

UNIVERSITÄT SAVOIE MONT BLANC

libm
Laboratoire Interuniversitaire de Biologie de la Motricité

Pedro JIMÉNEZ-REYES

EFFECTIVENESS OF AN INDIVIDUALIZED TRAINING BASED ON FORCE-VELOCITY PROFILE ON JUMP PERFORMANCE

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Which one is the most powerful ? **140 kW**

Which one can produce more force?

It depends at which velocity...

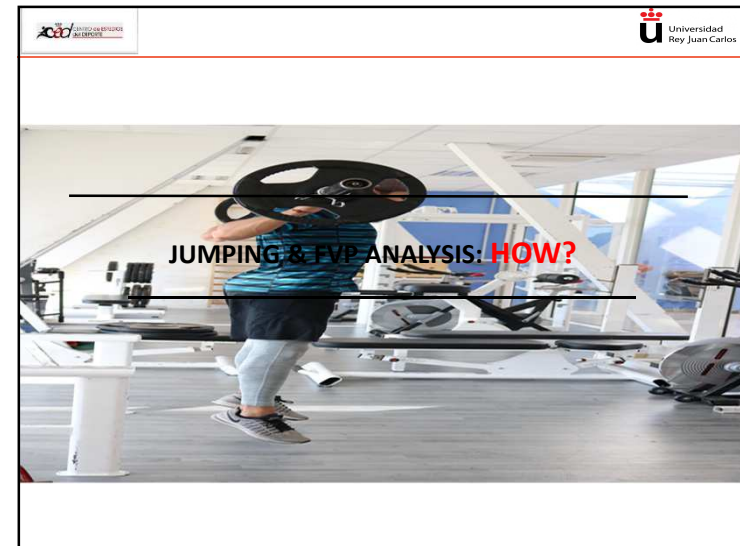
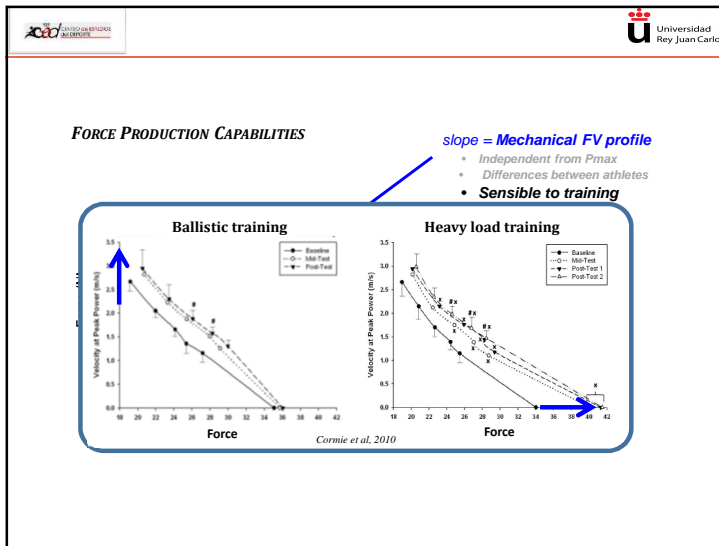
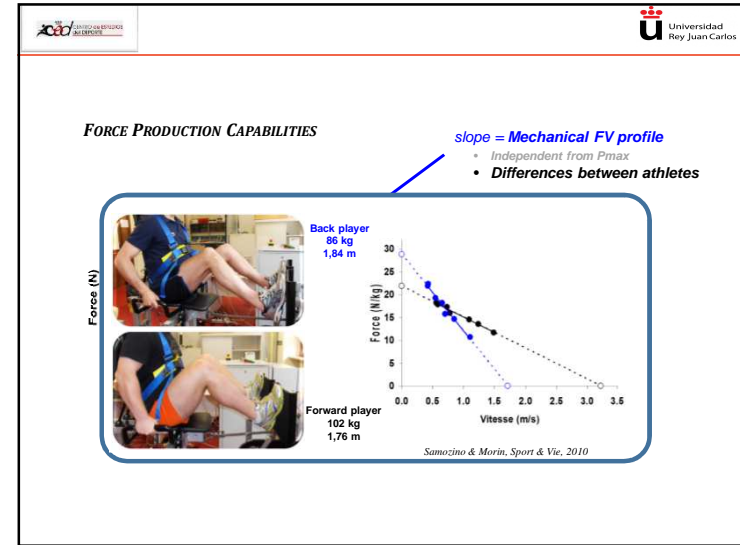
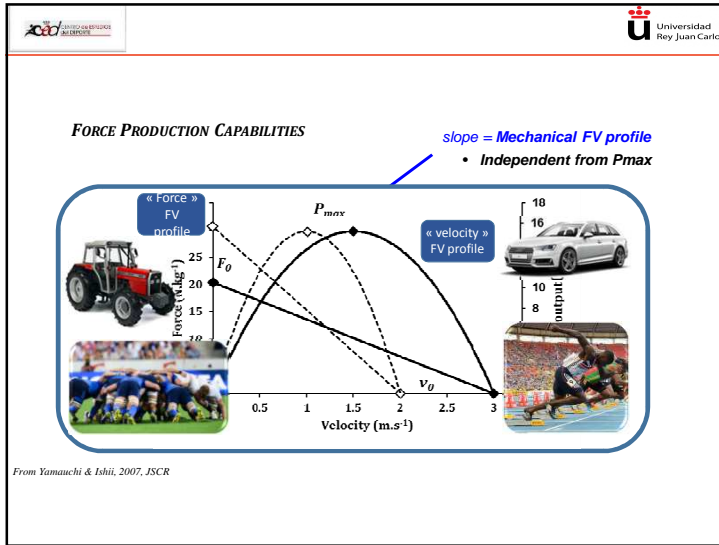
Who can produce more force?

