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CONDITIONING ASSOCIATION

2019 NSCA PERSONAL TRAINERS VIRTUAL CONFERENCE

OCTOBER 7 – 11

#NSCAPT19

CONFLICT OF INTEREST STATEMENT

I have one potential conflict of interest in relation to this presentation: I have a patent on a hip thrust device.

Force Vector Training

Bret Contreras, PhD, CSCS,*D

What to Expect

I. History of Force Vector Concept
II. Theories
III. Drawbacks
IV. Experiments
    I. Plyos
    II. Resistance Training
V. Conclusion

Force Vector Training

Where did it all begin? The emergence of the hip thrust in 2006…

Force Vector Training

Where did it all begin? A 2009 eBook…

Advanced Techniques in Glutei Maximi Strengthening:

The Secret to Top Speed Sprinting, Back and Knee Injury Prevention, and a Better Butt

By Bret Contreras

Force Vector Training

Where did it all begin? A 2009 TNation Article…

Dispelling the Glute Myth

by Bret Contreras | 09/16/09

Force Vector Training

Where did it all begin? A 2010 Blogpost…

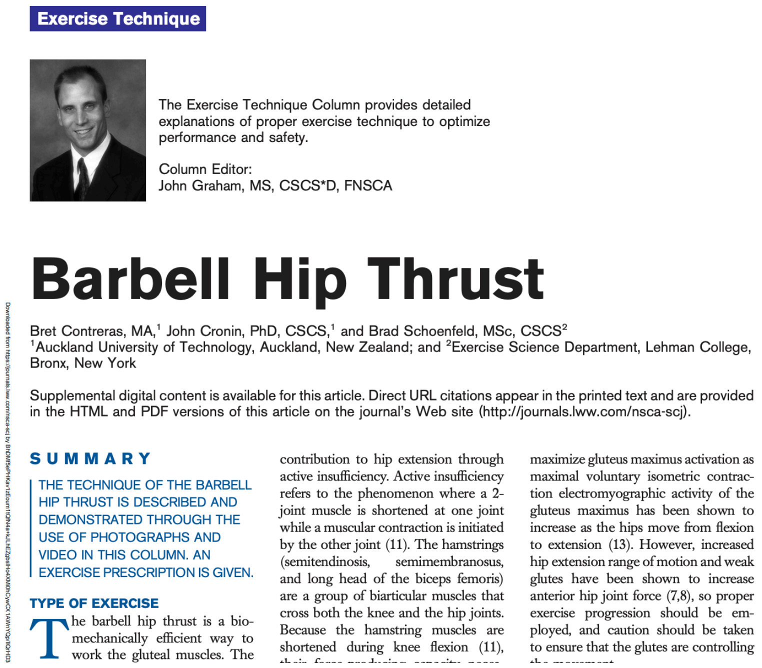
Load Vector Training (LVT)

By Bret Contreras | July 1, 2010 | Power, Sport Specific Training, Strength Training, Training Philosophy

This article is a very important read for any individual who works in the strength and conditioning and sport training professions. It is my hope that the terminology described within this article will catch on and appear more often in conversation and literature. Please read this article and decide for yourself which language you will proceed to use when describing movement..

Force Vector Training

Where did it all begin? A 2011 SCJ Article…



Exercise Technique

The Exercise Technique Column provides detailed explanations of proper exercise technique to optimize performance and safety.

Column Editor:
John Graham, MS, CSCS*D, FNSCA

Barbell Hip Thrust

Bret Contreras, MA,[1] John Cronin, PhD, CSCS,[1] and Brad Schoenfeld, MSc, CSCS[2]
[1]Auckland University of Technology, Auckland, New Zealand; and [2]Exercise Science Department, Lehman College, Bronx, New York

Supplemental digital content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's Web site (http://journals.lww.com/nsca-scj).

SUMMARY

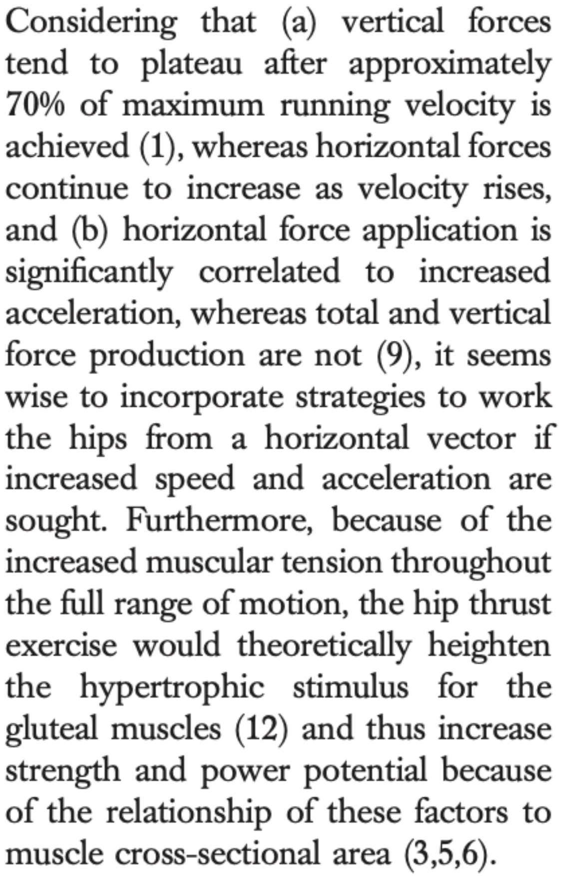
THE TECHNIQUE OF THE BARBELL HIP THRUST IS DESCRIBED AND DEMONSTRATED THROUGH THE USE OF PHOTOGRAPHS AND VIDEO IN THIS COLUMN. AN EXERCISE PRESCRIPTION IS GIVEN.

TYPE OF EXERCISE

The barbell hip thrust is a biomechanically efficient way to work the gluteal muscles. The

contribution to hip extension through active insufficiency. Active insufficiency refers to the phenomenon where a 2-joint muscle is shortened at one joint while a muscular contraction is initiated by the other joint (11). The hamstrings (semitendinosis, semimembranosus, and long head of the biceps femoris) are a group of biarticular muscles that cross both the knee and the hip joints. Because the hamstring muscles are shortened during knee flexion (11),

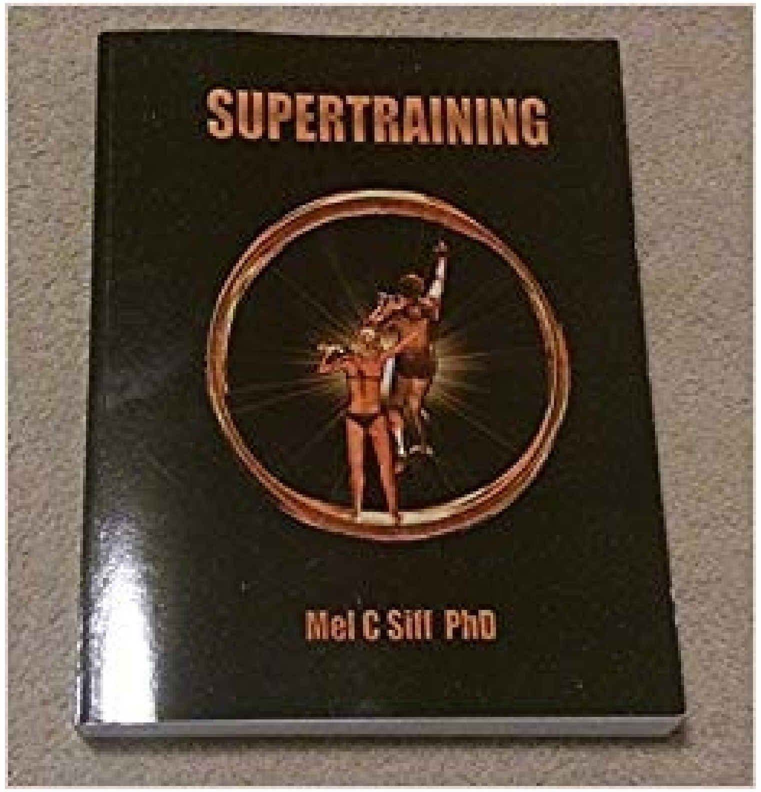
maximize gluteus maximus activation as maximal voluntary isometric contraction electromyographic activity of the gluteus maximus has been shown to increase as the hips move from flexion to extension (13). However, increased hip extension range of motion and weak glutes have been shown to increase anterior hip joint force (7,8), so proper exercise progression should be employed, and caution should be taken to ensure that the glutes are controlling



Considering that (a) vertical forces tend to plateau after approximately 70% of maximum running velocity is achieved (1), whereas horizontal forces continue to increase as velocity rises, and (b) horizontal force application is significantly correlated to increased acceleration, whereas total and vertical force production are not (9), it seems wise to incorporate strategies to work the hips from a horizontal vector if increased speed and acceleration are sought. Furthermore, because of the increased muscular tension throughout the full range of motion, the hip thrust exercise would theoretically heighten the hypertrophic stimulus for the gluteal muscles (12) and thus increase strength and power potential because of the relationship of these factors to muscle cross-sectional area (3,5,6).

It was, however, observed long before I came around…

Mel Siff & Yuri Verkoshansky, Supertraining



"In some events, such as swimming, inertia plays a major role in the entire process, unlike *in running, where the specificity of movement depends on horizontal thrust* and the vertical oscillation of the athlete's center of gravity."[i]

"To fulfill the criteria of correspondence with respect to the amplitude and direction of movement, it is advisable to select the exact starting position and posture of the athlete, as well as to calculate the direction of action of the forces associated with the working links of the system and the additional load. The line of action of the applied external resistance and of the loaded movement as a whole must also be taken into account."

"For example, in middle-distance running, skiing and skating, a knapsack full of sand or a weight belt are sometimes used as resistance. However, the muscles which bear the load are those which resist the weight of the body. This can increase the ability to cope with vertical loading and develop general strength-endurance, but does not strengthen those muscles which propel the body horizontally."

"Similarly, a skater may execute jumps on one leg on the floor or from a bench. These exercises strengthen the leg muscles supporting the body and the static-endurance of the back muscles, but do not fully imitate the working of the muscles for the push-off, where the force is directed backward."

"Skaters should use another method or resisted movement by changing the direction in which the force of resistance is acting. [Figure showing three different towing methods; 1) towing a human, 2) towing a weighted sled, and 3) towing a sled with a human sitting on it while skating] These methods to a large extent match the training exercise to the dynamics of the sport specific actions."[ii]

"The strength exercise should not only reproduce the full amplitude of the movement but also the specific direction of resistance to the pull of the muscles."[iii]

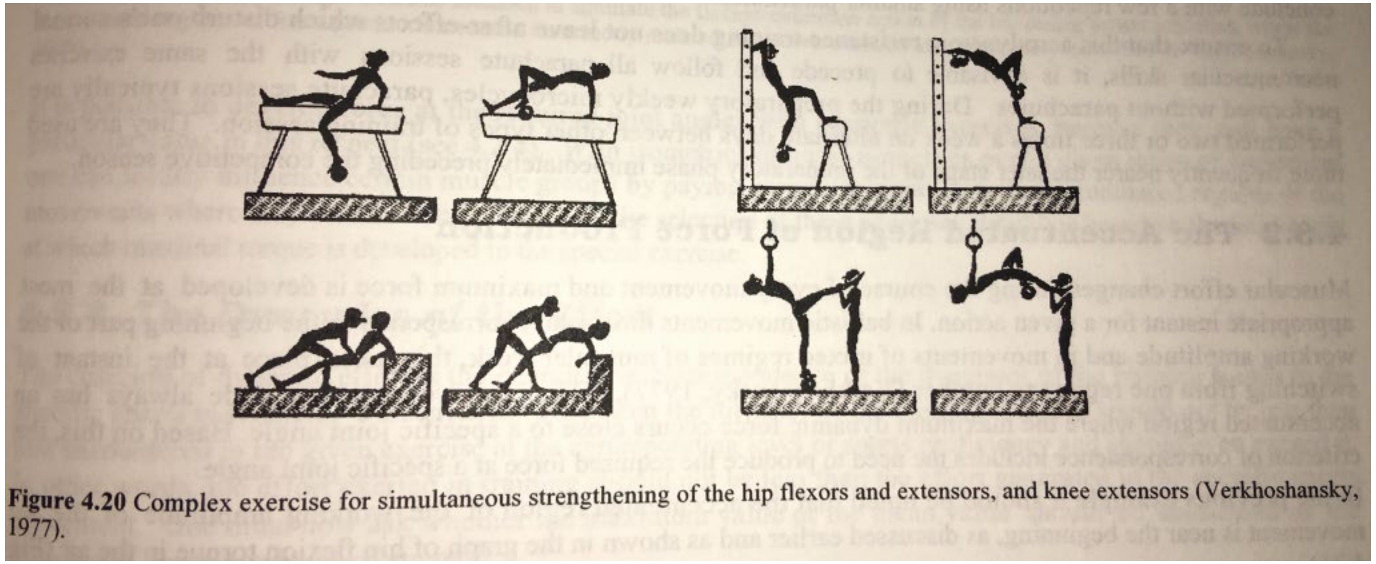


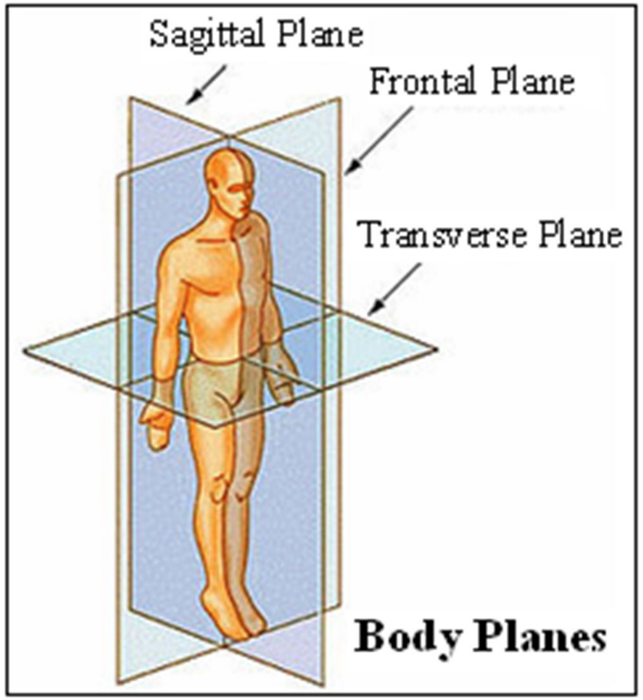
Figure 4.20 Complex exercise for simultaneous strengthening of the hip flexors and extensors, and knee extensors (Verkhoshansky, 1977).

Loaded single leg straight leg hip thrust variations from 1977

Planar Terminology

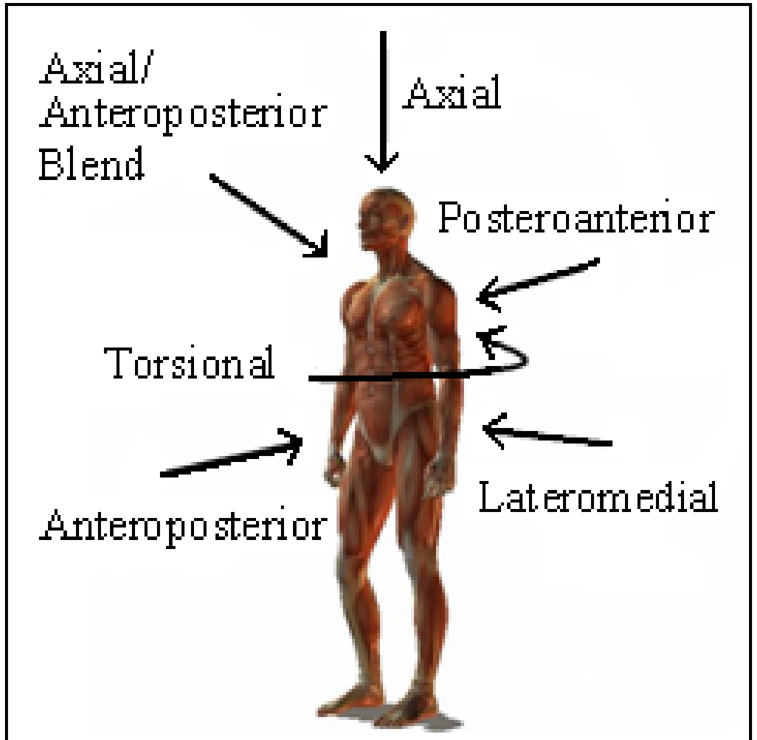
Popular amongst strength coaches

Drawback: Jumping upward, jumping forward, landing from a vertical or broad jump, sprinting forward, decelerating from linear running, and backpedaling are all sagittal plane activities



Vector Terminology

More Specific

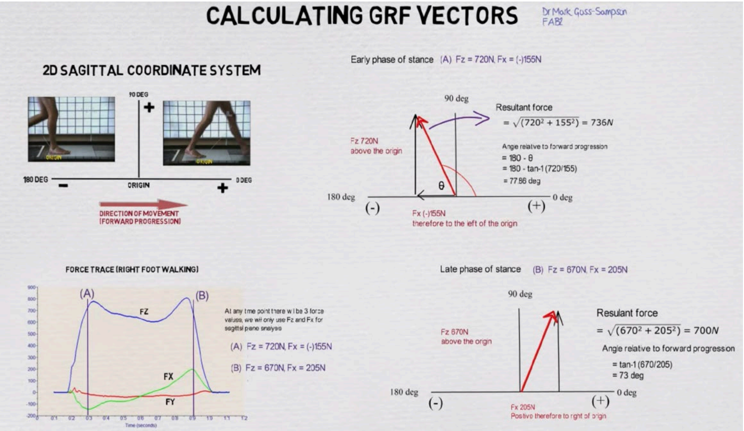


The 6 Primary Load Vectors
in Sports and the Weight Room

A Naming Problem: What to call it?

A force is a vector quantity; it has both magnitude and direction.

- Vector Specificity?
- Force Training?
- Multidirectional Training?
- Force Vector Specificity?
- Load Vector Training?



