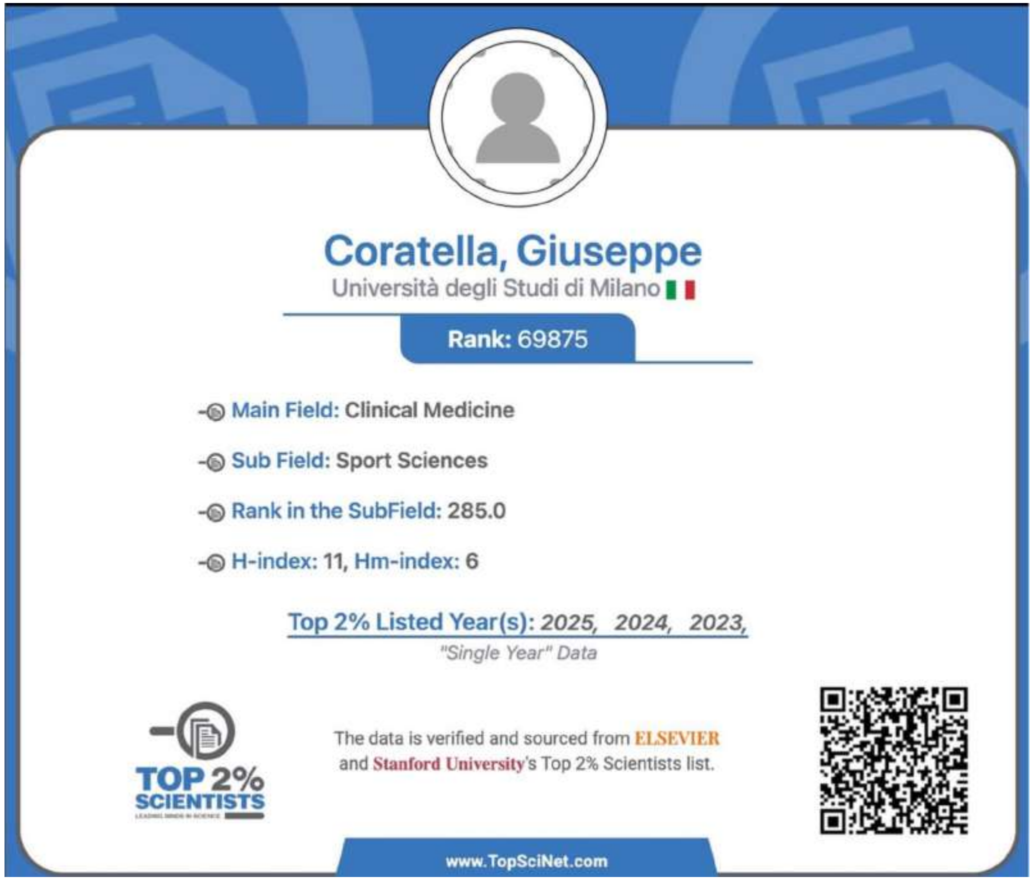

“Performing Fast
-> Training Fast?
Il ruolo della
velocità
nell’allenamento
di forza”
Prof. Giuseppe Coratella, Ph.D.,
Università degli Studi di Milano