It depends at which velocity...

FORCE PRODUCTION CAPABILITIES

From Yamauchi & Ishii, 2007, JSCR

- Sergoani et al, 1981
- Vandewalle et al, 1987
- Dorel et al, 2010
- Samozino et al, 2007
- Bosco et al, 1995
- Rahmani et al, 2001
- Samozino et al, 2014
- Jaric, 2015
- Yamauchi & Ishii, 2007
- Samozino et al, 2012
- Bodewert, 2012
- Jaskolska et al, 1999
- Morin et al, 2010
- Rambaux et al, 2008
- Garcia-Ramos et al, 2016
- Sreckovic et al, 2015



Field

A simple method for measuring force, velocity and power output during squat jump

Pierre Samozino*, Jean-Benoit Morin, Frédérique Hinzy, Alain Belli
Exercise Physiology Laboratory (U4-438), University of Savoie Evian-les-Bains - Médecine du Sport et de Médecine, CHU Savoie Evian-les-Bains, CHU Savoie Evian-les-Bains, CHU Savoie Evian-les-Bains

Pierre Samozino
 Univ Savoy

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

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

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

Mass + Load
 Jump height
 Push-off distance

APPROVED
 Validity and reliability

Loaded SJ or CMJ

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

Samozino et al. 2008, J Biomech

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Mass + Load
 Jump height
 Push-off distance

FV imbalance
 Optimal Profile

Field testing
 Pmax & FV Profile
 Comparison between athletes
 FV imbalance
 Individual optimisation

Samozino et al. 2008, J Biomech

A SIMPLE FIELD METHOD

Fg (N/kg)	42,4
v0	3,38
Pmax (W/kg)	35,8
Stv (N.s/m/kg)	-12,85

Force (N) vs Velocity (m/s)

F-V Profile

F0 v0
 FV_{IMB}
 Pmax

4-5 loaded jumps
 Simple computations

F-v Profile = 90% of the optimal
 FORCE is to be developed

Prediction errors : 4-6%

Interest ??

