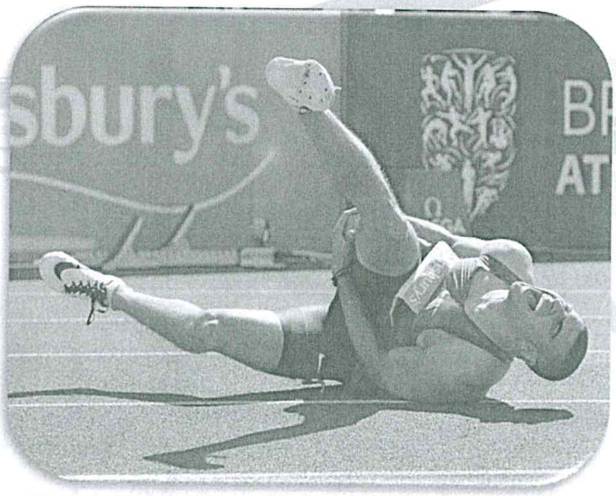
PLOS ONE — RESEARCH ARTICLE
Training at maximal power in resisted sprinting: Optimal load determination methodology and pilot results in team sport athletes
Matt R. Cross, Johan Lahti, Scott R. Brown, Mehdi Chedati, Pedro Jimenez-Reyes, Pierre Samozino, Ola Eriksrud, Jean-Benoit Morin

@peterjr49 (Univ @ an Lahti iv Nice) _johan

UNIVERSITÉ CÔTE D'AZUR jb morin

CONI SCUOLA DELLO SPORT

Applications: Injury Management



PREPARE & REPAIR

Season follow-up…

Primary prevention & Training Content Management

Physical qualities evaluated during the acceleration						Mechanical effectiveness			Performa[nce]		
Vmax theoretical V0 (m/s)	Fmax theoretical F0 (N)	Fmax theoretical F0 (N/kg)	Pmax (W)	Max Horizontal Power Pmax (W/kg)	Force-Velocity profile	mean RF on 10m	RF peak	DRF	Time @ 5 m (s)	Time @ 10 m (s)	Time @ 20 m (s)
[illegible]											
8.79	787	7.81	1717	17.0	-89.5	30%	54%	-0.079	1.34	2.07	3.35
[illegible]											
9.32	761	6.71	1762	15.5	-81.7	28%	48%	-0.065	1.41	2.18	3.42
[illegible]											
8.90	669	7.43	1475	16.4	-75.2	30%	53%	-0.074	1.35	2.12	1.40
8.04	790	6.38	1579	12.7	-93.3	25%	48%	-0.072	1.48	2.31	
9.34	733	7.65	1700	17.7	-78.5	30%	52%	-0.073	1.34	2.07	3.29
8.19	834	8.45	1697	17.2	-101.8	28%	54%	-0.092	1.31	2.08	3.39
8.30	517	5.47	1065	11.3	-62.3	22%	38%	-0.062	1.57	2.40	3.84
9.33	590	7.48	1365	17.3	-63.2	29%	49%	-0.073	1.37	2.07	3.32
[illegible]											
8.91	673	7.38	1485	16.3	-75.5	27%	47%	-0.076	1.37	2.11	3.39
8.70	694	7.80	1502	16.9	-79.8	27%	48%	-0.081	1.34	2.08	3.39
[illegible]											
8.49	815	7.53	1720	15.9	-96.0	26%	47%	-0.081	1.36	2.13	3.44
[illegible]											
8.66	828	9.11	1782	19.6	-95.6	30%	58%	-0.092	1.26	1.99	3.24
[illegible]											
9.04	814	7.91	1825	17.8	-90.0	30%	53%	-0.078	1.33	2.07	3.31
[illegible]											
8.77	755	8.39	1642	18.3	-86.1	30%	56%	-0.085	1.31	2.05	3.30
9.14	567	5.81	1287	13.2	-62.1	25%	39%	-0.059	1.52	2.32	3.63
10.15	621	6.75	1562	17.0	-61.2	31%	50%	-0.060	1.39	2.12	3.34
[illegible]											
8.41	665	7.33	1390	15.3	-79.2	27%	51%	-0.079	1.40	2.17	3.48
9.18	650	6.64	1482	15.1	-70.8	29%	49%	-0.065	1.43	2.20	3.48
[illegible]											
9.14	714	7.75	1621	17.6	-78.2	30%	52%	-0.076	1.33	2.07	3.32
8.59	796	7.32	1699	15.6	-92.7	28%	50%	-0.077	1.40	2.14	3.45
[illegible]											
9.92	550	6.39	1352	15.7	-55.4	31%	50%	-0.058	1.44	2.18	3.43
9.14	586	6.17	1330	14.0	-64.1	27%	46%	-0.061	1.45	2.24	3.56
8.96	695	7.25	1543	16.1	-78.0	28%	49%	-0.073	1.39	2.14	3.42
0.46	91	0.84	181	1.8	12.4	2%	4%	0.01	0.07	0.09	0.12
5%	13%	12%	12%	11%	16%	6%	8%	13%	5%	4%	4%
8.04	517	5.47	1065	11.3	-101.8	22%	38%	-0.09	1.26	1.99	3.24
10.15	834	9.11	1828	19.6	-55.4	31%	58%	-0.06	1.57	2.40	3.84