CALCULATING GRF VECTORS

Dr Mark Goss-Sampson FAB2

Early phase of stance (A) Fz = 720N, Fx = (-)155N

Resultant force $= \sqrt{(720^2 + 155^2)} = 736N$

Angle relative to forward progression
= 180 - θ
= 180 - tan-1 (720/155)
= 77.86 deg

Fz 720N above the origin

Fx (-)155N therefore to the left of the origin

At any time point there will be 3 force values, we will only use Fz and Fx for sagittal plane analysis

(A) Fz = 720N, Fx = (-)155N

(B) Fz = 670N, Fx = 205N

Late phase of stance (B) Fz = 670N, Fx = 205N

Resulant force $= \sqrt{(670^2 + 205^2)} = 700N$

Angle relative to forward progression
= tan-1 (670/205)
= 73 deg

Fz 670N above the origin

Fx 205N Positive therefore to right of origin

Theories: Why Would it Work?

Torque Angle Curve Specificity

Are All Hip Extension Exercises Created Equal?

Bret M. Contreras, MA, CSCS,[1] John B. Cronin, PhD,[1] Brad J. Schoenfeld, MSc, CSCS, CSPS, NSCA-CPT,[2]
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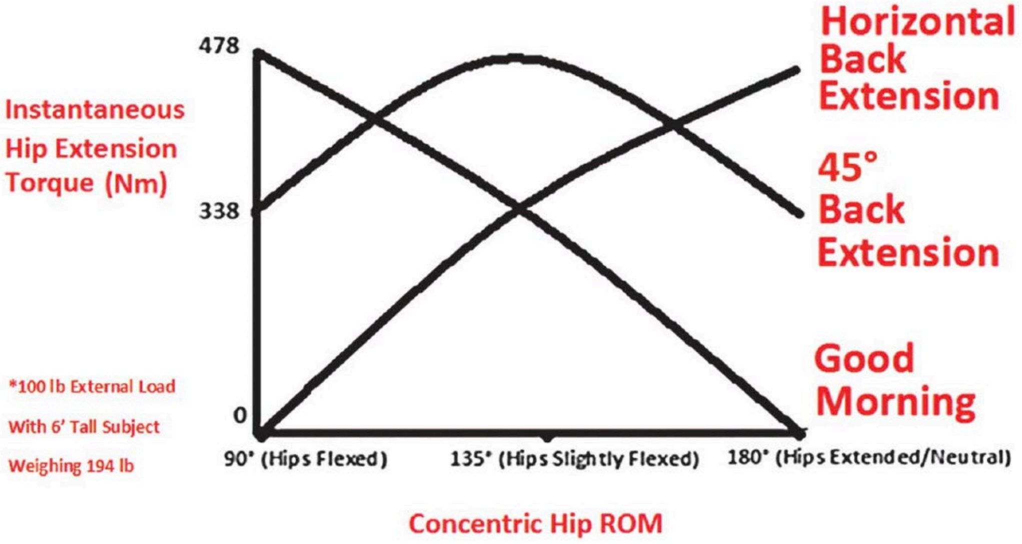
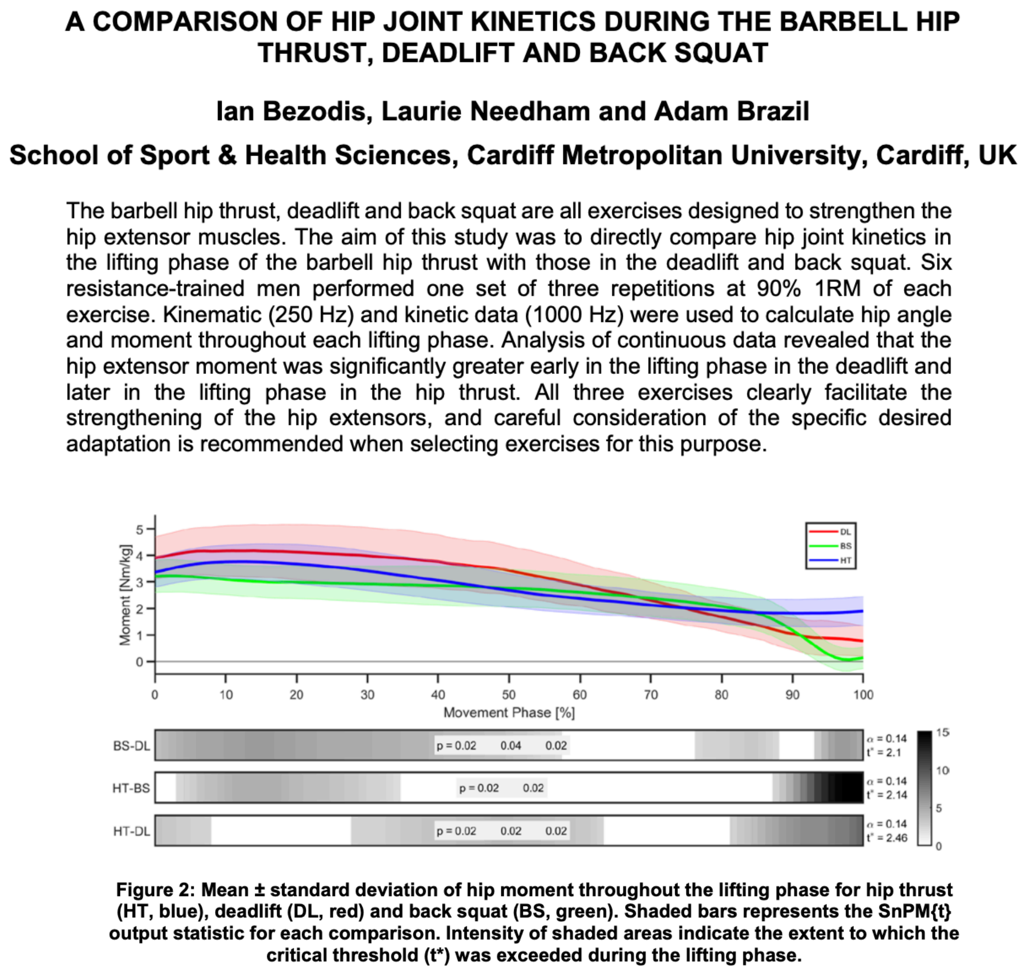


Figure 3. Graph of instantaneous hip extension torque at selected ranges of motion in 3 different hip extension exercises.

Figure 1. (A) Good morning exercise: 90°, 135°, and 180° of hip extension. (B) 45° Back extension exercise: 90°, 135°, and 180° of hip extension. (C) Horizontal back extension exercise: 90°, 135°, and 180° of hip extension.

Theories: Why Would it Work?

Torque Angle Curve Specificity



A COMPARISON OF HIP JOINT KINETICS DURING THE BARBELL HIP THRUST, DEADLIFT AND BACK SQUAT

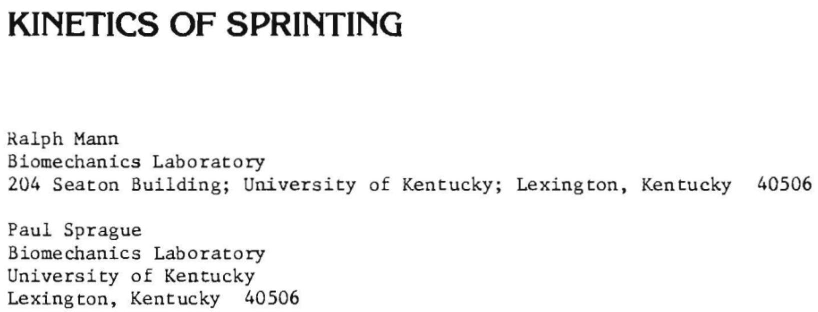
Ian Bezodis, Laurie Needham and Adam Brazil

School of Sport & Health Sciences, Cardiff Metropolitan University, Cardiff, UK

The barbell hip thrust, deadlift and back squat are all exercises designed to strengthen the hip extensor muscles. The aim of this study was to directly compare hip joint kinetics in the lifting phase of the barbell hip thrust with those in the deadlift and back squat. Six resistance-trained men performed one set of three repetitions at 90% 1RM of each exercise. Kinematic (250 Hz) and kinetic data (1000 Hz) were used to calculate hip angle and moment throughout each lifting phase. Analysis of continuous data revealed that the hip extensor moment was significantly greater early in the lifting phase in the deadlift and later in the lifting phase in the hip thrust. All three exercises clearly facilitate the strengthening of the hip extensors, and careful consideration of the specific desired adaptation is recommended when selecting exercises for this purpose.

Figure 2: Mean ± standard deviation of hip moment throughout the lifting phase for hip thrust (HT, blue), deadlift (DL, red) and back squat (BS, green). Shaded bars represents the SnPM{t} output statistic for each comparison. Intensity of shaded areas indicate the extent to which the critical threshold (t*) was exceeded during the lifting phase.

Hip Extension Moment Angle Curve in Sprinting



KINETICS OF SPRINTING

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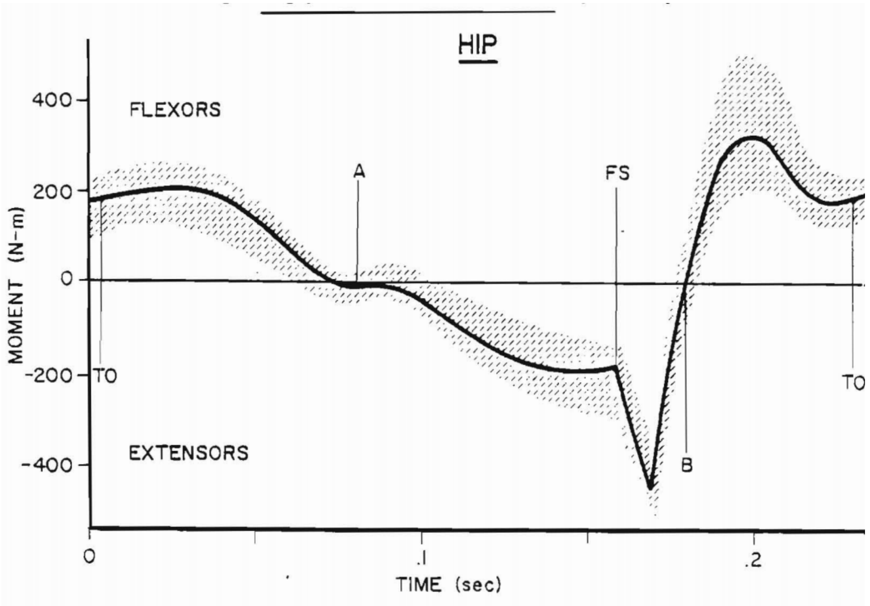
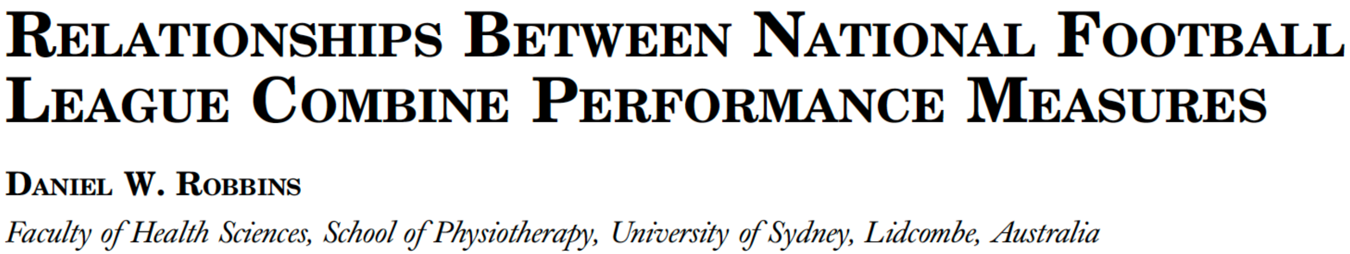


NFL Correlations
Jumping & Sprinting



RELATIONSHIPS BETWEEN NATIONAL FOOTBALL LEAGUE COMBINE PERFORMANCE MEASURES

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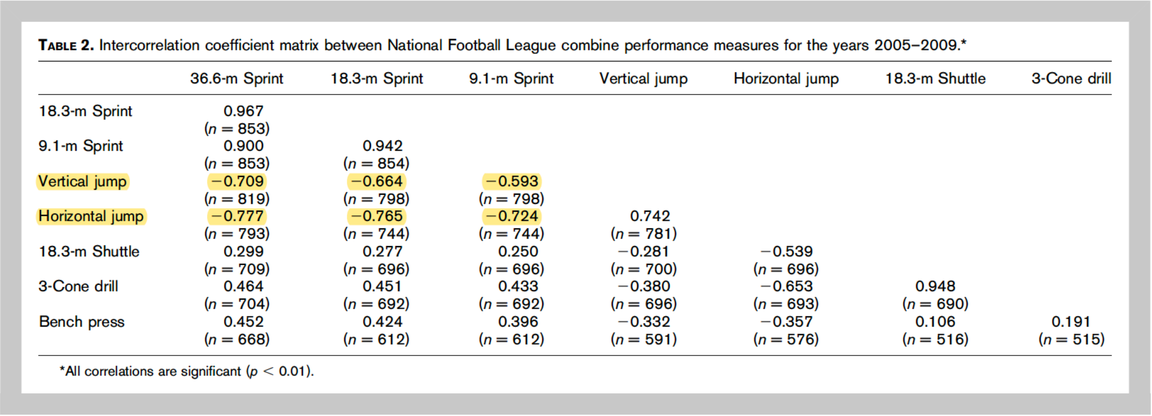
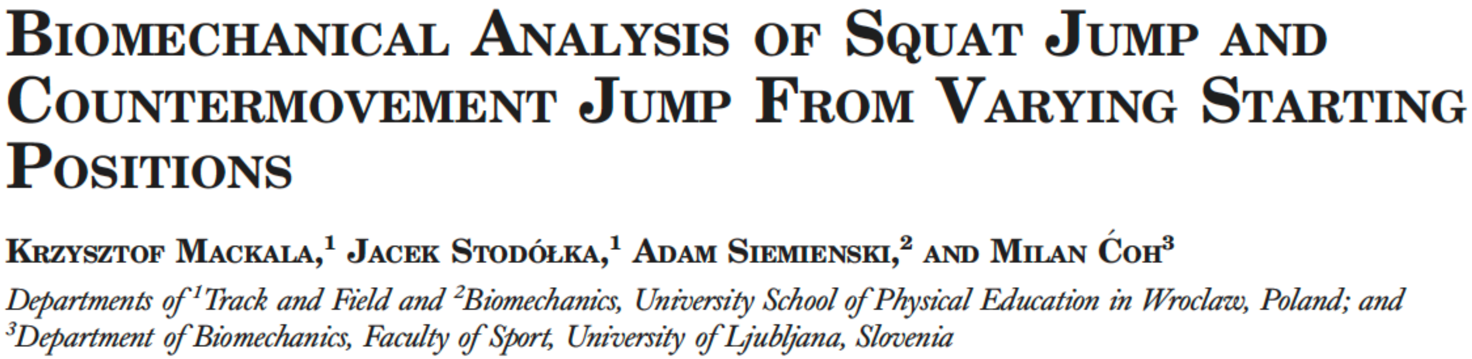


TABLE 2. Intercorrelation coefficient matrix between National Football League combine performance measures for the years 2005–2009.*

	36.6-m Sprint	18.3-m Sprint	9.1-m Sprint	Vertical jump	Horizontal jump	18.3-m Shuttle	3-Cone drill
18.3-m Sprint	0.967 ($n = 853$)						
9.1-m Sprint	0.900 ($n = 853$)	0.942 ($n = 854$)					
Vertical jump	−0.709 ($n = 819$)	−0.664 ($n = 798$)	−0.593 ($n = 798$)				
Horizontal jump	−0.777 ($n = 793$)	−0.765 ($n = 744$)	−0.724 ($n = 744$)	0.742 ($n = 781$)			
18.3-m Shuttle	0.299 ($n = 709$)	0.277 ($n = 696$)	0.250 ($n = 696$)	−0.281 ($n = 700$)	−0.539 ($n = 696$)		
3-Cone drill	0.464 ($n = 704$)	0.451 ($n = 692$)	0.433 ($n = 692$)	−0.380 ($n = 696$)	−0.653 ($n = 693$)	0.948 ($n = 690$)	
Bench press	0.452 ($n = 668$)	0.424 ($n = 612$)	0.396 ($n = 612$)	−0.332 ($n = 591$)	−0.357 ($n = 576$)	0.106 ($n = 516$)	0.191 ($n = 515$)

*All correlations are significant ($p < 0.01$).