Optimal Fv profile
 For a given Pmax
 - 30%

Improve performance with:
 Pmax
 FV imbalance

Samozino et al. 2010, J Theor Biol
 Samozino et al. 2012, MSSE

THEORETICAL EVIDENCE

A MACROSCOPIC BIOMECHANICAL MODEL

$$v_{TOmax} = l_{PC} \left(\sqrt{\frac{S_{PC}^2}{4} + \frac{2}{l_{PC}} (2\sqrt{P_{max} S_{PC}} - g \sin \alpha) + \frac{S_{PC}}{2}} \right)$$

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

Validity ??
 Interest ??

Optimal Fv profile
 For a given Pmax
 - 30%

Improve performance with:
 Pmax
 FV imbalance

Samozino et al. 2010, J Theor Biol
 Samozino et al. 2012, MSSE

EXPERIMENTAL EVIDENCE

EXPERIMENTAL EVIDENCE

Int J Sports Med 2014; 35: 505-510

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

48 high level Sport men (Soccer, Sprinters, Rugbymen)

Authors: P. Samozino¹, P. Edouard², S. Sanglier¹, M. Dringhallo¹, P. Gimenez¹, J.-B. Morin¹

✓ **Squat Jump performance** was significantly related to **HIGH Pmax** AND **LOW FV imbalance**

Effect of countermovement on power-force-velocity profile

54 high level Sprinters and jumpers

✓ **Same result in CMJ**

Pedro Jimenez-Reyes · Pierre Samozino · Victor Cuadrado-Peñafiel · Felipe Conceicao · Juan José González-Buñuel · Jean-Benoit Morin

EXPERIMENTAL EVIDENCE

- 48 sportsmen (pro soccer, rugby, athl)
- Pmax, FV profile, SJ performance
- **Statistical control** of the effect of Pm

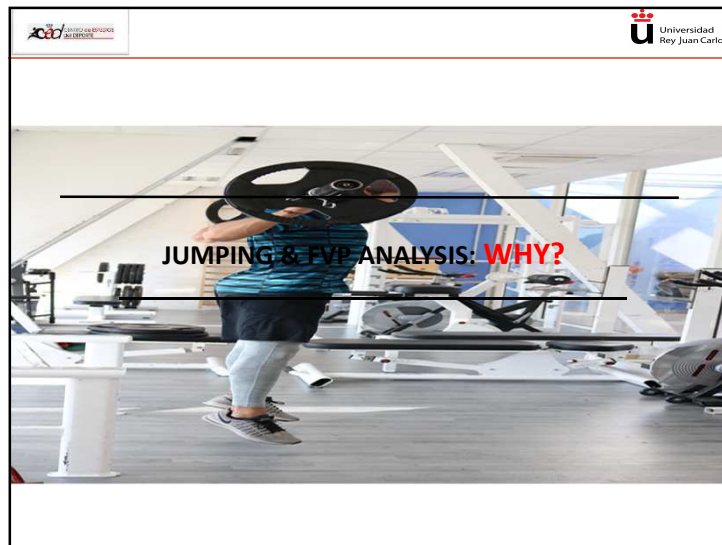
Fig. 2 Correlation between model-predicted and measured jump heights. Each point represents a subject. The solid line represents the identity line.

Table 2 Multiple regression analysis for the prediction of jump height (n = 47, one outlier was removed).

Multiple regression model		r ²	SEE (m)	P
		0.931	0.015	<0.001
Independent variables	Coefficient	t	P	
P _{max}	0.0122	23.0	<0.001	
FV _{MB}	-0.0810	-5.92	<0.001	
h _{LD}	0.617	13.9	<0.001	
Constant	-0.174	-7.13	<0.001	

SEE: Standard Error of Estimate; P_{max}: maximal power output; FV_{MB}: Force-velocity imbalance; h_{LD}: lower limb extension range

...experimentally supports the actual existence of an optimal F-v profile, specific to each individual, that maximizes jumping performance for a same given P_{max}.