Review

Sports-related workload and injury risk: simply knowing the risks will not prevent injuries

Michael K Drew,[1,2] Jill Cook,[2,3] Caroline F Finch[2]

ABSTRACT

Training loads contribute to sports injury risk but their mitigation has rarely been considered in a sports injury prevention framework. A key concept behind monitoring training loads for injury prevention is to screen for those at increased risk of injury so that workloads can be adjusted to minimise these risks. This review describes how advances in management of workload can be applied as a preventive measure. Primary prevention involves screening for preparticipation load risk factors, such as low training loads, prior to a training period or competition. Secondary prevention involves screening for workloads that are known to precede an injury developing so that modification can be undertaken to mitigate this risk. Tertiary prevention involves rehabilitation practices that include a graded return to training programme to reduce the risk of sustaining a subsequent injury. The association of training loads with injury incidence is now established. Prevention measures such as rule changes that affect the workload of an athlete are universal whereas those that address risk factors of an asymptomatic subgroup are more selective. Prevention measures, when implemented for asymptomatic individuals exhibiting possible injury risk factors, are indicated for an athlete at risk of developing a sports injury. Seven key indicated risks and associated prevention measures are proposed.

history of previous injuries sustained. Preseason hamstring strength testing with the Nordic hamstring test[4] followed by an eccentric strengthening programme for athletes with lower strength is one example of primary prevention.

Assessing prior training load history is critical. Conceptually, a lower 'training base' can result from a break in training or from chronically low workloads. Training bases can be assessed in simple or advanced ways. A study in junior elite football (soccer) players showed that athletes with a history of a low amount of training had higher rates of groin injuries after an intensive training programme.[5] Training history was simply defined as the number of training sessions per week prior to start of the training programme. An increase from two to three sessions a week to daily or twice daily (as is common in these training programmes and club situations) poses a large risk of injury to the athlete. However, simple measures to control this risk are feasible.

High performance training camps also pose significant risks of injury. In judo, camp injury rates have been as high as 83%,[6] and it has been suggested that these may be due to factors such as new techniques, higher intensity and scrutiny of coaching, or (micro) trauma from training. In this judo example, the average week-to-week increase in time

Return to sport …or return to (sprint) Performance

TABLE 2. Rehabilitation and RTS algorithm program for hamstring injury

	REGENERATION PHASE	FUNCTIONAL PHASE	
Manual therapy	Manual therapy: Plantar fascia, gastrocnemius and hamstring (avoiding injury site) massage; Lumbar Z-joint mobilization; Sliding Neural Mobilization; NMES	Manual therapy: Plantar fascia, gastrocnemius and hamstring (injury site included) massage; Lumbar Z-joint mobilization	1. 2. 3
Flexibility	[illegible]	[illegible]	2. 3
Gluteus	Gluteus Maximus; Option A; Option B; Gluteus Medius: [illegible]	Gluteus Maximus; Option A; Option B; Gluteus Medius: [illegible]	2
Hamstring strength	[illegible]	HIP dominant; KNEE dominant; Nordic hamstring [illegible]	2
Plyometrics		[illegible]	2
Ankle stabilizers	[illegible]	[illegible]	2
Lumbopelvic control	[illegible]	[illegible]	2. 3
Running technique	Frontal plane running drills; Sagittal plane running drills [illegible]	Warm Up: [illegible]; Hurdle drills [illegible]	1

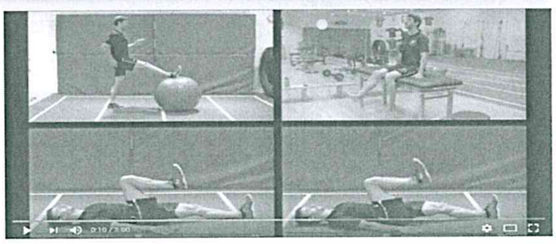
1, contents corresponding to the training day 1; 2, contents corresponding to the training day 2; 3, contents corresponding to the training day 3. Minimum of three blocks 1-2-3 in the functional phase before RTS.
Reps, repetitions; BW, body weight; NMES, neuromuscular electrical stimulation.