Jumping Upward vs. Jumping Forward



Biomechanical Analysis of Squat Jump and Countermovement Jump From Varying Starting Positions

Krzysztof Mackala,[1] Jacek Stodółka,[1] Adam Siemienski,[2] and Milan Čoh[3]

Departments of [1]Track and Field and [2]Biomechanics, University School of Physical Education in Wroclaw, Poland; and [3]Department of Biomechanics, Faculty of Sport, University of Ljubljana, Slovenia

Biomechanical Analysis of Standing Long Jump From Varying Starting Positions

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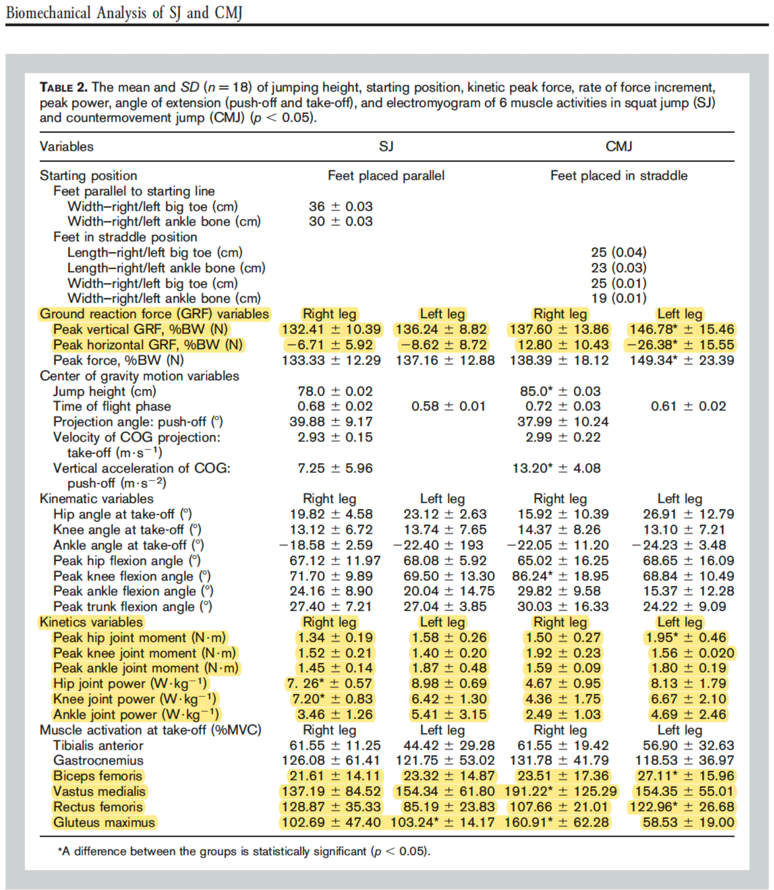
[1]Department of Track and Field; [2]Department of Biomechanics, University School of Physical Education in Wroclaw, Wroclaw, Poland; and [3]Faculty of Sport, University of Ljubljana, Ljubljana, Slovenia

Jumping Upward vs. Jumping Forward

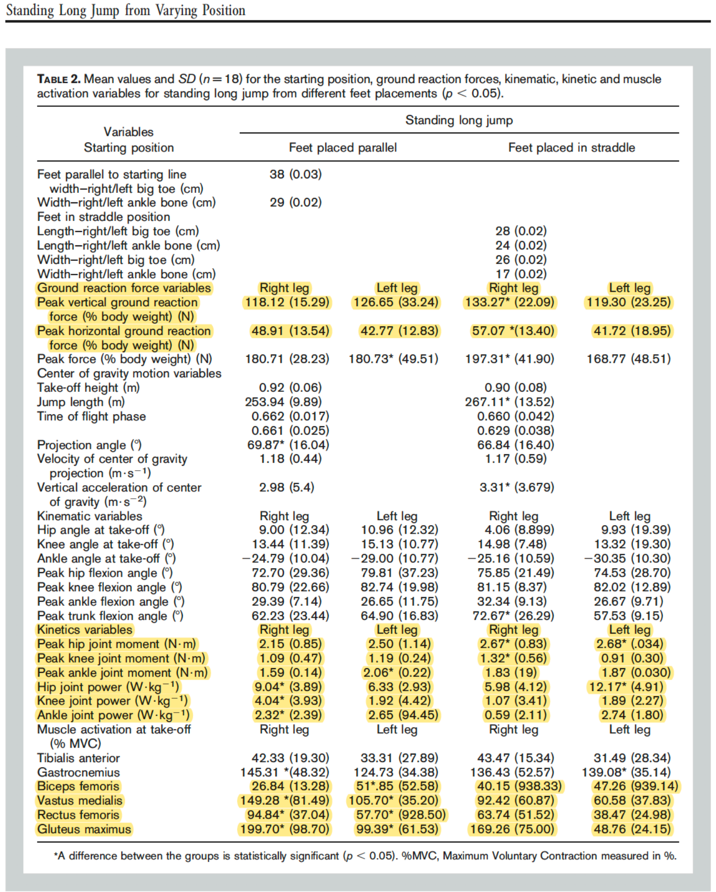


Biomechanical Analysis of SJ and CMJ

Table 2. The mean and *SD* ($n = 18$) of jumping height, starting position, kinetic peak force, rate of force increment, peak power, angle of extension (push-off and take-off), and electromyogram of 6 muscle activities in squat jump (SJ) and countermovement jump (CMJ) ($p < 0.05$).

Variables	SJ		CMJ	
Starting position	Feet placed parallel		Feet placed in straddle	
Feet parallel to starting line				
Width–right/left big toe (cm)	36 ± 0.03			
Width–right/left ankle bone (cm)	30 ± 0.03			
Feet in straddle position				
Length–right/left big toe (cm)			25 (0.04)	
Length–right/left ankle bone (cm)			23 (0.03)	
Width–right/left big toe (cm)			25 (0.01)	
Width–right/left ankle bone (cm)			19 (0.01)	
Ground reaction force (GRF) variables	Right leg	Left leg	Right leg	Left leg
Peak vertical GRF, %BW (N)	132.41 ± 10.39	136.24 ± 8.82	137.60 ± 13.86	146.78* ± 15.46
Peak horizontal GRF, %BW (N)	−6.71 ± 5.92	−8.62 ± 8.72	12.80 ± 10.43	−26.38* ± 15.55
Peak force, %BW (N)	133.33 ± 12.29	137.16 ± 12.88	138.39 ± 18.12	149.34* ± 23.39
Center of gravity motion variables				
Jump height (cm)	78.0 ± 0.02		85.0* ± 0.03	
Time of flight phase	0.68 ± 0.02	0.58 ± 0.01	0.72 ± 0.03	0.61 ± 0.02
Projection angle: push-off (°)	39.88 ± 9.17		37.99 ± 10.24	
Velocity of COG projection: take-off ($m \cdot s^{-1}$)	2.93 ± 0.15		2.99 ± 0.22	
Vertical acceleration of COG: push-off ($m \cdot s^{-2}$)	7.25 ± 5.96		13.20* ± 4.08	
Kinematic variables	Right leg	Left leg	Right leg	Left leg
Hip angle at take-off (°)	19.82 ± 4.58	23.12 ± 2.63	15.92 ± 10.39	26.91 ± 12.79
Knee angle at take-off (°)	13.12 ± 6.72	13.74 ± 7.65	14.37 ± 8.26	13.10 ± 7.21
Ankle angle at take-off (°)	−18.58 ± 2.59	−22.40 ± 193	−22.05 ± 11.20	−24.23 ± 3.48
Peak hip flexion angle (°)	67.12 ± 11.97	68.08 ± 5.92	65.02 ± 16.25	68.65 ± 16.09
Peak knee flexion angle (°)	71.70 ± 9.89	69.50 ± 13.30	86.24* ± 18.95	68.84 ± 10.49
Peak ankle flexion angle (°)	24.16 ± 8.90	20.04 ± 14.75	29.82 ± 9.58	15.37 ± 12.28
Peak trunk flexion angle (°)	27.40 ± 7.21	27.04 ± 3.85	30.03 ± 16.33	24.22 ± 9.09
Kinetics variables	Right leg	Left leg	Right leg	Left leg
Peak hip joint moment (N·m)	1.34 ± 0.19	1.58 ± 0.26	1.50 ± 0.27	1.95* ± 0.46
Peak knee joint moment (N·m)	1.52 ± 0.21	1.40 ± 0.20	1.92 ± 0.23	1.56 ± 0.020
Peak ankle joint moment (N·m)	1.45 ± 0.14	1.87 ± 0.48	1.59 ± 0.09	1.80 ± 0.19
Hip joint power ($W \cdot kg^{-1}$)	7. 26* ± 0.57	8.98 ± 0.69	4.67 ± 0.95	8.13 ± 1.79
Knee joint power ($W \cdot kg^{-1}$)	7.20* ± 0.83	6.42 ± 1.30	4.36 ± 1.75	6.67 ± 2.10
Ankle joint power ($W \cdot kg^{-1}$)	3.46 ± 1.26	5.41 ± 3.15	2.49 ± 1.03	4.69 ± 2.46
Muscle activation at take-off (%MVC)	Right leg	Left leg	Right leg	Left leg
Tibialis anterior	61.55 ± 11.25	44.42 ± 29.28	61.55 ± 19.42	56.90 ± 32.63
Gastrocnemius	126.08 ± 61.41	121.75 ± 53.02	131.78 ± 41.79	118.53 ± 36.97
Biceps femoris	21.61 ± 14.11	23.32 ± 14.87	23.51 ± 17.36	27.11* ± 15.96
Vastus medialis	137.19 ± 84.52	154.34 ± 61.80	191.22* ± 125.29	154.35 ± 55.01
Rectus femoris	128.87 ± 35.33	85.19 ± 23.83	107.66 ± 21.01	122.96* ± 26.68
Gluteus maximus	102.69 ± 47.40	103.24* ± 14.17	160.91* ± 62.28	58.53 ± 19.00

*A difference between the groups is statistically significant ($p < 0.05$).



Standing Long Jump from Varying Position

Table 2. Mean values and *SD* ($n = 18$) for the starting position, ground reaction forces, kinematic, kinetic and muscle activation variables for standing long jump from different feet placements ($p < 0.05$).

Variables Starting position	Standing long jump			
	Feet placed parallel		Feet placed in straddle	
Feet parallel to starting line width–right/left big toe (cm)	38 (0.03)			
Width–right/left ankle bone (cm)	29 (0.02)			
Feet in straddle position				
Length–right/left big toe (cm)			28 (0.02)	
Length–right/left ankle bone (cm)			24 (0.02)	
Width–right/left big toe (cm)			26 (0.02)	
Width–right/left ankle bone (cm)			17 (0.02)	
Ground reaction force variables	Right leg	Left leg	Right leg	Left leg
Peak vertical ground reaction force (% body weight) (N)	118.12 (15.29)	126.65 (33.24)	133.27* (22.09)	119.30 (23.25)
Peak horizontal ground reaction force (% body weight) (N)	48.91 (13.54)	42.77 (12.83)	57.07 *(13.40)	41.72 (18.95)
Peak force (% body weight) (N)	180.71 (28.23)	180.73* (49.51)	197.31* (41.90)	168.77 (48.51)
Center of gravity motion variables				
Take-off height (m)	0.92 (0.06)		0.90 (0.08)	
Jump length (m)	253.94 (9.89)		267.11* (13.52)	
Time of flight phase	0.662 (0.017)		0.660 (0.042)	
	0.661 (0.025)		0.629 (0.038)	
Projection angle (°)	69.87* (16.04)		66.84 (16.40)	
Velocity of center of gravity projection ($m \cdot s^{-1}$)	1.18 (0.44)		1.17 (0.59)	
Vertical acceleration of center of gravity ($m \cdot s^{-2}$)	2.98 (5.4)		3.31* (3.679)	
Kinematic variables	Right leg	Left leg	Right leg	Left leg
Hip angle at take-off (°)	9.00 (12.34)	10.96 (12.32)	4.06 (8.899)	9.93 (19.39)
Knee angle at take-off (°)	13.44 (11.39)	15.13 (10.77)	14.98 (7.48)	13.32 (19.30)
Ankle angle at take-off (°)	−24.79 (10.04)	−29.00 (10.77)	−25.16 (10.59)	−30.35 (10.30)
Peak hip flexion angle (°)	72.70 (29.36)	79.81 (37.23)	75.85 (21.49)	74.53 (28.70)
Peak knee flexion angle (°)	80.79 (22.66)	82.74 (19.98)	81.15 (8.37)	82.02 (12.89)
Peak ankle flexion angle (°)	29.39 (7.14)	26.65 (11.75)	32.34 (9.13)	26.67 (9.71)
Peak trunk flexion angle (°)	62.23 (23.44)	64.90 (16.83)	72.67* (26.29)	57.53 (9.15)
Kinetics variables	Right leg	Left leg	Right leg	Left leg
Peak hip joint moment (N·m)	2.15 (0.85)	2.50 (1.14)	2.67* (0.83)	2.68* (.034)
Peak knee joint moment (N·m)	1.09 (0.47)	1.19 (0.24)	1.32* (0.56)	0.91 (0.30)
Peak ankle joint moment (N·m)	1.59 (0.14)	2.06* (0.22)	1.83 (19)	1.87 (0.030)
Hip joint power ($W \cdot kg^{-1}$)	9.04* (3.89)	6.33 (2.93)	5.98 (4.12)	12.17* (4.91)
Knee joint power ($W \cdot kg^{-1}$)	4.04* (3.93)	1.92 (4.42)	1.07 (3.41)	1.89 (2.27)
Ankle joint power ($W \cdot kg^{-1}$)	2.32* (2.39)	2.65 (94.45)	0.59 (2.11)	2.74 (1.80)
Muscle activation at take-off (% MVC)	Right leg	Left leg	Right leg	Left leg
Tibialis anterior	42.33 (19.30)	33.31 (27.89)	43.47 (15.34)	31.49 (28.34)
Gastrocnemius	145.31 *(48.32)	124.73 (34.38)	136.43 (52.57)	139.08* (35.14)
Biceps femoris	26.84 (13.28)	51*.85 (52.58)	40.15 (938.33)	47.26 (939.14)
Vastus medialis	149.28 *(81.49)	105.70* (35.20)	92.42 (60.87)	60.58 (37.83)
Rectus femoris	94.84* (37.04)	57.70* (928.50)	63.74 (51.52)	38.47 (24.98)
Gluteus maximus	199.70* (98.70)	99.39* (61.53)	169.26 (75.00)	48.76 (24.15)

*A difference between the groups is statistically significant ($p < 0.05$). %MVC, Maximum Voluntary Contraction measured in %.

Jumping Upward vs. Jumping Forward

ORIGINAL RESEARCH

Kinetics of Standing Broad and Vertical Jumping

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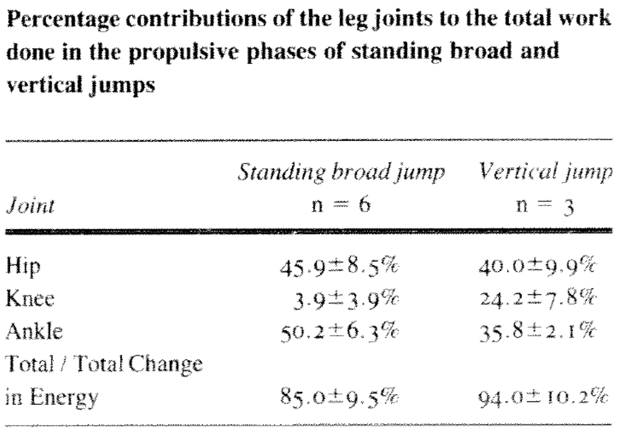
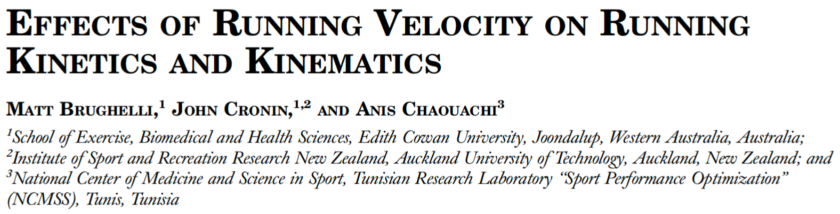


Percentage contributions of the leg joints to the total work done in the propulsive phases of standing broad and vertical jumps

Joint	*Standing broad jump* n = 6	*Vertical jump* n = 3
Hip	45.9±8.5%	40.0±9.9%
Knee	3.9±3.9%	24.2±7.8%
Ankle	50.2±6.3%	35.8±2.1%
Total / Total Change in Energy	85.0±9.5%	94.0±10.2%

Horizontal jump – more hip and ankle work, less knee

Horizontal Force in Sprinting



EFFECTS OF RUNNING VELOCITY ON RUNNING KINETICS AND KINEMATICS

MATT BRUGHELLI,[1] JOHN CRONIN,[1,2] AND ANIS CHAOUACHI[3]

[1]School of Exercise, Biomedical and Health Sciences, Edith Cowan University, Joondalup, Western Australia, Australia; [2]Institute of Sport and Recreation Research New Zealand, Auckland University of Technology, Auckland, New Zealand; and [3]National Center of Medicine and Science in Sport, Tunisian Research Laboratory "Sport Performance Optimization" (NCMSS), Tunis, Tunisia

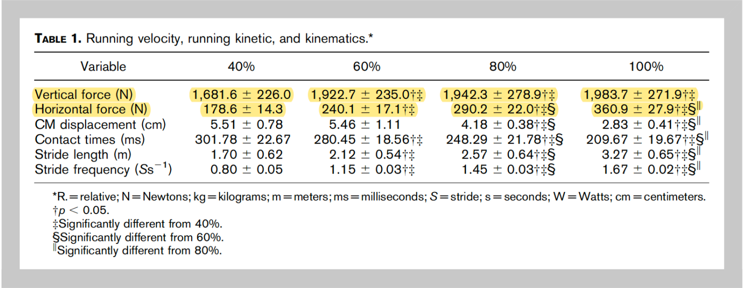
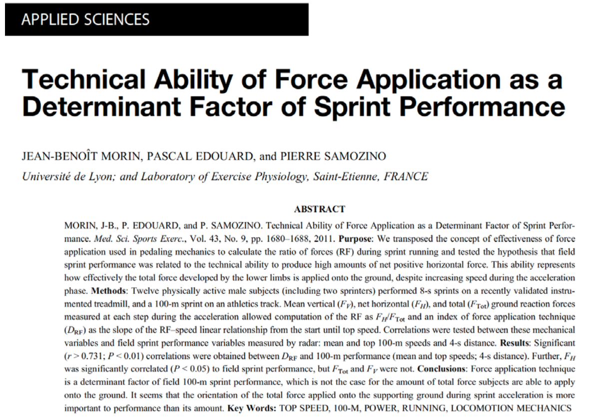


TABLE 1. Running velocity, running kinetic, and kinematics.*

Variable	40%	60%	80%	100%
Vertical force (N)	1,681.6 ± 226.0	1,922.7 ± 235.0†‡	1,942.3 ± 278.9†‡	1,983.7 ± 271.9†‡
Horizontal force (N)	178.6 ± 14.3	240.1 ± 17.1†‡	290.2 ± 22.0†‡§	360.9 ± 27.9†‡§‖
CM displacement (cm)	5.51 ± 0.78	5.46 ± 1.11	4.18 ± 0.38†‡§	2.83 ± 0.41†‡§‖
Contact times (ms)	301.78 ± 22.67	280.45 ± 18.56†‡	248.29 ± 21.78†‡§	209.67 ± 19.67†‡§‖
Stride length (m)	1.70 ± 0.62	2.12 ± 0.54†‡	2.57 ± 0.64†‡§	3.27 ± 0.65†‡§‖
Stride frequency (Ss^{-1})	0.80 ± 0.05	1.15 ± 0.03†‡	1.45 ± 0.03†‡§	1.67 ± 0.02†‡§‖

*R. = relative; N = Newtons; kg = kilograms; m = meters; ms = milliseconds; *S* = stride; s = seconds; W = Watts; cm = centimeters.
†$p < 0.05$.
‡Significantly different from 40%.
§Significantly different from 60%.
‖Significantly different from 80%.