45

40

0.0 **4.0**

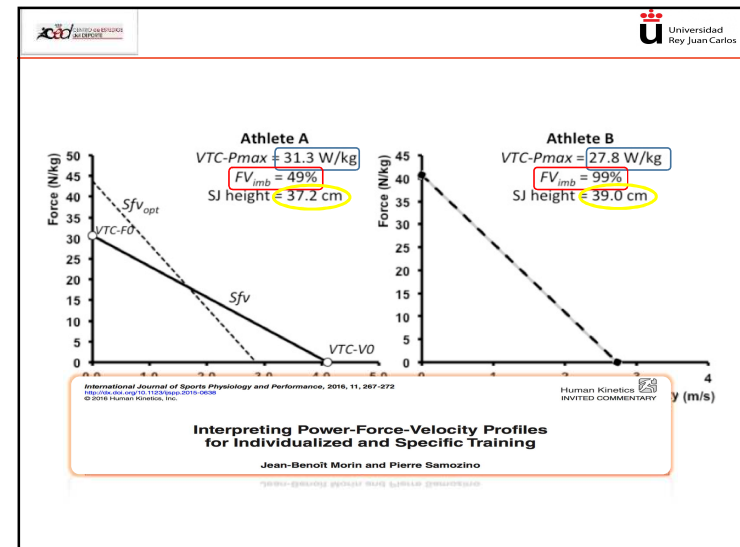
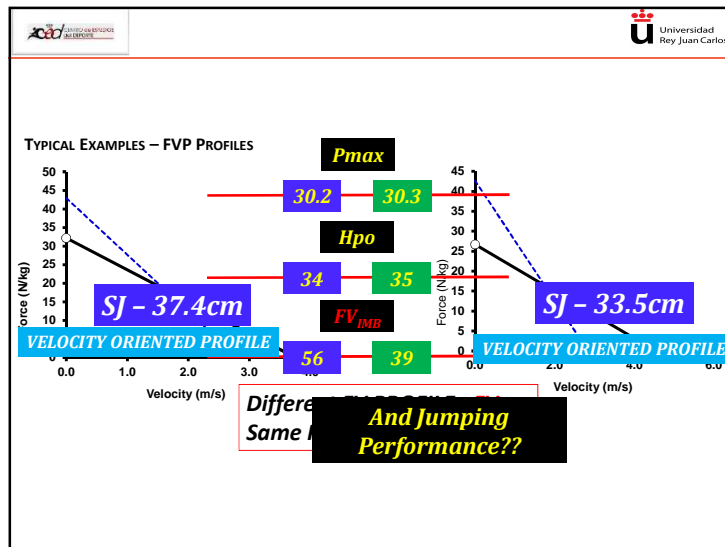
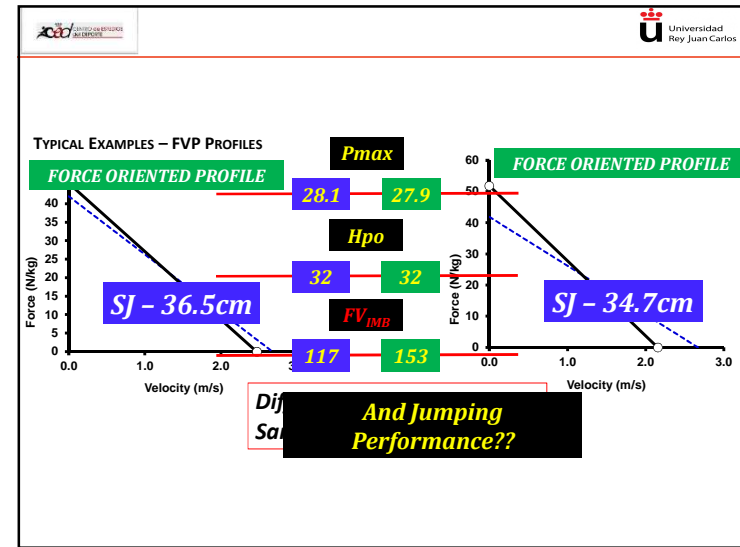
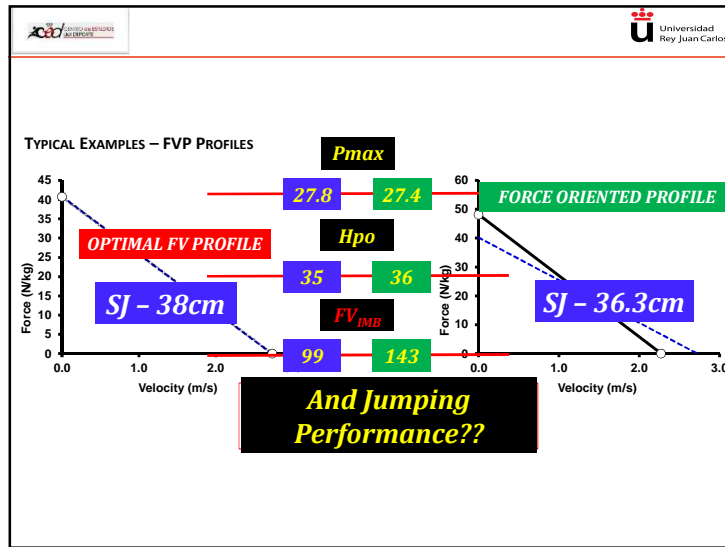
Force (N/kg) **velocity (m/s)**