APPLIED SCIENCES

A Multifactorial, Criteria-based Progressive Algorithm for Hamstring Injury Treatment

JURDAN MENDIGUCHIA[1], ENRIQUE MARTINEZ-RUIZ[2], PASCAL EDOUARD[3,4,5], JEAN-BENOÎT MORIN[6], FRANCISCO MARTINEZ-MARTINEZ[7], FERNANDO IDOATE[8], and ALBERTO MENDEZ-VILLANUEVA[9]

Medicine & Science in Sports & Exercise



Hamstring rehab for football players (Mendiguchia et al. 2017)
20 039 vues

Jurdan Mendiguchia
Zentrum Center
Baranain, Spain

REHABILITAITON
TARGET REFERENCE
PROFILE (PRE-INJURY)

Sprint Mechanics and Performance included in final functional steps

PREPARE

REPAIR

Return to sport …or return to (sprint) Performance

FV Sprint profile for an injured player: 3 tests

1 & 2 = PRE-INJURY

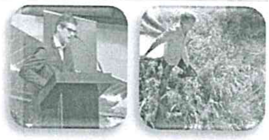
Test	Date	Height (m)	Mass (kg)	30-m Time (s)	V Max (m/s)	F0 (N/Kg)	V0 (m/s)	P Max (W)	P Max (W/Kg)	DRF	FV slope	RF_10 m	RF Peak
1	21/09/2017	1,87	95	4,58	8,88	6,98	9,20	1524	16,1	-7%	-72,1	32%	50%
2	22/11/2017	1,87	95	4,62	8,39	7,63	8,65	1567	16,5	-8%	-83,9	32%	52%
3	09/02/2018	1,87	95	4,48	8,55	8,40	8,80	1755	18,5	-9%	-90,7	32%	55%

TEST 3: AFTER return-to-sport, to validate the « return to performance »

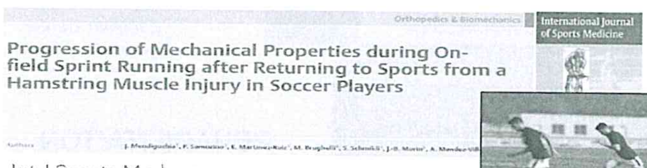
Johan Lahti
(Univ Nice)
@lahti_johan

Use in prevention ??
Sprint mechanics as a « risk » factor

Return to sport …or return to (sprint) Performance



Jurdan Mendiguchia
Zentrum Center
Baranain, Spain


Orthopedics & Biomechanics
International Journal of Sports Medicine

Progression of Mechanical Properties during On-field Sprint Running after Returning to Sports from a Hamstring Muscle Injury in Soccer Players

Int J Sports Med, 2014

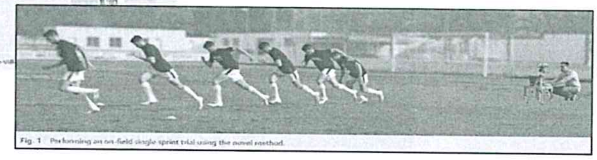


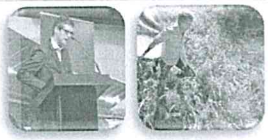
Fig. 1 Performing an on-field single sprint trial using the novel method.

At return to sport (post hamstring injury):

- **Power (Pmax)** and **Max Force (F0),** lower in injured players
- **but** not velocity (V0)
- 2 months later, values overall returned to normal

> 1/ what objective & functional data led to « RTS » decision?
>
> 2/ what « risk » during this 2-month (*or shorter*) period !?