APPLIED SCIENCES

Technical Ability of Force Application as a Determinant Factor of Sprint Performance

JEAN-BENOÎT MORIN, PASCAL EDOUARD, and PIERRE SAMOZINO

Université de Lyon; and Laboratory of Exercise Physiology, Saint-Etienne, FRANCE

ABSTRACT

MORIN, J-B., P. EDOUARD, and P. SAMOZINO. Technical Ability of Force Application as a Determinant Factor of Sprint Performance. *Med. Sci. Sports Exerc.*, Vol. 43, No. 9, pp. 1680–1688, 2011. **Purpose**: We transposed the concept of effectiveness of force application used in pedaling mechanics to calculate the ratio of forces (RF) during sprint running and tested the hypothesis that field sprint performance was related to the technical ability to produce high amounts of net positive horizontal force. This ability represents how effectively the total force developed by the lower limbs is applied onto the ground, despite increasing speed during the acceleration phase. **Methods**: Twelve physically active male subjects (including two sprinters) performed 8-s sprints on a recently validated instrumented treadmill, and a 100-m sprint on an athletics track. Mean vertical (F_V), net horizontal (F_H), and total (F_{Tot}) ground reaction forces measured at each step during the acceleration allowed computation of the RF as F_H/F_{Tot} and an index of force application technique (D_{RF}) as the slope of the RF–speed linear relationship from the start until top speed. Correlations were tested between these mechanical variables and field sprint performance variables measured by radar: mean and top 100-m speeds and 4-s distance. **Results**: Significant ($r > 0.731$; $P < 0.01$) correlations were obtained between D_{RF} and 100-m performance (mean and top speeds; 4-s distance). Further, F_H was significantly correlated ($P < 0.05$) to field sprint performance, but F_{Tot} and F_V were not. **Conclusions**: Force application technique is a determinant factor of field 100-m sprint performance, which is not the case for the amount of total force subjects are able to apply onto the ground. It seems that the orientation of the total force applied onto the supporting ground during sprint acceleration is more important to performance than its amount. **Key Words:** TOP SPEED, 100-M, POWER, RUNNING, LOCOMOTION MECHANICS

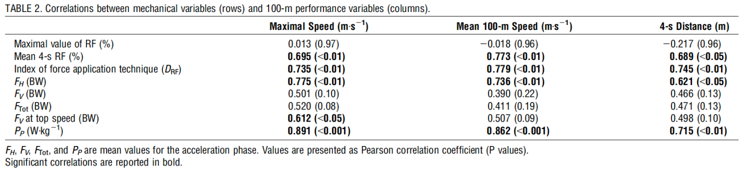


TABLE 2. Correlations between mechanical variables (rows) and 100-m performance variables (columns).

	Maximal Speed ($m \cdot s^{-1}$)	Mean 100-m Speed ($m \cdot s^{-1}$)	4-s Distance (m)
Maximal value of RF (%)	0.013 (0.97)	−0.018 (0.96)	−0.217 (0.96)
Mean 4-s RF (%)	**0.695 (<0.01)**	**0.773 (<0.01)**	**0.689 (<0.05)**
Index of force application technique (D_{RF})	**0.735 (<0.01)**	**0.779 (<0.01)**	**0.745 (<0.01)**
F_H (BW)	**0.775 (<0.01)**	**0.736 (<0.01)**	**0.621 (<0.05)**
F_V (BW)	0.501 (0.10)	0.390 (0.22)	0.466 (0.13)
F_{Tot} (BW)	0.520 (0.08)	0.411 (0.19)	0.471 (0.13)
F_V at top speed (BW)	**0.612 (<0.05)**	0.507 (0.09)	0.498 (0.10)
P_P ($W \cdot kg^{-1}$)	**0.891 (<0.001)**	**0.862 (<0.001)**	**0.715 (<0.01)**

F_H, F_V, F_{Tot}, and P_P are mean values for the acceleration phase. Values are presented as Pearson correlation coefficient (P values).
Significant correlations are reported in bold.

Sprint Acceleration Mechanics: The Major Role of Hamstrings in Horizontal Force Production

Jean-Benoît Morin[1]*, Philippe Gimenez[2], Pascal Edouard[3,4], Pierrick Arnal[3],
Pedro Jiménez-Reyes[5], Pierre Samozino[6], Matt Brughelli[7] and Jurdan Mendiguchia[8]

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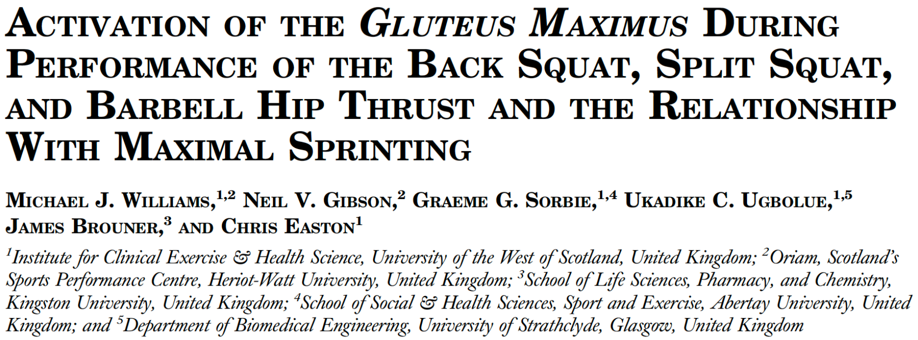
Recent literature supports the importance of horizontal ground reaction force (GRF) production for sprint acceleration performance. Modeling and clinical studies have shown that the hip extensors are very likely contributors to sprint acceleration performance. We experimentally tested the role of the hip extensors in horizontal GRF production during short, maximal, treadmill sprint accelerations. Torque capabilities of the knee and hip extensors and flexors were assessed using an isokinetic dynamometer in 14 males familiar with sprint running. Then, during 6-s sprints on an instrumented motorized treadmill, horizontal and vertical GRF were synchronized with electromyographic (EMG) activity of the *vastus lateralis, rectus femoris, biceps femoris*, and *gluteus maximus* averaged over the first half of support, entire support, entire swing and end-of-swing phases. No significant correlations were found between isokinetic or EMG variables and horizontal GRF. Multiple linear regression analysis showed a significant relationship ($P = 0.024$) between horizontal GRF and the combination of *biceps femoris* EMG activity during the end of the swing and the knee flexors eccentric peak torque. In conclusion, subjects who produced the greatest amount of horizontal force were both able to highly activate their hamstring muscles just before ground contact and present high eccentric hamstring peak torque capability.



ACTIVATION OF THE *GLUTEUS MAXIMUS* DURING PERFORMANCE OF THE BACK SQUAT, SPLIT SQUAT, AND BARBELL HIP THRUST AND THE RELATIONSHIP WITH MAXIMAL SPRINTING

MICHAEL J. WILLIAMS,[1,2] NEIL V. GIBSON,[2] GRAEME G. SORBIE,[1,4] UKADIKE C. UGBOLUE,[1,5] JAMES BROUNER,[3] AND CHRIS EASTON[1]

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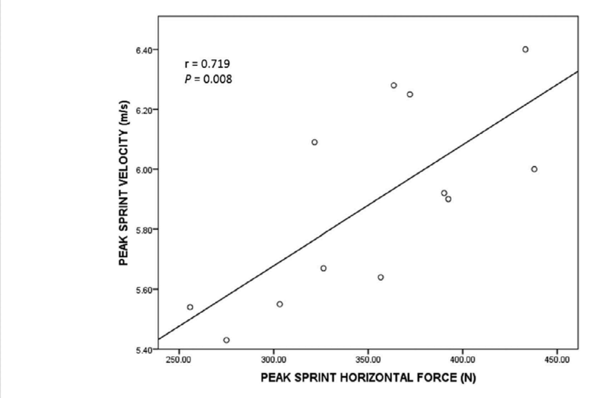


Figure 4. Correlation between peak anterior-posterior horizontal force during sprinting and peak sprint velocity.

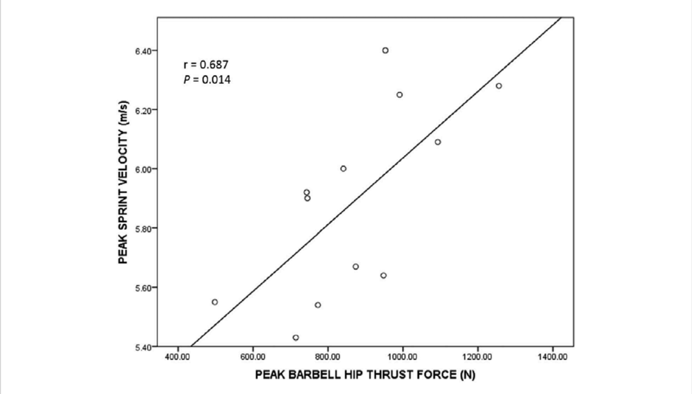
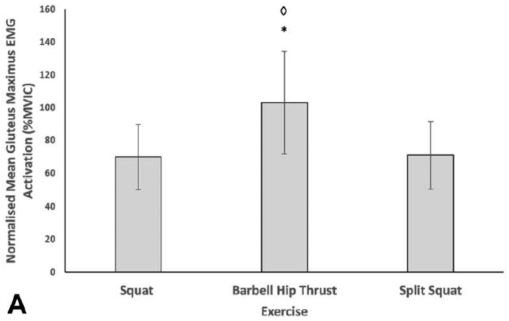


Figure 5. Correlation between peak force during the barbell hip thrust and peak sprint velocity.



RESEARCH ARTICLE

Vertically and horizontally directed muscle power exercises: Relationships with top-level sprint performance

Irineu Loturco[1]*, Bret Contreras[2], Ronaldo Kobal[1], Victor Fernandes[3,4], Neilton Moura[3], Felipe Siqueira[4,5], Ciro Winckler[6], Timothy Suchomel[7], Lucas Adriano Pereira[1]

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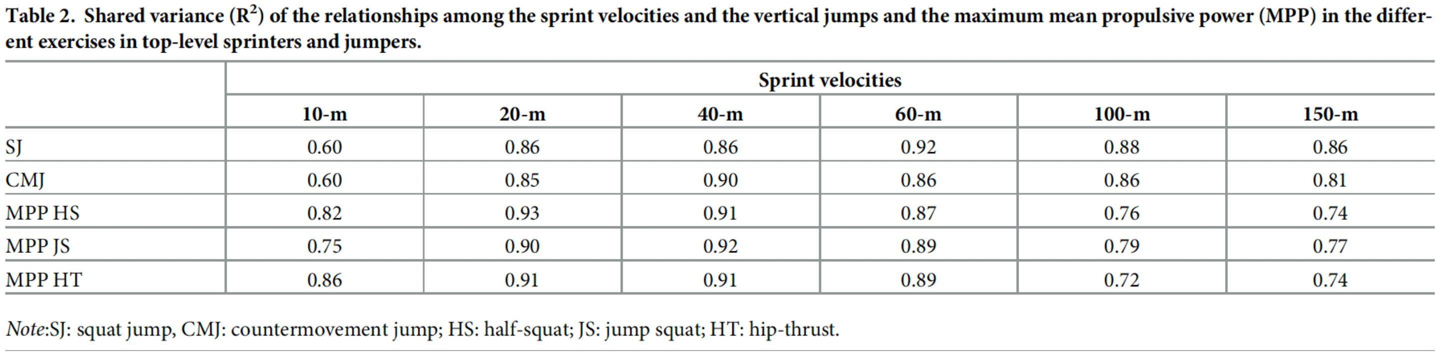


Table 2. Shared variance (R^2) of the relationships among the sprint velocities and the vertical jumps and the maximum mean propulsive power (MPP) in the different exercises in top-level sprinters and jumpers.

	Sprint velocities					
	10-m	20-m	40-m	60-m	100-m	150-m
SJ	0.60	0.86	0.86	0.92	0.88	0.86
CMJ	0.60	0.85	0.90	0.86	0.86	0.81
MPP HS	0.82	0.93	0.91	0.87	0.76	0.74
MPP JS	0.75	0.90	0.92	0.89	0.79	0.77
MPP HT	0.86	0.91	0.91	0.89	0.72	0.74

Note:SJ: squat jump, CMJ: countermovement jump; HS: half-squat; JS: jump squat; HT: hip-thrust.

Transference of Strength and Power Adaptation to Sports Performance–Horizontal and Vertical Force Production

Aaron D. Randell, MSc,[1] John B. Cronin, PhD,[1,2] Justin W.L. Keogh, PhD,[1] and Nicholas D. Gill, PhD[1]
[1]Sport Performance Research Institute New Zealand, AUT University, Auckland, New Zealand; and [2]School of Environmental, Biomedical and Health Sciences, Edith Cowan University, Perth, Western Australia, Australia

Importance of Horizontally Loaded Movements to Sports Performance

Michael Zweifel, MS, CSCS
Building Better Athletes, Dubuque, Iowa

Biggest Drawback of FV Model

Must Be a Highly Effective Exercise

- Example: Full Squat vs. Band Pull Through

Another Drawback

Overly Simplistic

- Is a landmine cross-body single leg RDL axial, anteroposterior, lateromedial, or torsional?

Another Drawback

Overly Simplistic

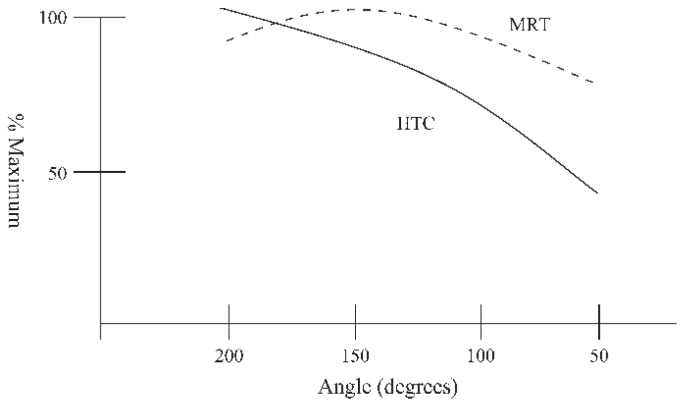
- Squats will likely transfer well to every vector (axial, torsional, anteroposterior, lateral)

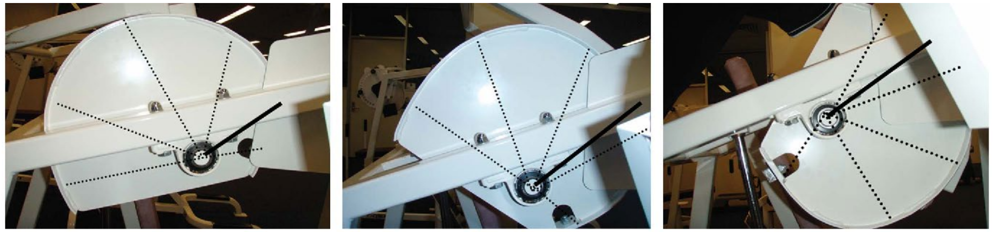
Another Drawback

Overly Simplistic

Forms of Variable Resistance Training

D. Travis McMaster,[1] John Cronin, PhD,[1,2] and Michael McGuigan, PhD, CSCS[1]
[1]Edith Cowan University, Perth, Australia; and [2]AUT University, Auckland, New Zealand





- Implies that isokinetics and machines would trump free weights for sports performance

Another Drawback

Overly Simplistic

1. Muscle action (eccentric or concentric)
2. Velocity (fast or slow)
3. Repetition range (maximum strength or muscular endurance)
4. Range of motion (full or partial)
5. Degree of stability (stable or unstable)
6. External load type (constant load or accommodating resistance)
7. Force vector (vertical or horizontal)
8. Muscle group

External load type
Muscle
Contraction mode
Load
Strength is
Joint angle
Speed
Stability
Force vector
specific

The key to optimal strength training for sports

By Chris Beardsley

- It’s just one of 8 types of specificity in strength training

Another Drawback

Ignores Velocity Specificity

RESEARCH ARTICLE

Optimized training for jumping performance using the force-velocity imbalance: Individual adaptation kinetics

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

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International Journal of Sports Physiology and Performance, 2016, 11, 267-272
http://dx.doi.org/10.1123/ijspp.2015-0638
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Human Kinetics
INVITED COMMENTA

Interpreting Power-Force-Velocity Profiles for Individualized and Specific Training

Jean-Benoît Morin and Pierre Samozino

Recent studies have brought new insights into the evaluation of power-force-velocity profiles in both ballistic push-offs (eg, jumps) and sprint movements. These are major physical components of performance in many sports, and the methods the authors developed and validated are based on data that are now rather simple to obtain in field conditions (eg, body mass, jump height, sprint times, or velocity). The promising aspect of these approaches is that they allow for more individualized and accurate evaluation, monitoring, and training practices, the success of which is highly dependent on the correct collection, generation, and interpretation of athletes' mechanical outputs. The authors therefore wanted to provide a practical vade mecum to sports practitioners interested in implementing these power-force-velocity–profiling approaches. After providing a summary of theoretical and practical definitions for the main variables, the authors first detail how vertical profiling can be used to manage ballistic push-off performance, with emphasis on the concept of optimal force–velocity profile and the associated force–velocity imbalance. Furthermore, they discuss these same concepts with regard to horizontal profiling in the management of sprinting performance. These sections are illustrated by typical examples from the authors' practice. Finally, they provide a practical and operational synthesis and outline future challenges that will help further develop these approaches.