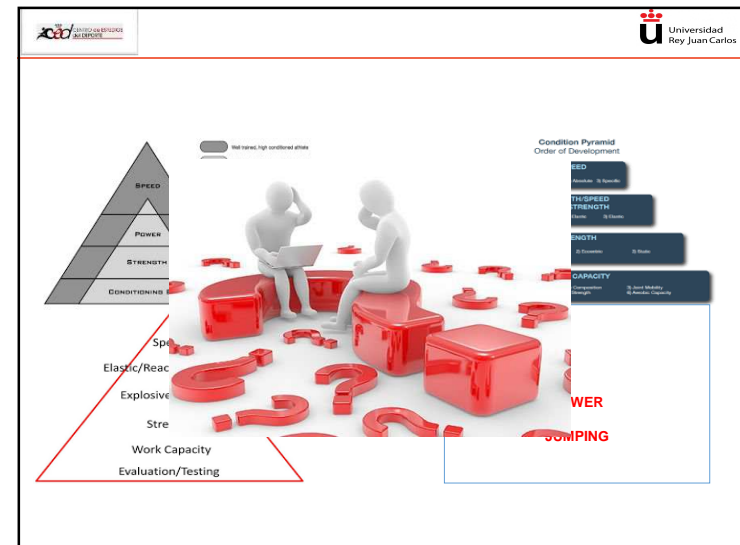
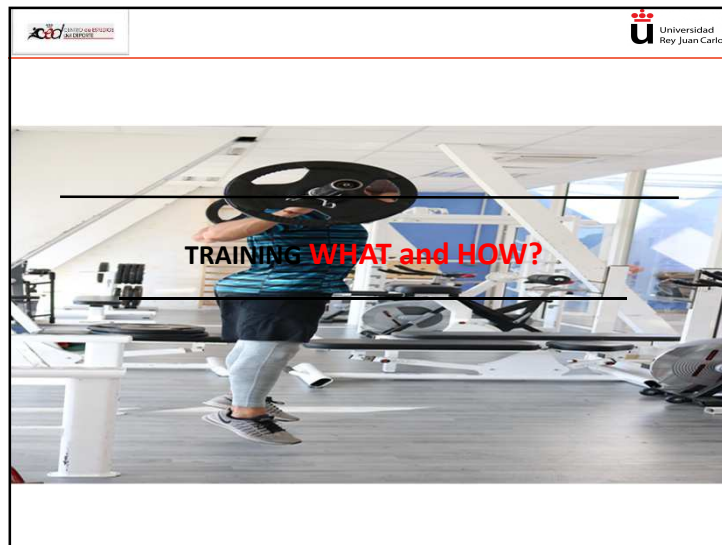
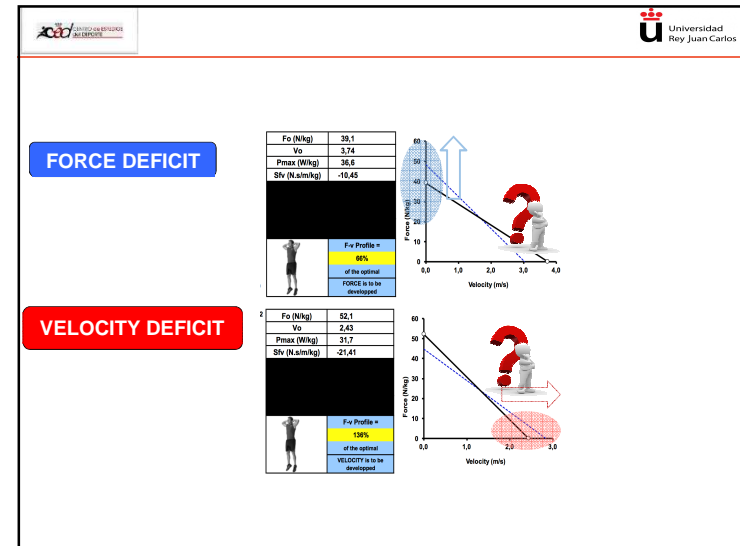
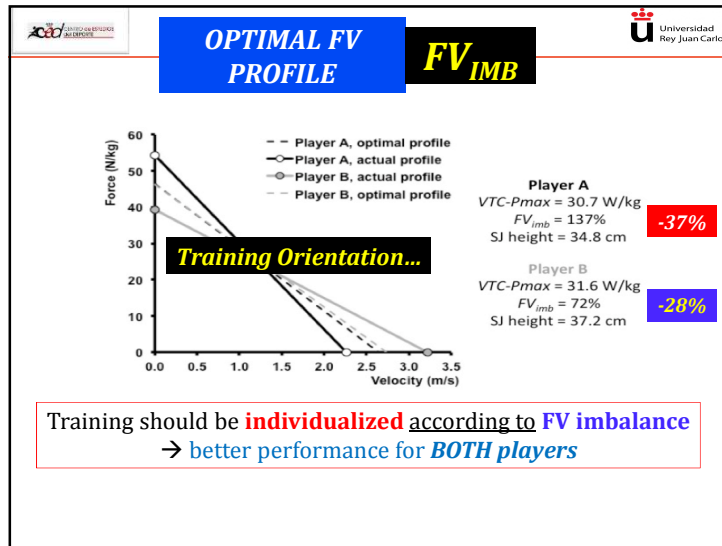
- FVP PROFILE → INFO FV RELATIONSHIP
- FVP PROFILE → NEEDS OF ATHLETES
- FVP PROFILE → INDIVIDUALIZATION
- FVP PROFILE → RE-CHECKINS...FOLLOW-UP