Return to sport …or return to (sprint) Performance



Jurdan Mendiguchia
Zentrum Center
Baranain, Spain

JOURNAL OF SPORTS SCIENCES, 2015
http://dx.doi.org/10.1080/02640414.2015.1122207
Routledge Taylor & Francis Group

Field monitoring of sprinting power–force–velocity profile before, during and after hamstring injury: two case reports

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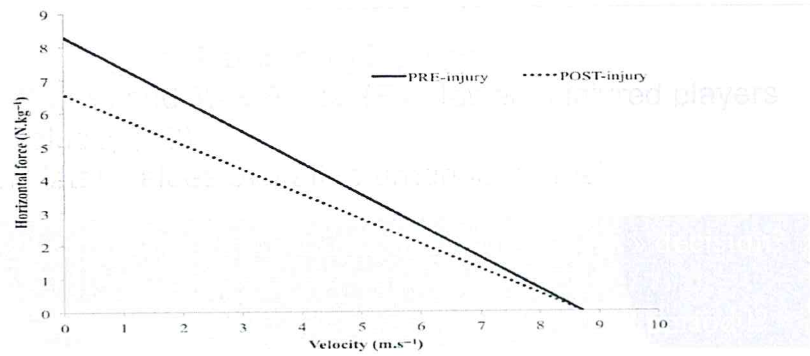
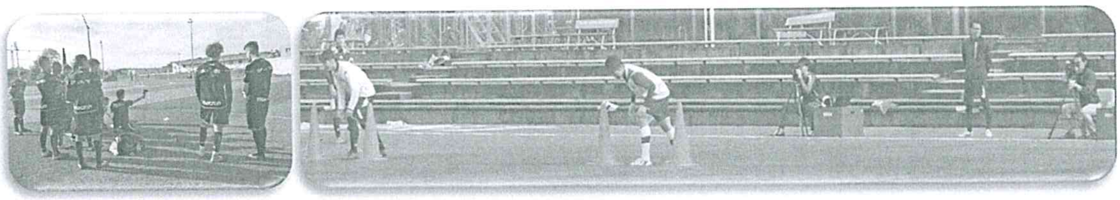


Pre-Injury data…

Use in Prevention?



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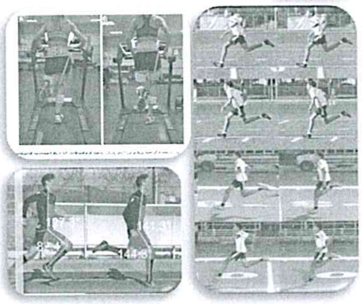
Ongoing 3rd-season large observational follow-up in several groups

1/ Is F-V-P profile related to a higher risk?

2/ Could it be an objective parameter in the prevention process?



Sprint « pattern » and pelvic control as additional pieces of the puzzle

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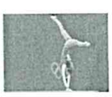
YouTube



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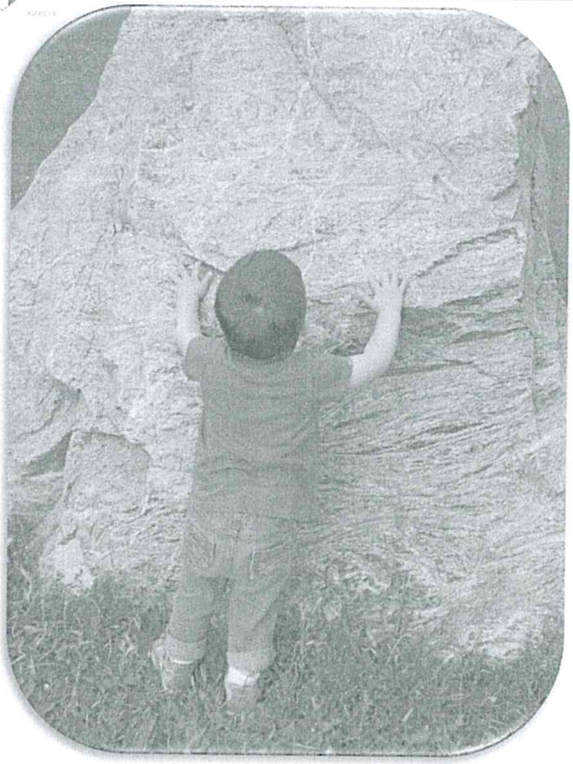

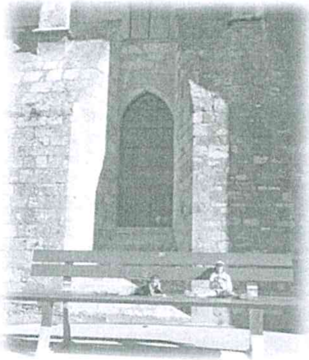

Merci !