Keywords: explosive performance, jump, sprint, team sports, athletics, strength training

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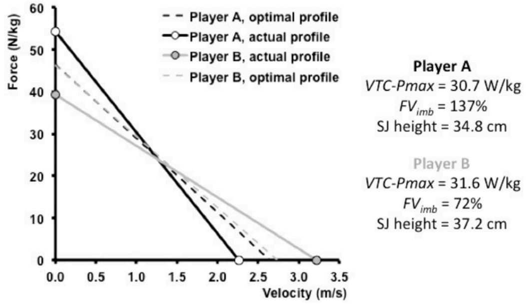

Figure 2 — Vertical force–velocity profiles of 2 elite young (under-19) soccer players (body mass for A, 78 kg, and B, 75.5 kg; push-off distance for A, 0.26 m, and B, 0.28 m) obtained from maximal squat jumps (SJ) against additional loads of 0, 10, 20, 40, and 50 kg. One player has a force deficit (magnitude of the relative difference between the slope of the linear force–velocity relationship [Sfv] and Sfv_{opt} [FV_{imb}] of 72%), whereas the other has a velocity deficit (FV_{imb} of 137%). Player A is a central defender and player B is a goalkeeper. Abbreviation: *VTC-Pmax,* maximal mechanical power output.

PeerJ

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

Pedro Jiménez-Reyes[1,2], Pierre Samozino[3], Amador García-Ramos[4,5], Víctor Cuadrado-Peñafiel[6], Matt Brughelli[7] and Jean-Benoît Morin[7,8]

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The low correlations generally observed between jumping and sprinting mechanical outputs suggest that both tasks provide distinctive information regarding the FVP profile of lower-body muscles. Therefore, we recommend the assessment of the FVP profile both in jumping and sprinting to gain a deeper insight into the maximal mechanical capacities of lower-body muscles, especially at high and elite levels.

- Ignores force-velocity profiling

The Twin Experiment

Not Published; Part of My PhD Thesis

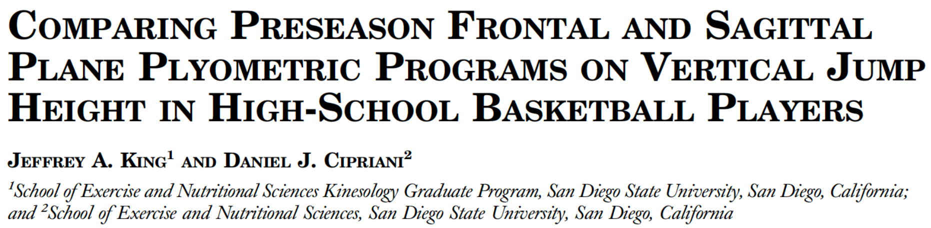
	1RM Squat	1RM Hip Thrust	Maximum Horizontal Pushing Force	Upper Gluteus Maximus Thickness	Lower Gluteus Maximus Thickness
Squat Twin	↑ 63%	↑ 16%	↑ 20%	↑ 20%	↑ 21%
Hip Thrust Twin	↑ 42%	↑ 54%	↑ 32%	↑ 28%	↑ 28%

Published Research

Does Theory Match Experiments?

Plyometric Studies

Lateral vs. Vertical



COMPARING PRESEASON FRONTAL AND SAGITTAL PLANE PLYOMETRIC PROGRAMS ON VERTICAL JUMP HEIGHT IN HIGH-SCHOOL BASKETBALL PLAYERS

JEFFREY A. KING[1] **AND DANIEL J. CIPRIANI**[2]

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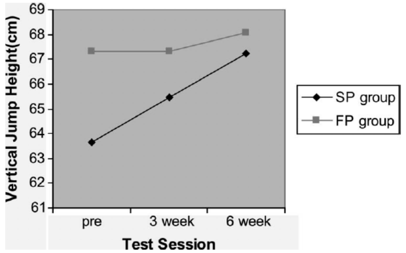
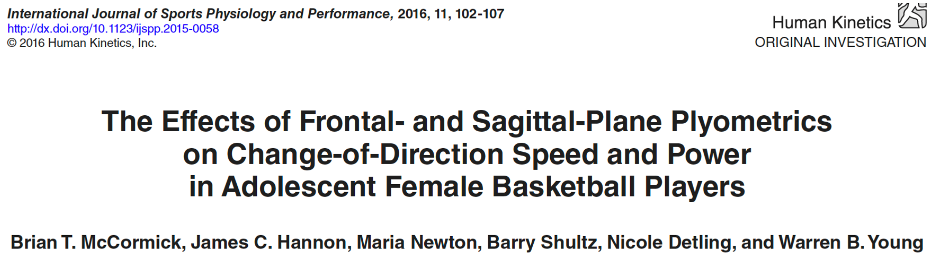




International Journal of Sports Physiology and Performance, 2016, 11, 102-107
http://dx.doi.org/10.1123/ijspp.2015-0058

Human Kinetics
ORIGINAL INVESTIGATION

The Effects of Frontal- and Sagittal-Plane Plyometrics on Change-of-Direction Speed and Power in Adolescent Female Basketball Players

Brian T. McCormick, James C. Hannon, Maria Newton, Barry Shultz, Nicole Detling, and Warren B. Young

Vertical better for jumping,
lateral better for lateral agility

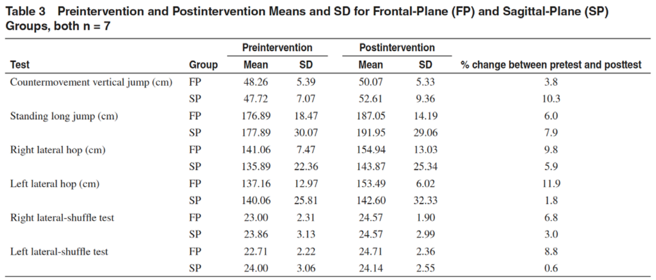
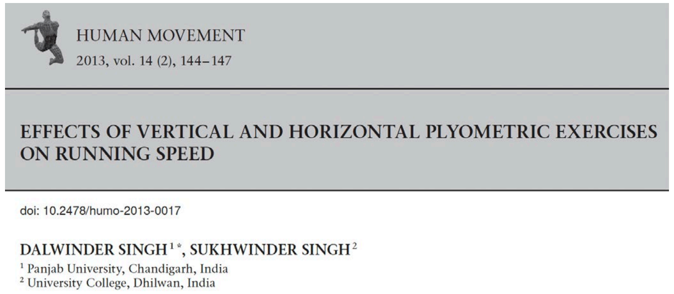


Table 3 Preintervention and Postintervention Means and SD for Frontal-Plane (FP) and Sagittal-Plane (SP) Groups, both n = 7

		Preintervention		Postintervention		
Test	**Group**	**Mean**	**SD**	**Mean**	**SD**	**% change between pretest and posttest**
Countermovement vertical jump (cm)	FP	48.26	5.39	50.07	5.33	3.8
	SP	47.72	7.07	52.61	9.36	10.3
Standing long jump (cm)	FP	176.89	18.47	187.05	14.19	6.0
	SP	177.89	30.07	191.95	29.06	7.9
Right lateral hop (cm)	FP	141.06	7.47	154.94	13.03	9.8
	SP	135.89	22.36	143.87	25.34	5.9
Left lateral hop (cm)	FP	137.16	12.97	153.49	6.02	11.9
	SP	140.06	25.81	142.60	32.33	1.8
Right lateral-shuffle test	FP	23.00	2.31	24.57	1.90	6.8
	SP	23.86	3.13	24.57	2.99	3.0
Left lateral-shuffle test	FP	22.71	2.22	24.71	2.36	8.8
	SP	24.00	3.06	24.14	2.55	0.6

Plyometric Studies

Vertical vs. Horizontal


HUMAN MOVEMENT
2013, vol. 14 (2), 144–147

EFFECTS OF VERTICAL AND HORIZONTAL PLYOMETRIC EXERCISES ON RUNNING SPEED

doi: 10.2478/humo-2013-0017

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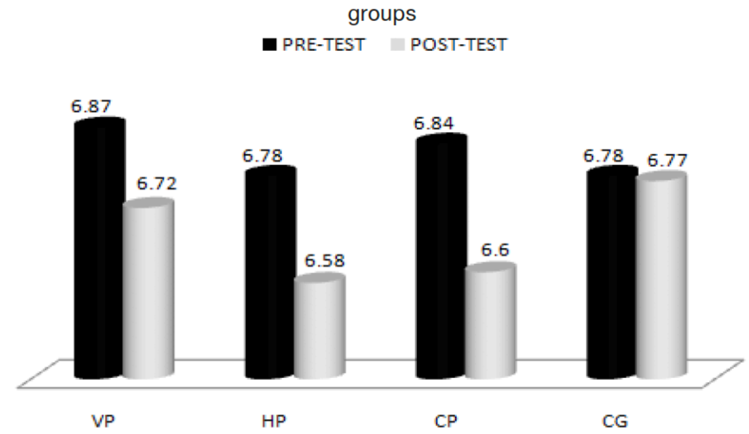
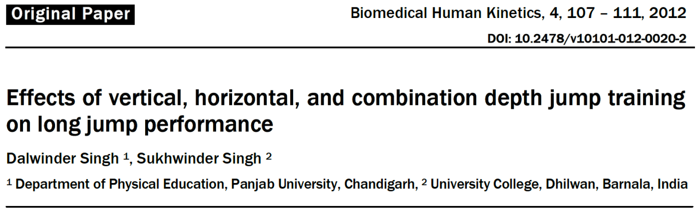


VP – vertical depth jump group, HP – horizontal depth jump group, CP – vertical and horizontal depth jump group, CG – control group

Figure 2. Pre-test and post-test running speed means (s) of the experimental and control


Original Paper Biomedical Human Kinetics, 4, 107 – 111, 2012
DOI: 10.2478/v10101-012-0020-2

Effects of vertical, horizontal, and combination depth jump training on long jump performance

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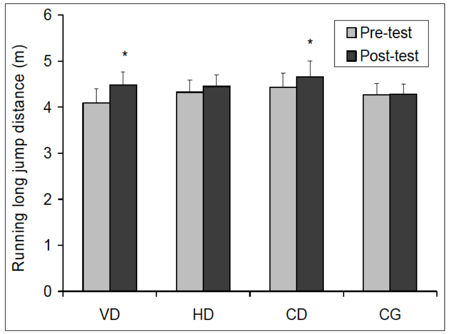


Fig. 2. The mean and standard deviation values for running long jump performance obtained in studied groups during pre- and post-test

Legend: VD – Vertical depth jumping; HD – Horizontal depth jumping; CD – Combination of vertical depth jumping and horizontal depth jumping; CG – Control group. * Significantly (p<0.05) different from CG

Both groups good for jumping and sprinting but vertical better for jumping and horizontal better for sprinting

Unilateral horizontal superior for 10m sprint and multiple COD

European Journal of Sport Science

ISSN: 1746-1391 (Print) 1536-7290 (Online) Journal homepage: http://www.tandfonline.com/loi/tejs20

Influence of force-vector and force application plyometric training in young elite basketball players

Oliver Gonzalo-Skok, Jorge Sánchez-Sabaté, Luis Izquierdo-Lupón & Eduardo Sáez de Villarreal

To cite this article: Oliver Gonzalo-Skok, Jorge Sánchez-Sabaté, Luis Izquierdo-Lupón & Eduardo Sáez de Villarreal (2018): Influence of force-vector and force application plyometric training in young elite basketball players, European Journal of Sport Science, DOI: 10.1080/17461391.2018.1502357

To link to this article: https://doi.org/10.1080/17461391.2018.1502357

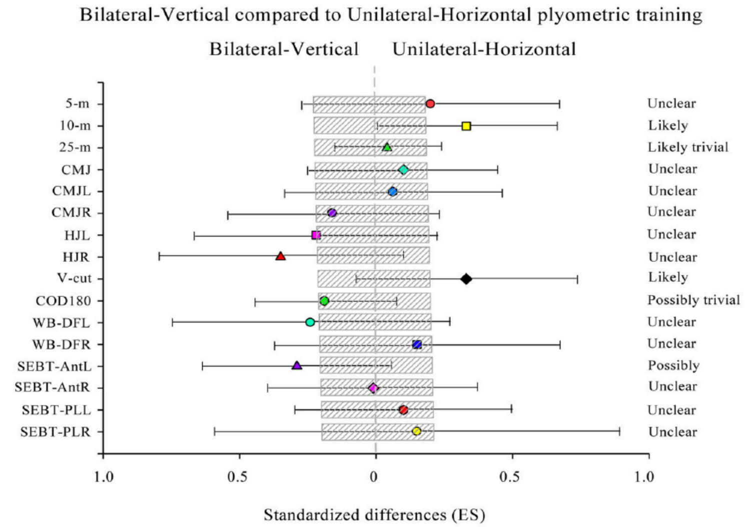
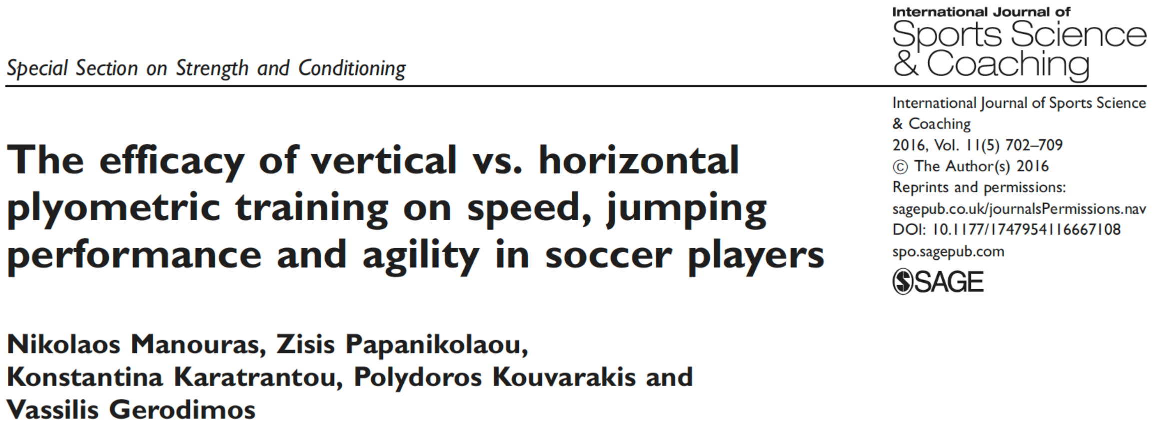


Figure 1. Efficiency of the unilateral-horizontal (UH) compared to bilateral-vertical (BV) plyometric training programme to improve 5, 10 and 25-m sprint time, countermovement jump bilateral (CMJ), left (CMJ_L) and right (CMJ_R) performance, horizontal jump with left (HJ_L) and right (HJ_R) performance, multiple change of direction (V-cut test), change of direction of 180° (COD180), weight-bearing dorsi-flexion range of motion with left ($WB\text{-}DF_L$) and right ($WB\text{-}DF_R$) ankle and the distance in the star excursion balance test in the anterior direction with left ($SEBT\text{-}A_L$) and right ($SEBT\text{-}A_R$) leg and in the posterior-lateral direction with left ($SEBT\text{-}PL_L$) and right ($SEBT\text{-}PL_R$) leg (bars indicate uncertainty in the true mean changes with 90% confidence limits). Trivial areas were the smallest worthwhile change (SWC) (see methods).


Special Section on Strength and Conditioning

International Journal of Sports Science & Coaching

International Journal of Sports Science & Coaching
2016, Vol. 11(5) 702–709

DOI: 10.1177/1747954116667108
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The efficacy of vertical vs. horizontal plyometric training on speed, jumping performance and agility in soccer players

Nikolaos Manouras, Zisis Papanikolaou, Konstantina Karatrantou, Polydoros Kouvarakis and Vassilis Gerodimos

Both groups great for sprint, agility, and jumping, but horizontal better for broad jump

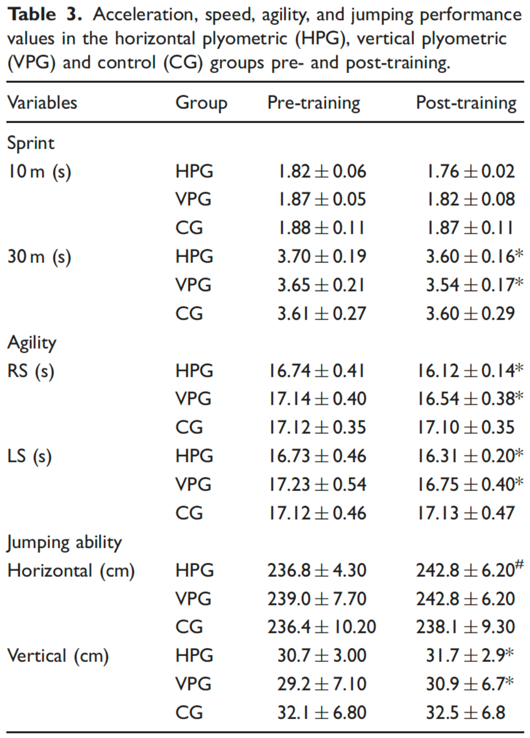
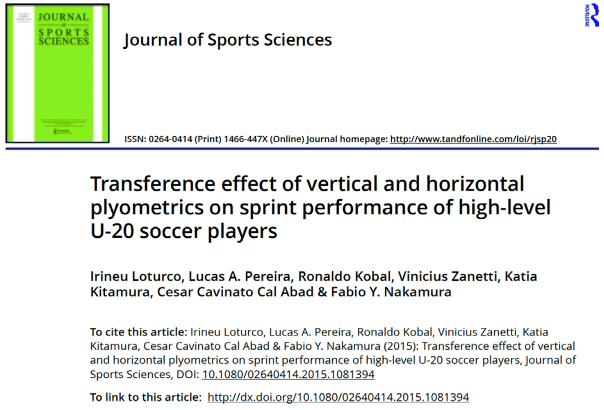


Table 3. Acceleration, speed, agility, and jumping performance values in the horizontal plyometric (HPG), vertical plyometric (VPG) and control (CG) groups pre- and post-training.