1RM Assessment...

Enough INFO...

Different kind of jumps...





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ONE-SIZE-FITS-ALL

INDIVIDUALIZED

IMPROVEMENT ??

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SPECIFICITY

EXERCISES

International Journal of Sports Medicine

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

Authors: Jean Romain Rivière¹, Jeremy Rossi², Pedro Jiménez-Reyes³, Jean-Benoit Morin⁴, Pierre Samozino⁵

HOW FAST IS A HORIZONTAL SQUAT JUMP?

PIERRE SAMOZINO^{1*}, JEAN ROMAIN RIVIERE², JÉRÉMY ROSSI³, JEAN-BENOIT MORIN⁴, PEDRO JIMÉNEZ-REYES⁵

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

Pedro Jiménez-Reyes¹, Pierre Samozino², Matt Brughelli³ and Jean-Benoit Morin^{4,5*}

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→ 9 weeks
→ OPTIMIZED (46) vs NON-OPTIMIZED (18)

Experimental group:

22 force deficit
18 velocity deficit
6 well-balanced

✔

frontiers in Physiology

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

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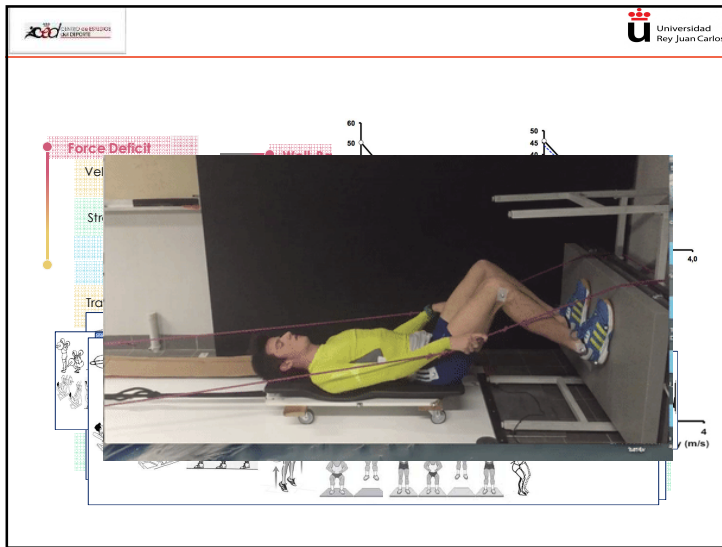
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F_{limb} categories	F-v profile in % of optimal thresholds (%)	Training loads ratio*
High force deficit	<60	3 Strength 2 Strength-power 1 Power
Low force deficit	60-90	2 Strength 2 Strength-power 2 Power
Well-balanced	>90-110	1 Strength 1 Strength-power 2 Power 1 Power-speed 1 Speed
Low Velocity Deficit	=110-140	2 Speed 2 Power-speed 2 Power
High Velocity Deficit	>140	3 Speed 2 Power-speed 1 Power

OPTIMIZED GROUP: High Force Deficit, Low Force Deficit, Well-Balanced, Low Velocity Deficit, High Velocity Deficit

CONTROL GROUP: No training, Sensibility F-v Profile

F_{limb}: F-v imbalance. *Ratio based on six exercises/week, three sets/exercise and 10 sets/week.



FV_{IMB}

TABLE 1 | Force-velocity imbalance categories, thresholds, and associated resistance training load ratios.

FV _{imb} categories	F-v profile in % of optimal thresholds (%)	Training loads ratio*
High force deficit	<60	3 Strength 2 Strength-power 1 Power
Low force deficit	60-90	2 Strength 2 Strength-power 2 Power
Well-balanced	>90	1 Strength 1 Strength-power 1 Power
Low velocity deficit	<60	2 Strength 2 Strength-power 2 Power
High velocity deficit	>90	1 Strength 1 Strength-power 1 Power