Variables	Group	Pre-training	Post-training
Sprint			
10 m (s)	HPG	1.82 ± 0.06	1.76 ± 0.02
	VPG	1.87 ± 0.05	1.82 ± 0.08
	CG	1.88 ± 0.11	1.87 ± 0.11
30 m (s)	HPG	3.70 ± 0.19	3.60 ± 0.16*
	VPG	3.65 ± 0.21	3.54 ± 0.17*
	CG	3.61 ± 0.27	3.60 ± 0.29
Agility			
RS (s)	HPG	16.74 ± 0.41	16.12 ± 0.14*
	VPG	17.14 ± 0.40	16.54 ± 0.38*
	CG	17.12 ± 0.35	17.10 ± 0.35
LS (s)	HPG	16.73 ± 0.46	16.31 ± 0.20*
	VPG	17.23 ± 0.54	16.75 ± 0.40*
	CG	17.12 ± 0.46	17.13 ± 0.47
Jumping ability			
Horizontal (cm)	HPG	236.8 ± 4.30	242.8 ± 6.20#
	VPG	239.0 ± 7.70	242.8 ± 6.20
	CG	236.4 ± 10.20	238.1 ± 9.30
Vertical (cm)	HPG	30.7 ± 3.00	31.7 ± 2.9*
	VPG	29.2 ± 7.10	30.9 ± 6.7*
	CG	32.1 ± 6.80	32.5 ± 6.8



Journal of Sports Sciences

ISSN: 0264-0414 (Print) 1466-447X (Online) Journal homepage: http://www.tandfonline.com/loi/rjsp20

Transference effect of vertical and horizontal plyometrics on sprint performance of high-level U-20 soccer players

Irineu Loturco, Lucas A. Pereira, Ronaldo Kobal, Vinicius Zanetti, Katia Kitamura, Cesar Cavinato Cal Abad & Fabio Y. Nakamura

To cite this article: Irineu Loturco, Lucas A. Pereira, Ronaldo Kobal, Vinicius Zanetti, Katia Kitamura, Cesar Cavinato Cal Abad & Fabio Y. Nakamura (2015): Transference effect of vertical and horizontal plyometrics on sprint performance of high-level U-20 soccer players, Journal of Sports Sciences, DOI: 10.1080/02640414.2015.1081394

To link to this article: http://dx.doi.org/10.1080/02640414.2015.1081394

Vertical better for vertical jump, horizontal better for broad jump and sprinting

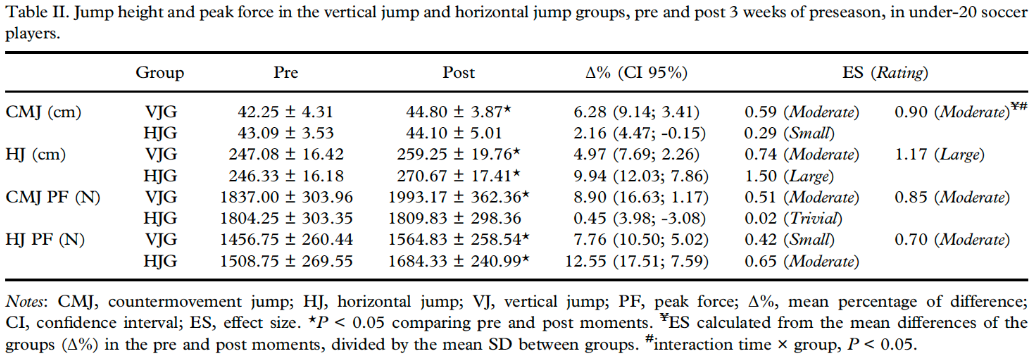


Table II. Jump height and peak force in the vertical jump and horizontal jump groups, pre and post 3 weeks of preseason, in under-20 soccer players.

	Group	Pre	Post	Δ% (CI 95%)	ES (*Rating*)	
CMJ (cm)	VJG	42.25 ± 4.31	44.80 ± 3.87*	6.28 (9.14; 3.41)	0.59 (*Moderate*)	0.90 (*Moderate*)$^{¥\#}$
	HJG	43.09 ± 3.53	44.10 ± 5.01	2.16 (4.47; -0.15)	0.29 (*Small*)	
HJ (cm)	VJG	247.08 ± 16.42	259.25 ± 19.76*	4.97 (7.69; 2.26)	0.74 (*Moderate*)	1.17 (*Large*)
	HJG	246.33 ± 16.18	270.67 ± 17.41*	9.94 (12.03; 7.86)	1.50 (*Large*)	
CMJ PF (N)	VJG	1837.00 ± 303.96	1993.17 ± 362.36*	8.90 (16.63; 1.17)	0.51 (*Moderate*)	0.85 (*Moderate*)
	HJG	1804.25 ± 303.35	1809.83 ± 298.36	0.45 (3.98; -3.08)	0.02 (*Trivial*)	
HJ PF (N)	VJG	1456.75 ± 260.44	1564.83 ± 258.54*	7.76 (10.50; 5.02)	0.42 (*Small*)	0.70 (*Moderate*)
	HJG	1508.75 ± 269.55	1684.33 ± 240.99*	12.55 (17.51; 7.59)	0.65 (*Moderate*)	

Notes: CMJ, countermovement jump; HJ, horizontal jump; VJ, vertical jump; PF, peak force; Δ%, mean percentage of difference; CI, confidence interval; ES, effect size. *$P < 0.05$ comparing pre and post moments. ¥ES calculated from the mean differences of the groups (Δ%) in the pre and post moments, divided by the mean SD between groups. #interaction time × group, $P < 0.05$.

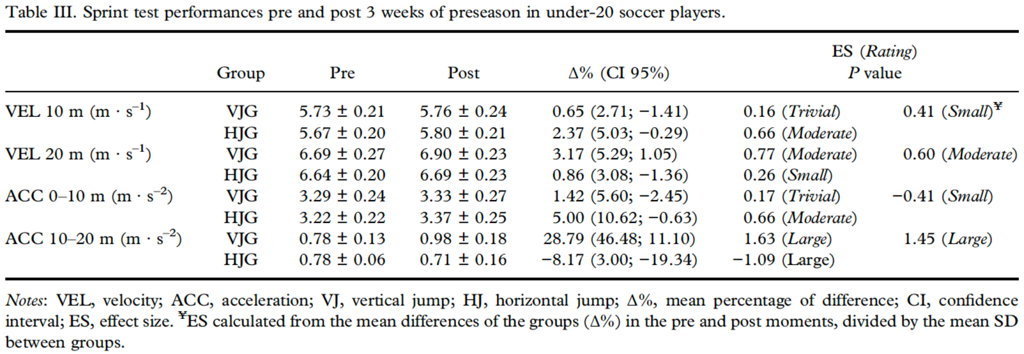


Table III. Sprint test performances pre and post 3 weeks of preseason in under-20 soccer players.

	Group	Pre	Post	Δ% (CI 95%)	ES (*Rating*) *P* value	
VEL 10 m ($m \cdot s^{-1}$)	VJG	5.73 ± 0.21	5.76 ± 0.24	0.65 (2.71; −1.41)	0.16 (*Trivial*)	0.41 (*Small*)¥
	HJG	5.67 ± 0.20	5.80 ± 0.21	2.37 (5.03; −0.29)	0.66 (*Moderate*)	
VEL 20 m ($m \cdot s^{-1}$)	VJG	6.69 ± 0.27	6.90 ± 0.23	3.17 (5.29; 1.05)	0.77 (*Moderate*)	0.60 (*Moderate*)
	HJG	6.64 ± 0.20	6.69 ± 0.23	0.86 (3.08; −1.36)	0.26 (*Small*)	
ACC 0–10 m ($m \cdot s^{-2}$)	VJG	3.29 ± 0.24	3.33 ± 0.27	1.42 (5.60; −2.45)	0.17 (*Trivial*)	−0.41 (*Small*)
	HJG	3.22 ± 0.22	3.37 ± 0.25	5.00 (10.62; −0.63)	0.66 (*Moderate*)	
ACC 10–20 m ($m \cdot s^{-2}$)	VJG	0.78 ± 0.13	0.98 ± 0.18	28.79 (46.48; 11.10)	1.63 (*Large*)	1.45 (*Large*)
	HJG	0.78 ± 0.06	0.71 ± 0.16	−8.17 (3.00; −19.34)	−1.09 (Large)	

Notes: VEL, velocity; ACC, acceleration; VJ, vertical jump; HJ, horizontal jump; Δ%, mean percentage of difference; CI, confidence interval; ES, effect size. ¥ES calculated from the mean differences of the groups (Δ%) in the pre and post moments, divided by the mean SD between groups.

VERTICAL- VS. HORIZONTAL-ORIENTED DROP JUMP TRAINING: CHRONIC EFFECTS ON EXPLOSIVE PERFORMANCES OF ELITE HANDBALL PLAYERS

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Vertical better for jumping, horizontal better for sprinting and agility

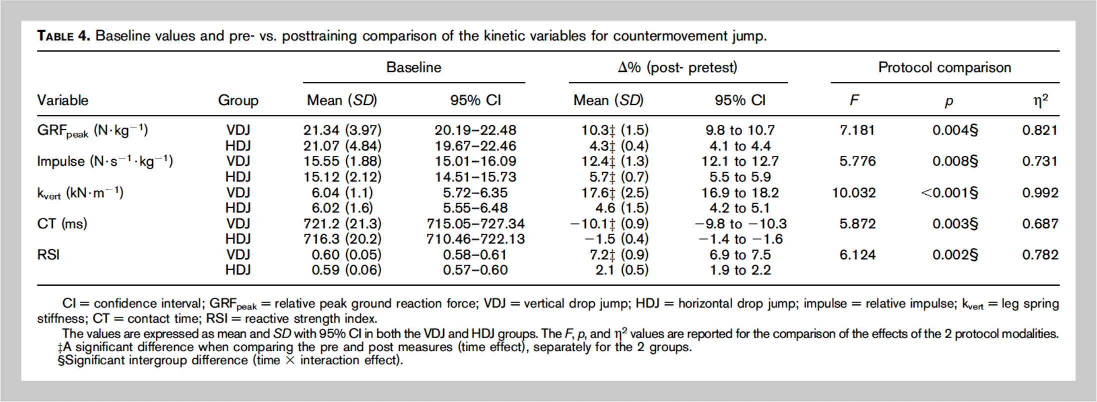


TABLE 4. Baseline values and pre- vs. posttraining comparison of the kinetic variables for countermovement jump.

		Baseline		Δ% (post- pretest)		Protocol comparison		
Variable	Group	Mean (*SD*)	95% CI	Mean (*SD*)	95% CI	*F*	*p*	η^2
GRF_{peak} (N·kg^{-1})	VDJ	21.34 (3.97)	20.19–22.48	10.3‡ (1.5)	9.8 to 10.7	7.181	0.004§	0.821
	HDJ	21.07 (4.84)	19.67–22.46	4.3‡ (0.4)	4.1 to 4.4			
Impulse (N·s^{-1}·kg^{-1})	VDJ	15.55 (1.88)	15.01–16.09	12.4‡ (1.3)	12.1 to 12.7	5.776	0.008§	0.731
	HDJ	15.12 (2.12)	14.51–15.73	5.7‡ (0.7)	5.5 to 5.9			
k_{vert} (kN·m^{-1})	VDJ	6.04 (1.1)	5.72–6.35	17.6‡ (2.5)	16.9 to 18.2	10.032	<0.001§	0.992
	HDJ	6.02 (1.6)	5.55–6.48	4.6 (1.5)	4.2 to 5.1			
CT (ms)	VDJ	721.2 (21.3)	715.05–727.34	−10.1‡ (0.9)	−9.8 to −10.3	5.872	0.003§	0.687
	HDJ	716.3 (20.2)	710.46–722.13	−1.5 (0.4)	−1.4 to −1.6			
RSI	VDJ	0.60 (0.05)	0.58–0.61	7.2‡ (0.9)	6.9 to 7.5	6.124	0.002§	0.782
	HDJ	0.59 (0.06)	0.57–0.60	2.1 (0.5)	1.9 to 2.2			

CI = confidence interval; GRF_{peak} = relative peak ground reaction force; VDJ = vertical drop jump; HDJ = horizontal drop jump; impulse = relative impulse; k_{vert} = leg spring stiffness; CT = contact time; RSI = reactive strength index.

The values are expressed as mean and *SD* with 95% CI in both the VDJ and HDJ groups. The *F*, *p*, and η^2 values are reported for the comparison of the effects of the 2 protocol modalities.

‡A significant difference when comparing the pre and post measures (time effect), separately for the 2 groups.

§Significant intergroup difference (time × interaction effect).

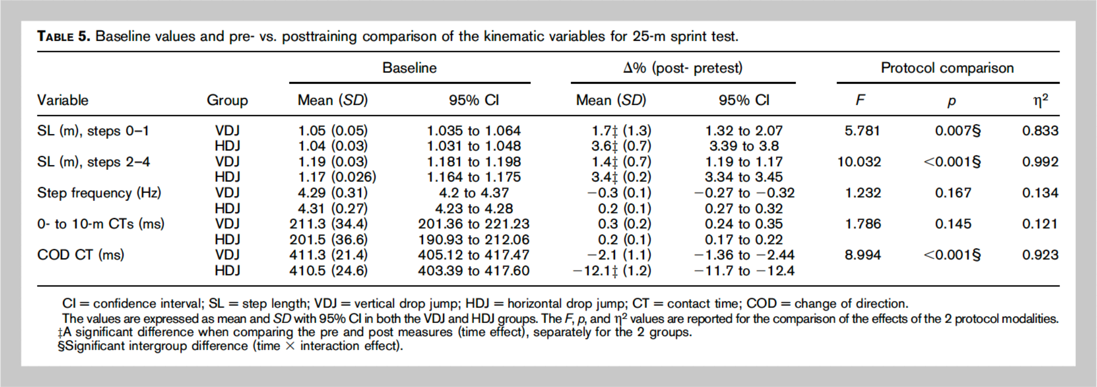


TABLE 5. Baseline values and pre- vs. posttraining comparison of the kinematic variables for 25-m sprint test.

		Baseline		Δ% (post- pretest)		Protocol comparison		
Variable	Group	Mean (*SD*)	95% CI	Mean (*SD*)	95% CI	*F*	*p*	η^2
SL (m), steps 0–1	VDJ	1.05 (0.05)	1.035 to 1.064	1.7‡ (1.3)	1.32 to 2.07	5.781	0.007§	0.833
	HDJ	1.04 (0.03)	1.031 to 1.048	3.6‡ (0.7)	3.39 to 3.8			
SL (m), steps 2–4	VDJ	1.19 (0.03)	1.181 to 1.198	1.4‡ (0.7)	1.19 to 1.17	10.032	<0.001§	0.992
	HDJ	1.17 (0.026)	1.164 to 1.175	3.4‡ (0.2)	3.34 to 3.45			
Step frequency (Hz)	VDJ	4.29 (0.31)	4.2 to 4.37	−0.3 (0.1)	−0.27 to −0.32	1.232	0.167	0.134
	HDJ	4.31 (0.27)	4.23 to 4.28	0.2 (0.1)	0.27 to 0.32			
0- to 10-m CTs (ms)	VDJ	211.3 (34.4)	201.36 to 221.23	0.3 (0.2)	0.24 to 0.35	1.786	0.145	0.121
	HDJ	201.5 (36.6)	190.93 to 212.06	0.2 (0.1)	0.17 to 0.22			
COD CT (ms)	VDJ	411.3 (21.4)	405.12 to 417.47	−2.1 (1.1)	−1.36 to −2.44	8.994	<0.001§	0.923
	HDJ	410.5 (24.6)	403.39 to 417.60	−12.1‡ (1.2)	−11.7 to −12.4			

CI = confidence interval; SL = step length; VDJ = vertical drop jump; HDJ = horizontal drop jump; CT = contact time; COD = change of direction.

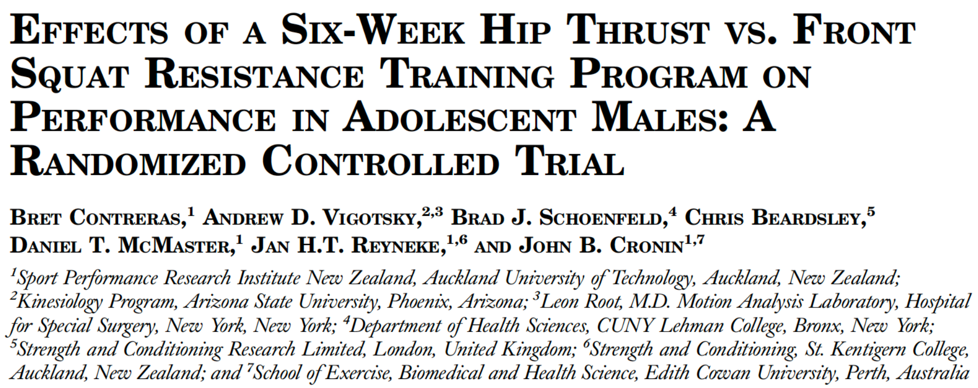
The values are expressed as mean and *SD* with 95% CI in both the VDJ and HDJ groups. The *F*, *p*, and η^2 values are reported for the comparison of the effects of the 2 protocol modalities.

‡A significant difference when comparing the pre and post measures (time effect), separately for the 2 groups.

§Significant intergroup difference (time × interaction effect).

Resistance Training Studies

Squat vs. Hip Thrust



EFFECTS OF A SIX-WEEK HIP THRUST VS. FRONT SQUAT RESISTANCE TRAINING PROGRAM ON PERFORMANCE IN ADOLESCENT MALES: A RANDOMIZED CONTROLLED TRIAL

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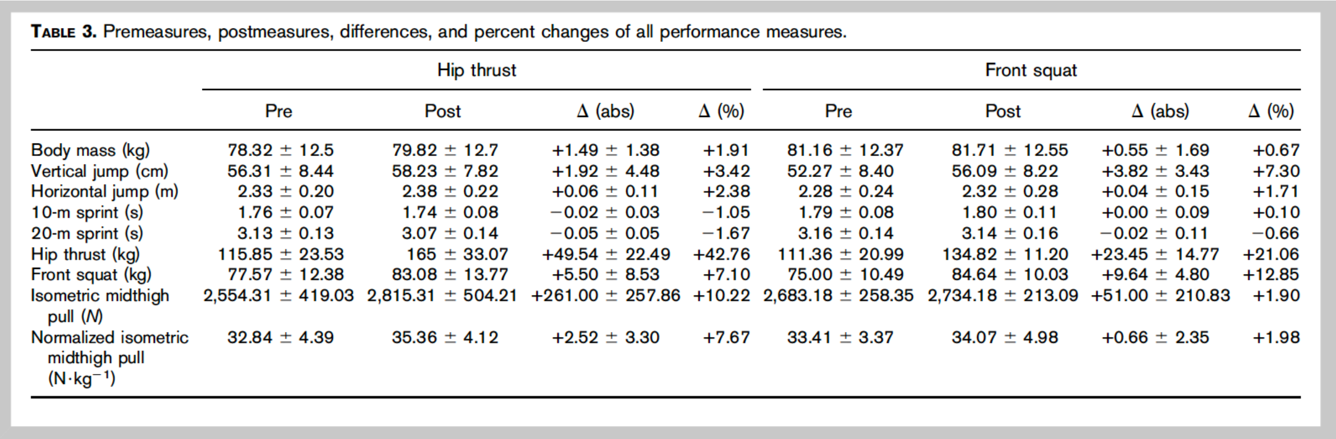
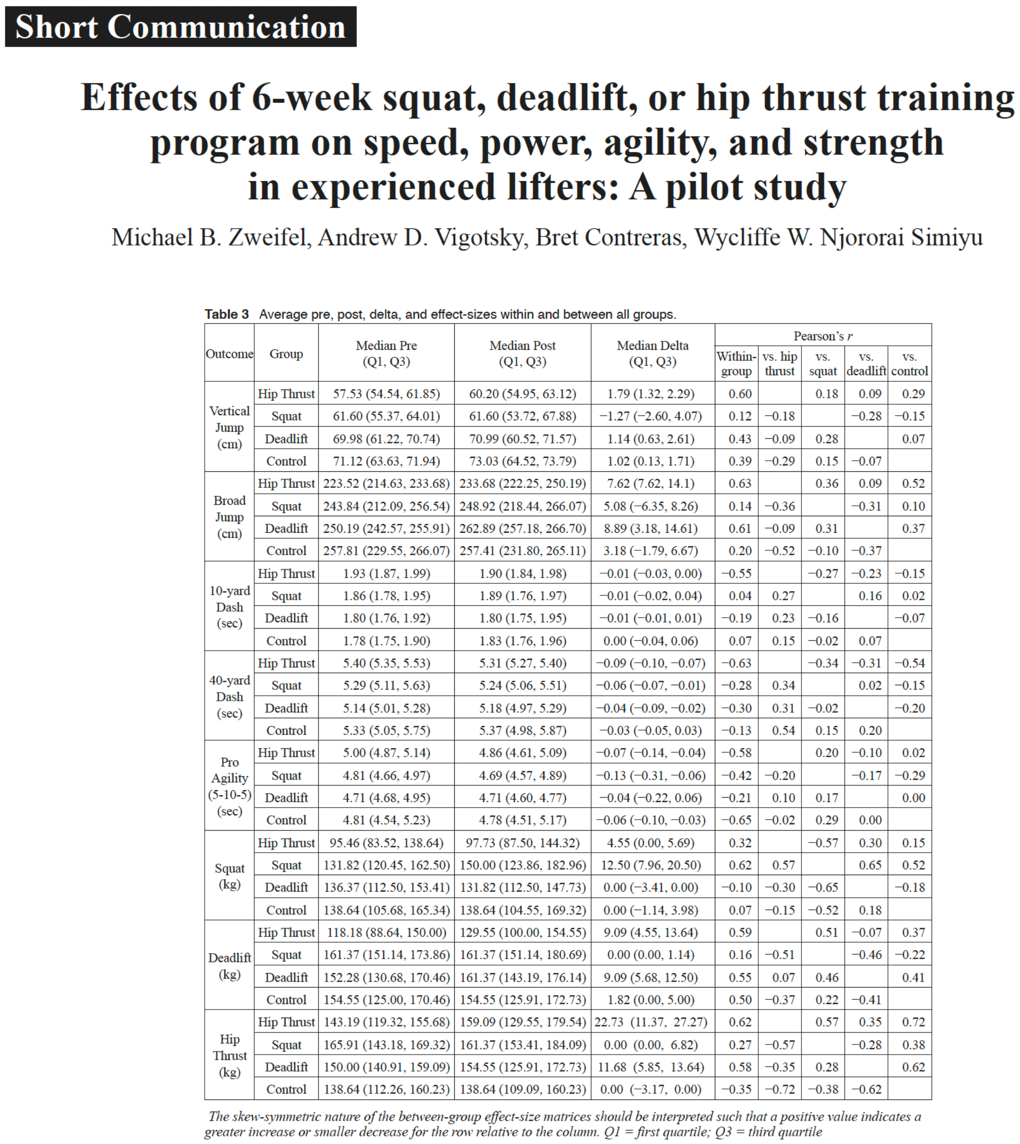


TABLE 3. Premeasures, postmeasures, differences, and percent changes of all performance measures.

	Hip thrust				Front squat			
	Pre	Post	Δ (abs)	Δ (%)	Pre	Post	Δ (abs)	Δ (%)
Body mass (kg)	78.32 ± 12.5	79.82 ± 12.7	+1.49 ± 1.38	+1.91	81.16 ± 12.37	81.71 ± 12.55	+0.55 ± 1.69	+0.67
Vertical jump (cm)	56.31 ± 8.44	58.23 ± 7.82	+1.92 ± 4.48	+3.42	52.27 ± 8.40	56.09 ± 8.22	+3.82 ± 3.43	+7.30
Horizontal jump (m)	2.33 ± 0.20	2.38 ± 0.22	+0.06 ± 0.11	+2.38	2.28 ± 0.24	2.32 ± 0.28	+0.04 ± 0.15	+1.71
10-m sprint (s)	1.76 ± 0.07	1.74 ± 0.08	−0.02 ± 0.03	−1.05	1.79 ± 0.08	1.80 ± 0.11	+0.00 ± 0.09	+0.10
20-m sprint (s)	3.13 ± 0.13	3.07 ± 0.14	−0.05 ± 0.05	−1.67	3.16 ± 0.14	3.14 ± 0.16	−0.02 ± 0.11	−0.66
Hip thrust (kg)	115.85 ± 23.53	165 ± 33.07	+49.54 ± 22.49	+42.76	111.36 ± 20.99	134.82 ± 11.20	+23.45 ± 14.77	+21.06
Front squat (kg)	77.57 ± 12.38	83.08 ± 13.77	+5.50 ± 8.53	+7.10	75.00 ± 10.49	84.64 ± 10.03	+9.64 ± 4.80	+12.85
Isometric midthigh pull (*N*)	2,554.31 ± 419.03	2,815.31 ± 504.21	+261.00 ± 257.86	+10.22	2,683.18 ± 258.35	2,734.18 ± 213.09	+51.00 ± 210.83	+1.90
Normalized isometric midthigh pull ($N \cdot kg^{-1}$)	32.84 ± 4.39	35.36 ± 4.12	+2.52 ± 3.30	+7.67	33.41 ± 3.37	34.07 ± 4.98	+0.66 ± 2.35	+1.98



Short Communication

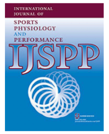
Effects of 6-week squat, deadlift, or hip thrust training program on speed, power, agility, and strength in experienced lifters: A pilot study

Michael B. Zweifel, Andrew D. Vigotsky, Bret Contreras, Wycliffe W. Njororai Simiyu

Table 3 Average pre, post, delta, and effect-sizes within and between all groups.

Outcome	Group	Median Pre (Q1, Q3)	Median Post (Q1, Q3)	Median Delta (Q1, Q3)	Pearson's *r*				
					Within-group	vs. hip thrust	vs. squat	vs. deadlift	vs. control
Vertical Jump (cm)	Hip Thrust	57.53 (54.54, 61.85)	60.20 (54.95, 63.12)	1.79 (1.32, 2.29)	0.60		0.18	0.09	0.29
	Squat	61.60 (55.37, 64.01)	61.60 (53.72, 67.88)	−1.27 (−2.60, 4.07)	0.12	−0.18		−0.28	−0.15
	Deadlift	69.98 (61.22, 70.74)	70.99 (60.52, 71.57)	1.14 (0.63, 2.61)	0.43	−0.09	0.28		0.07
	Control	71.12 (63.63, 71.94)	73.03 (64.52, 73.79)	1.02 (0.13, 1.71)	0.39	−0.29	0.15	−0.07	
Broad Jump (cm)	Hip Thrust	223.52 (214.63, 233.68)	233.68 (222.25, 250.19)	7.62 (7.62, 14.1)	0.63		0.36	0.09	0.52
	Squat	243.84 (212.09, 256.54)	248.92 (218.44, 266.07)	5.08 (−6.35, 8.26)	0.14	−0.36		−0.31	0.10
	Deadlift	250.19 (242.57, 255.91)	262.89 (257.18, 266.70)	8.89 (3.18, 14.61)	0.61	−0.09	0.31		0.37
	Control	257.81 (229.55, 266.07)	257.41 (231.80, 265.11)	3.18 (−1.79, 6.67)	0.20	−0.52	−0.10	−0.37	
10-yard Dash (sec)	Hip Thrust	1.93 (1.87, 1.99)	1.90 (1.84, 1.98)	−0.01 (−0.03, 0.00)	−0.55		−0.27	−0.23	−0.15
	Squat	1.86 (1.78, 1.95)	1.89 (1.76, 1.97)	−0.01 (−0.02, 0.04)	0.04	0.27		0.16	0.02
	Deadlift	1.80 (1.76, 1.92)	1.80 (1.75, 1.95)	−0.01 (−0.01, 0.01)	−0.19	0.23	−0.16		−0.07
	Control	1.78 (1.75, 1.90)	1.83 (1.76, 1.96)	0.00 (−0.04, 0.06)	0.07	0.15	−0.02	0.07	
40-yard Dash (sec)	Hip Thrust	5.40 (5.35, 5.53)	5.31 (5.27, 5.40)	−0.09 (−0.10, −0.07)	−0.63		−0.34	−0.31	−0.54
	Squat	5.29 (5.11, 5.63)	5.24 (5.06, 5.51)	−0.06 (−0.07, −0.01)	−0.28	0.34		0.02	−0.15
	Deadlift	5.14 (5.01, 5.28)	5.18 (4.97, 5.29)	−0.04 (−0.09, −0.02)	−0.30	0.31	−0.02		−0.20
	Control	5.33 (5.05, 5.75)	5.37 (4.98, 5.87)	−0.03 (−0.05, 0.03)	−0.13	0.54	0.15	0.20	
Pro Agility (5-10-5) (sec)	Hip Thrust	5.00 (4.87, 5.14)	4.86 (4.61, 5.09)	−0.07 (−0.14, −0.04)	−0.58		0.20	−0.10	0.02
	Squat	4.81 (4.66, 4.97)	4.69 (4.57, 4.89)	−0.13 (−0.31, −0.06)	−0.42	−0.20		−0.17	−0.29
	Deadlift	4.71 (4.68, 4.95)	4.71 (4.60, 4.77)	−0.04 (−0.22, 0.06)	−0.21	0.10	0.17		0.00
	Control	4.81 (4.54, 5.23)	4.78 (4.51, 5.17)	−0.06 (−0.10, −0.03)	−0.65	−0.02	0.29	0.00	
Squat (kg)	Hip Thrust	95.46 (83.52, 138.64)	97.73 (87.50, 144.32)	4.55 (0.00, 5.69)	0.32		−0.57	0.30	0.15
	Squat	131.82 (120.45, 162.50)	150.00 (123.86, 182.96)	12.50 (7.96, 20.50)	0.62	0.57		0.65	0.52
	Deadlift	136.37 (112.50, 153.41)	131.82 (112.50, 147.73)	0.00 (−3.41, 0.00)	−0.10	−0.30	−0.65		−0.18
	Control	138.64 (105.68, 165.34)	138.64 (104.55, 169.32)	0.00 (−1.14, 3.98)	0.07	−0.15	−0.52	0.18	
Deadlift (kg)	Hip Thrust	118.18 (88.64, 150.00)	129.55 (100.00, 154.55)	9.09 (4.55, 13.64)	0.59		0.51	−0.07	0.37
	Squat	161.37 (151.14, 173.86)	161.37 (151.14, 180.69)	0.00 (0.00, 1.14)	0.16	−0.51		−0.46	−0.22
	Deadlift	152.28 (130.68, 170.46)	161.37 (143.19, 176.14)	9.09 (5.68, 12.50)	0.55	0.07	0.46		0.41
	Control	154.55 (125.00, 170.46)	154.55 (125.91, 172.73)	1.82 (0.00, 5.00)	0.50	−0.37	0.22	−0.41	
Hip Thrust (kg)	Hip Thrust	143.19 (119.32, 155.68)	159.09 (129.55, 179.54)	22.73 (11.37, 27.27)	0.62		0.57	0.35	0.72
	Squat	165.91 (143.18, 169.32)	161.37 (153.41, 184.09)	0.00 (0.00, 6.82)	0.27	−0.57		−0.28	0.38
	Deadlift	150.00 (140.91, 159.09)	154.55 (125.91, 172.73)	11.68 (5.85, 13.64)	0.58	−0.35	0.28		0.62
	Control	138.64 (112.26, 160.23)	138.64 (109.09, 160.23)	0.00 (−3.17, 0.00)	−0.35	−0.72	−0.38	−0.62	

The skew-symmetric nature of the between-group effect-size matrices should be interpreted such that a positive value indicates a greater increase or smaller decrease for the row relative to the column. Q1 = first quartile; Q3 = third quartile



International Journal of Sports Physiology and Performance – 2016

BRIEF REPORT

VERY-HEAVY SLED TRAINING FOR IMPROVING HORIZONTAL FORCE OUTPUT IN SOCCER PLAYERS

Morin JB[1,4@], Petrakos G[2], Jimenez-Reyes P[3], Brown SR[4], Samozino P[5], Cross MR[4]

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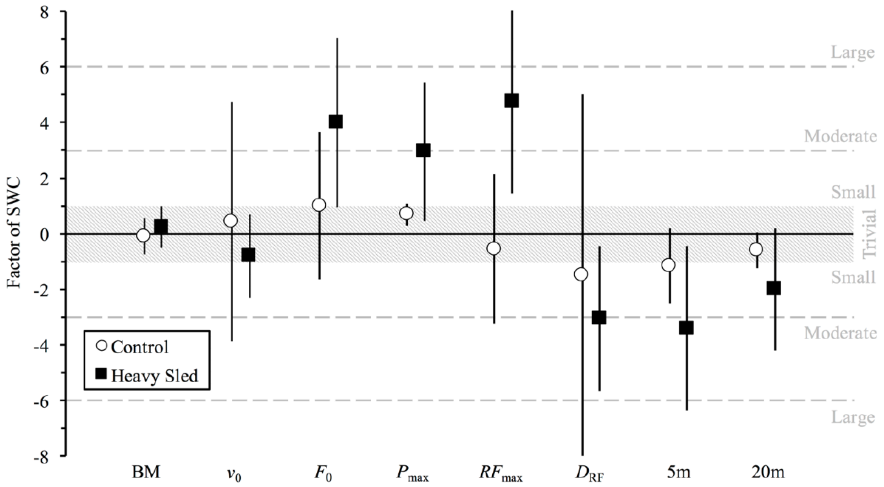
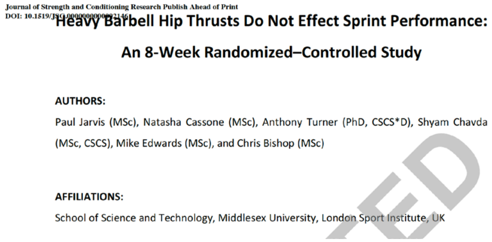


Figure 1. *Magnitude of pre-post changes in the main sprint acceleration performance and mechanical outputs. The standardised differences are expressed as a factor of the smallest worthwhile change (SWC). Bars indicate the 90% confidence limits. BM: body-mass; v_0: maximal theoretical running velocity; F_0: theoretical maximal horizontal force; P_{max}: maximal power; RF_{max}: maximal ratio of force; D_{RF}: decrease in the ratio of force; 5m: 5-m sprint time; 20m: 20-m sprint time.*

Hip Thrust Gains with no Speed Gains?



Journal of Strength and Conditioning Research Publish Ahead of Print
DOI: 10.1519/JSC.0000000000002146

Heavy Barbell Hip Thrusts Do Not Effect Sprint Performance: An 8-Week Randomized–Controlled Study

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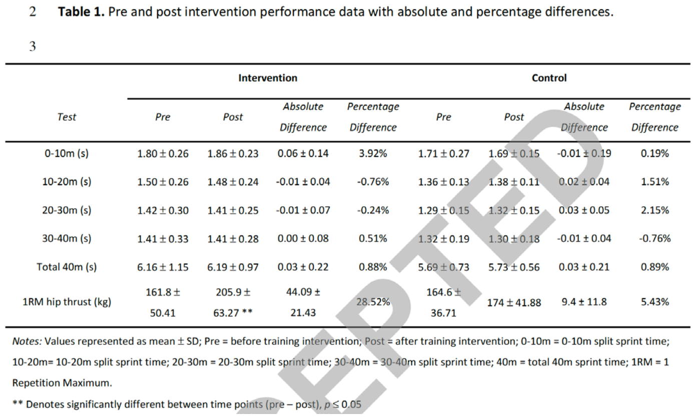
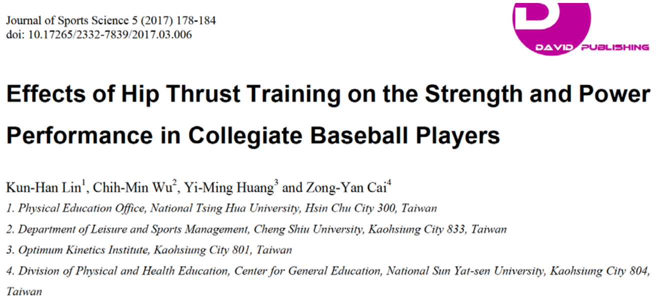


Table 1. Pre and post intervention performance data with absolute and percentage differences.