*F_{velo}: F_v ratio sets/wk

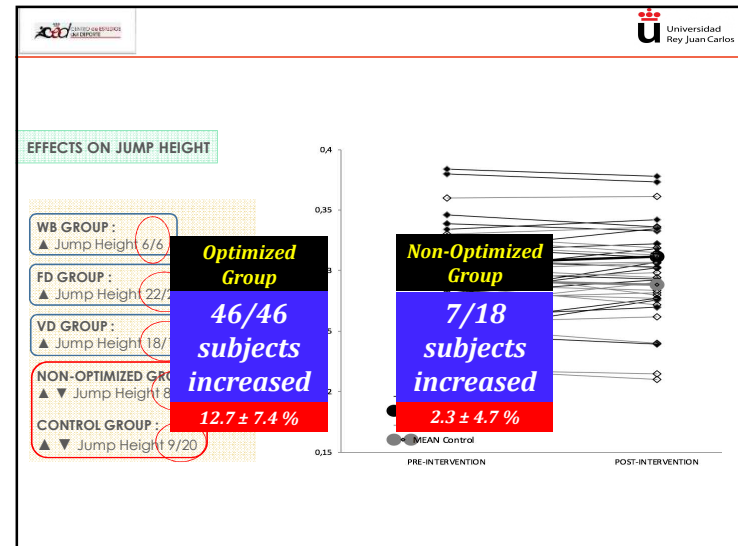
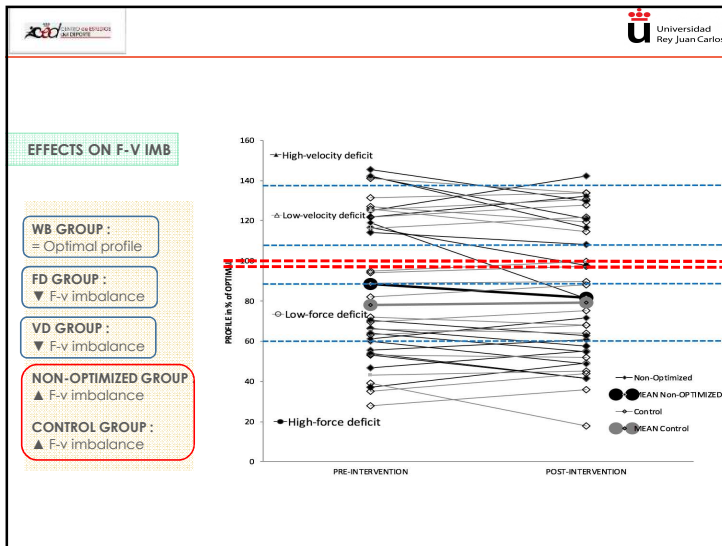


TABLE 1 | Force-velocity imbalance categories, thresholds, and associated resistance training load ratios.

FV _{max} categories	F-v profile in % of optimal (breakdown (%))	Training loads ratio*
High force deficit	>60	2 Strength 1 Strength-power 1 Power
Low force deficit	60-90	2 Strength 2 Strength-power 2 Power
Well-balanced	~90-110	1 Strength 1 Strength-power 2 Power 1 Power-speed 1 Speed 2 Speed
Low velocity deficit	>110-140	Power-speed
High velocity deficit	>140	Power-speed

TABLE 2 | Loading target for the F-v spectrum and exercises and training loads for each exercise.

Loading focus/target	Exercises	Training loads
Strength	Back squat Squat press Chest press	80-90% 1RM 90-95% 1RM 90-95% 1RM
Strength-power	Clean pull Clean lift SJ CMJ	90% 1RM 90% 1RM 2-3BW or EW ~ 80% of BW
Power	SJ CMJ	20-30% of BW 35-45% of BW
Power-speed	Single leg SJ Single leg CMJ Clean pull jumps Depth jumps	EW EW 10% of BW 85% 1RM
Speed	EW EW EW	EW EW EW

FV_{max}, F-v imbalance category.

Deficit in force... Deficit in velocity?

Samozino et al. USPP In Press

BM Squat Jump Horizontal Squat Assisted Horizontal Squat BM Squat Jump Horizontal Squat Assisted Horizontal Squat

CONCLUSION & PRACTICAL APPLICATION

Individualized training program specifically addressing the FV imbalance is **more efficient** in improving jump height than a traditional one-size-fits-all program overlooking FV imbalance

S&C coaches should quantify and consider individual FV imbalances to **orient and individualize training loads** and exercises to :

- optimize FV profile
- and/or increase Pmax
- in turn, improve jump performance