	Intervention				Control			
Test	*Pre*	*Post*	*Absolute Difference*	*Percentage Difference*	*Pre*	*Post*	*Absolute Difference*	*Percentage Difference*
0-10m (s)	1.80 ± 0.26	1.86 ± 0.23	0.06 ± 0.14	3.92%	1.71 ± 0.27	1.69 ± 0.15	-0.01 ± 0.19	0.19%
10-20m (s)	1.50 ± 0.26	1.48 ± 0.24	-0.01 ± 0.04	-0.76%	1.36 ± 0.13	1.38 ± 0.11	0.02 ± 0.04	1.51%
20-30m (s)	1.42 ± 0.30	1.41 ± 0.25	-0.01 ± 0.07	-0.24%	1.29 ± 0.15	1.32 ± 0.15	0.03 ± 0.05	2.15%
30-40m (s)	1.41 ± 0.33	1.41 ± 0.28	0.00 ± 0.08	0.51%	1.32 ± 0.19	1.30 ± 0.18	-0.01 ± 0.04	-0.76%
Total 40m (s)	6.16 ± 1.15	6.19 ± 0.97	0.03 ± 0.22	0.88%	5.69 ± 0.73	5.73 ± 0.56	0.03 ± 0.21	0.89%
1RM hip thrust (kg)	161.8 ± 50.41	205.9 ± 63.27 **	44.09 ± 21.43	28.52%	164.6 ± 36.71	174 ± 41.88	9.4 ± 11.8	5.43%

Notes: Values represented as mean ± SD; Pre = before training intervention; Post = after training intervention; 0-10m = 0-10m split sprint time; 10-20m= 10-20m split sprint time; 20-30m = 20-30m split sprint time; 30-40m = 30-40m split sprint time; 40m = total 40m sprint time; 1RM = 1 Repetition Maximum.

** Denotes significantly different between time points (pre – post), $p \leq 0.05$



Journal of Sports Science 5 (2017) 178-184
doi: 10.17265/2332-7839/2017.03.006

DAVID PUBLISHING

Effects of Hip Thrust Training on the Strength and Power Performance in Collegiate Baseball Players

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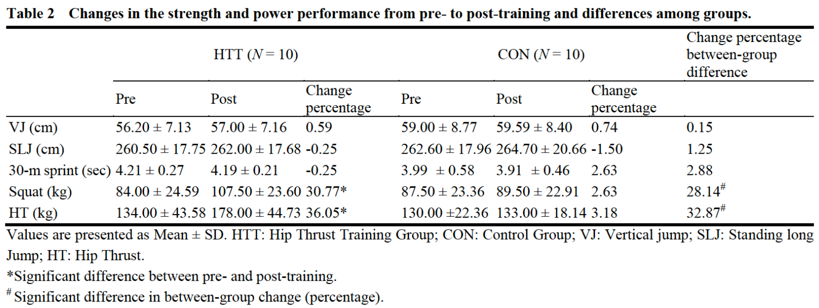

Table 2 Changes in the strength and power performance from pre- to post-training and differences among groups.

	HTT ($N = 10$)			CON ($N = 10$)			Change percentage between-group difference
	Pre	Post	Change percentage	Pre	Post	Change percentage	
VJ (cm)	56.20 ± 7.13	57.00 ± 7.16	0.59	59.00 ± 8.77	59.59 ± 8.40	0.74	0.15
SLJ (cm)	260.50 ± 17.75	262.00 ± 17.68	-0.25	262.60 ± 17.96	264.70 ± 20.66	-1.50	1.25
30-m sprint (sec)	4.21 ± 0.27	4.19 ± 0.21	-0.25	3.99 ± 0.58	3.91 ± 0.46	2.63	2.88
Squat (kg)	84.00 ± 24.59	107.50 ± 23.60	30.77*	87.50 ± 23.36	89.50 ± 22.91	2.63	28.14#
HT (kg)	134.00 ± 43.58	178.00 ± 44.73	36.05*	130.00 ±22.36	133.00 ± 18.14	3.18	32.87#

Values are presented as Mean ± SD. HTT: Hip Thrust Training Group; CON: Control Group; VJ: Vertical jump; SLJ: Standing long Jump; HT: Hip Thrust.

*Significant difference between pre- and post-training.

Significant difference in between-group change (percentage).

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Article

The Magical Horizontal Force Muscle? A Preliminary Study Examining the "Force-Vector" Theory

David A. Fitzpatrick, Giuseppe Cimadoro and Daniel J. Cleather *

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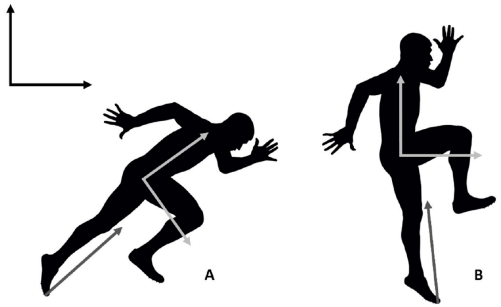


Figure 1. Relationship between global (world fixed—black axes) and local (athlete fixed—light grey axes) coordinate frames. (**A**) An athlete accelerating experiences a ground reaction force (dark grey arrow) which has substantial horizontal and vertical components relative to the global frame. (**B**) If the athlete is rotated such that the local and global frames are aligned, it is apparent that the direction of the ground reaction force relative to the athlete is largely vertical.

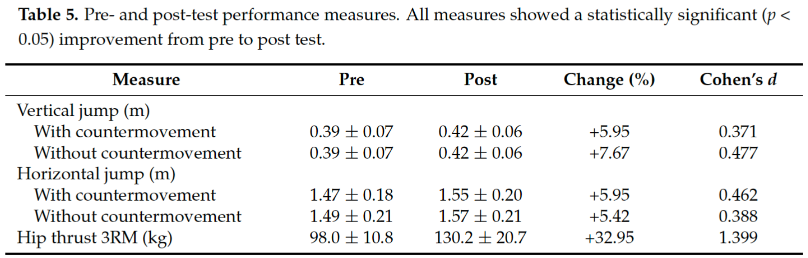
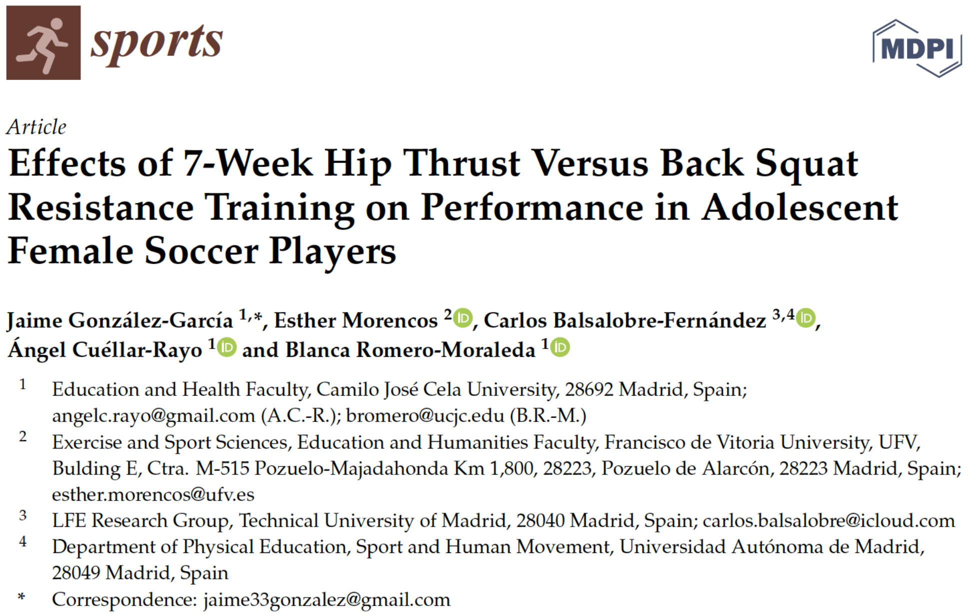


Table 5. Pre- and post-test performance measures. All measures showed a statistically significant ($p < 0.05$) improvement from pre to post test.

Measure	Pre	Post	Change (%)	Cohen's *d*
Vertical jump (m)				
With countermovement	0.39 ± 0.07	0.42 ± 0.06	+5.95	0.371
Without countermovement	0.39 ± 0.07	0.42 ± 0.06	+7.67	0.477
Horizontal jump (m)				
With countermovement	1.47 ± 0.18	1.55 ± 0.20	+5.95	0.462
Without countermovement	1.49 ± 0.21	1.57 ± 0.21	+5.42	0.388
Hip thrust 3RM (kg)	98.0 ± 10.8	130.2 ± 20.7	+32.95	1.399



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Article

Effects of 7-Week Hip Thrust Versus Back Squat Resistance Training on Performance in Adolescent Female Soccer Players

Jaime González-García [1,*], Esther Morencos [2], Carlos Balsalobre-Fernández [3,4], Ángel Cuéllar-Rayo [1] and Blanca Romero-Moraleda [1]

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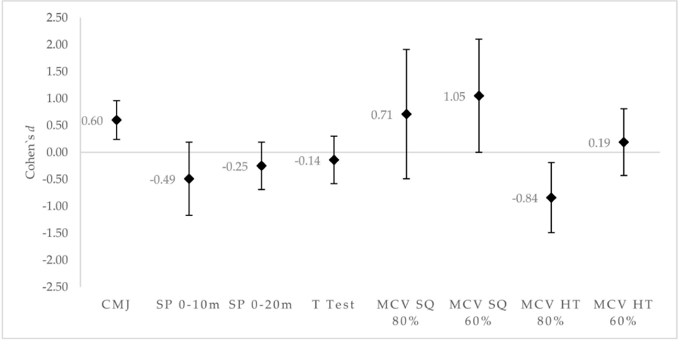


Figure 2. Differences in effect size (ES): Back squat group versus control group. Positive values favor SQG. Negative values favor CG.

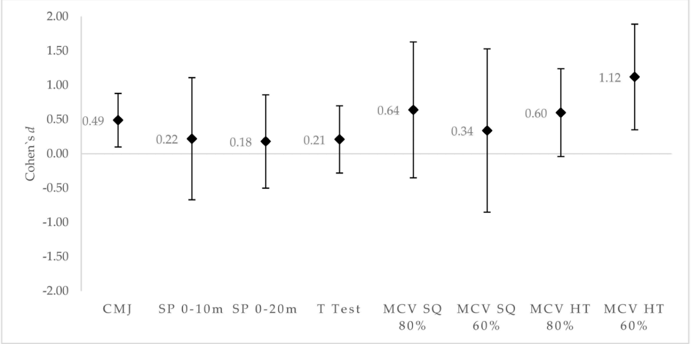
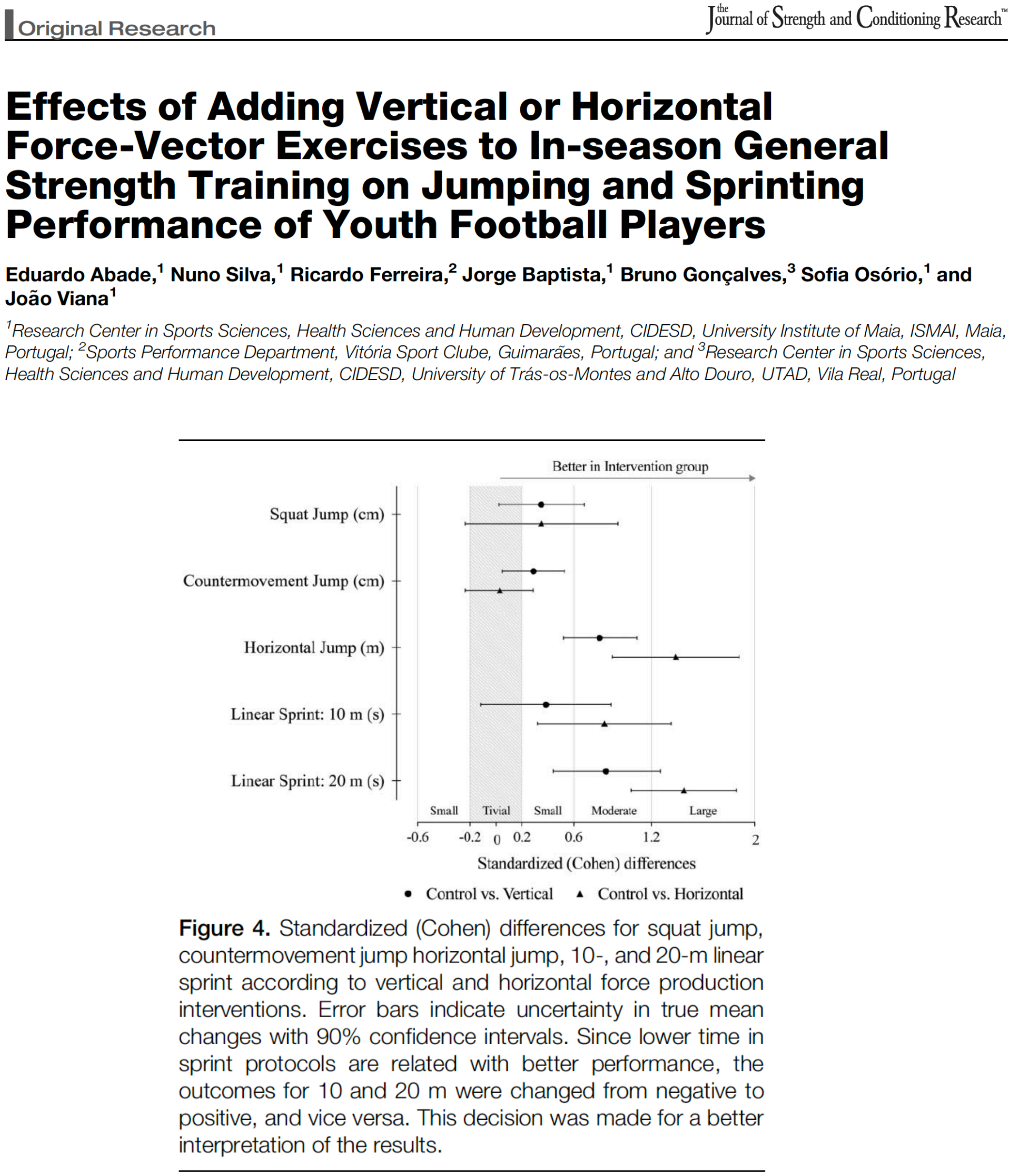


Figure 3. Differences in ES: Hip thrust group versus control group. Positive values favor HTG. Negative values favor CG.



Original Research
The Journal of Strength and Conditioning Research™

Effects of Adding Vertical or Horizontal Force-Vector Exercises to In-season General Strength Training on Jumping and Sprinting Performance of Youth Football Players

Eduardo Abade,[1] Nuno Silva,[1] Ricardo Ferreira,[2] Jorge Baptista,[1] Bruno Gonçalves,[3] Sofia Osório,[1] and João Viana[1]

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Figure 4. Standardized (Cohen) differences for squat jump, countermovement jump horizontal jump, 10-, and 20-m linear sprint according to vertical and horizontal force production interventions. Error bars indicate uncertainty in true mean changes with 90% confidence intervals. Since lower time in sprint protocols are related with better performance, the outcomes for 10 and 20 m were changed from negative to positive, and vice versa. This decision was made for a better interpretation of the results.

Section: Original Investigation

Article Title: Effects of Plyometric vs Optimum Power Training on Components of Physical Fitness in Young Male Soccer Players

Authors: João Ribeiro,[1,2] Luís Teixeira,[3] Rui Lemos,[1] Anderson Santiago Teixeira,[4] Vitor Moreira,[1] Pedro Silva,[5,6] and Fábio Yuzo Nakamura.[7,8,9]

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Journal: *International Journal of Sports Physiology and Performance*

Acceptance Date: April 29, 2019

DOI: https://doi.org/10.1123/ijspp.2019-0039

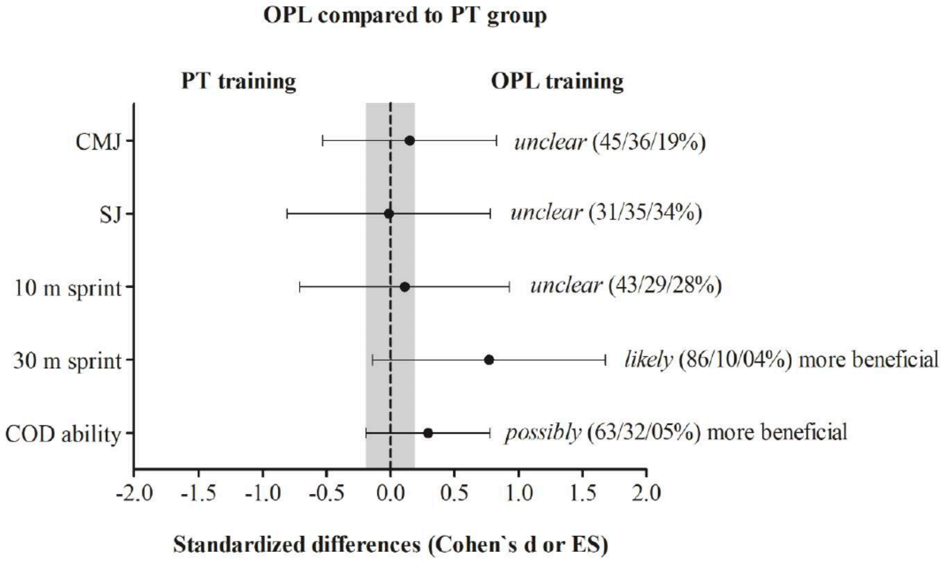

Figure 3. Efficiency of Optimum power load (OPL) compared to Plyometric training (PT) to improve countermovement (CMJ), and squat jump, (SJ), 10 and 30 m sprint, and COD performance. Bars indicate uncertainty in the true mean changes (with 90% confidence limits). Grey area represents the smallest worthwhile change

Conclusion

- Force Vector Theory is Legit but Just One of Many Forms of Specificity
- Vertical Plyos and Squats are Better for Jumping
- Horizontal Plyos and Hip Thrusts are Better for Sprint Acceleration
- Hip Thrusts May Work Better on Younger and Lesser Developed Athletes
- Do it All For Maximal Performance Improvements