Chi sono? SAPERE



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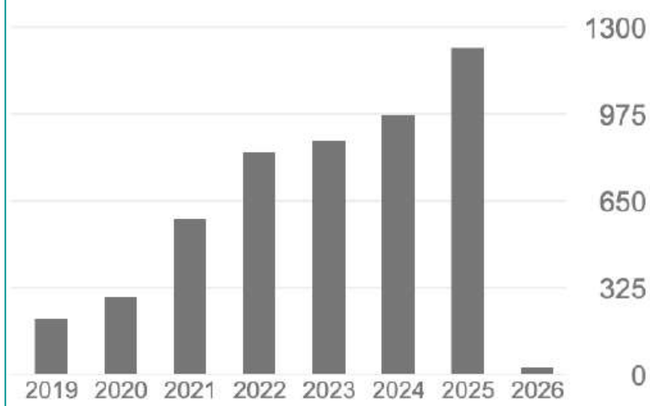
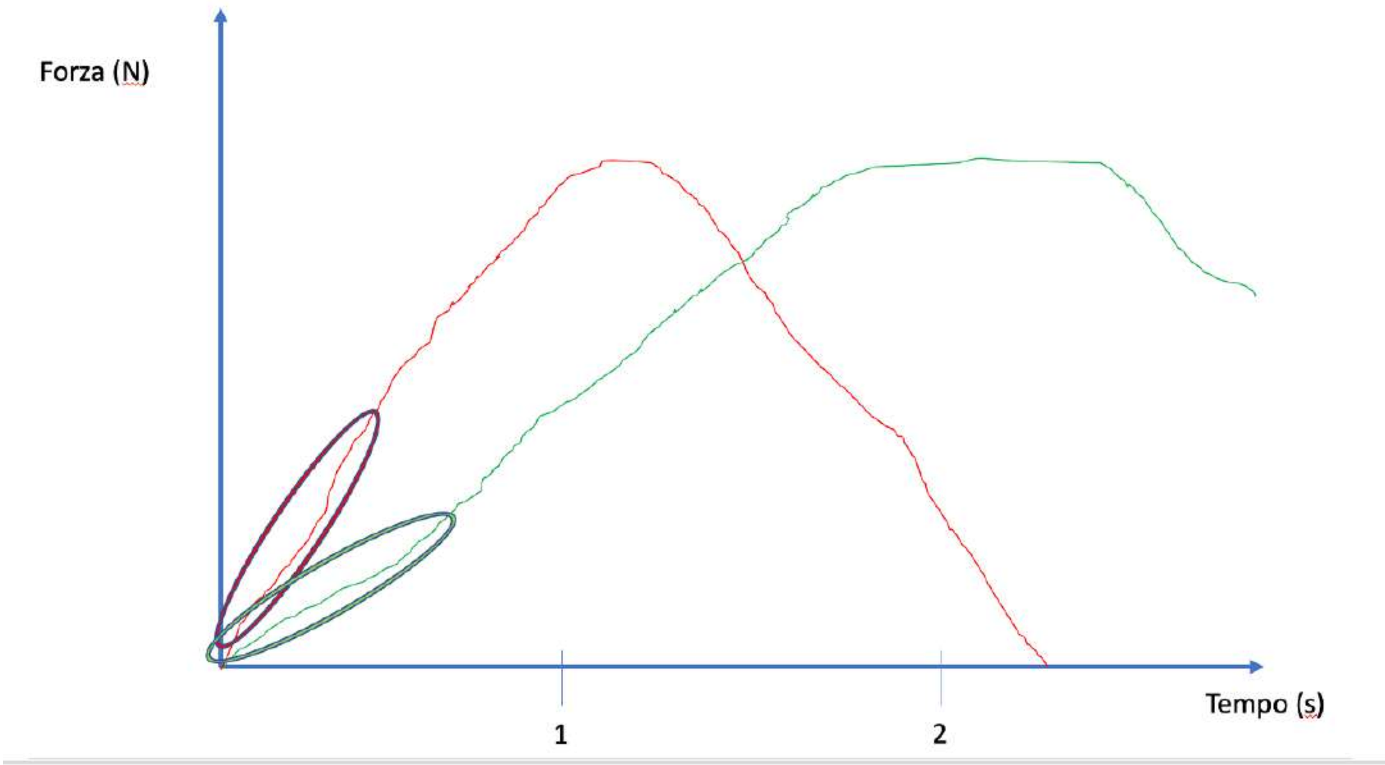


Chi sono? SAPER FARE

Chi sono?SAPER FAR FARE

Performing fast: come quantificare la prestazione rapida?

Rate of Force Development



RFD: come si misura?

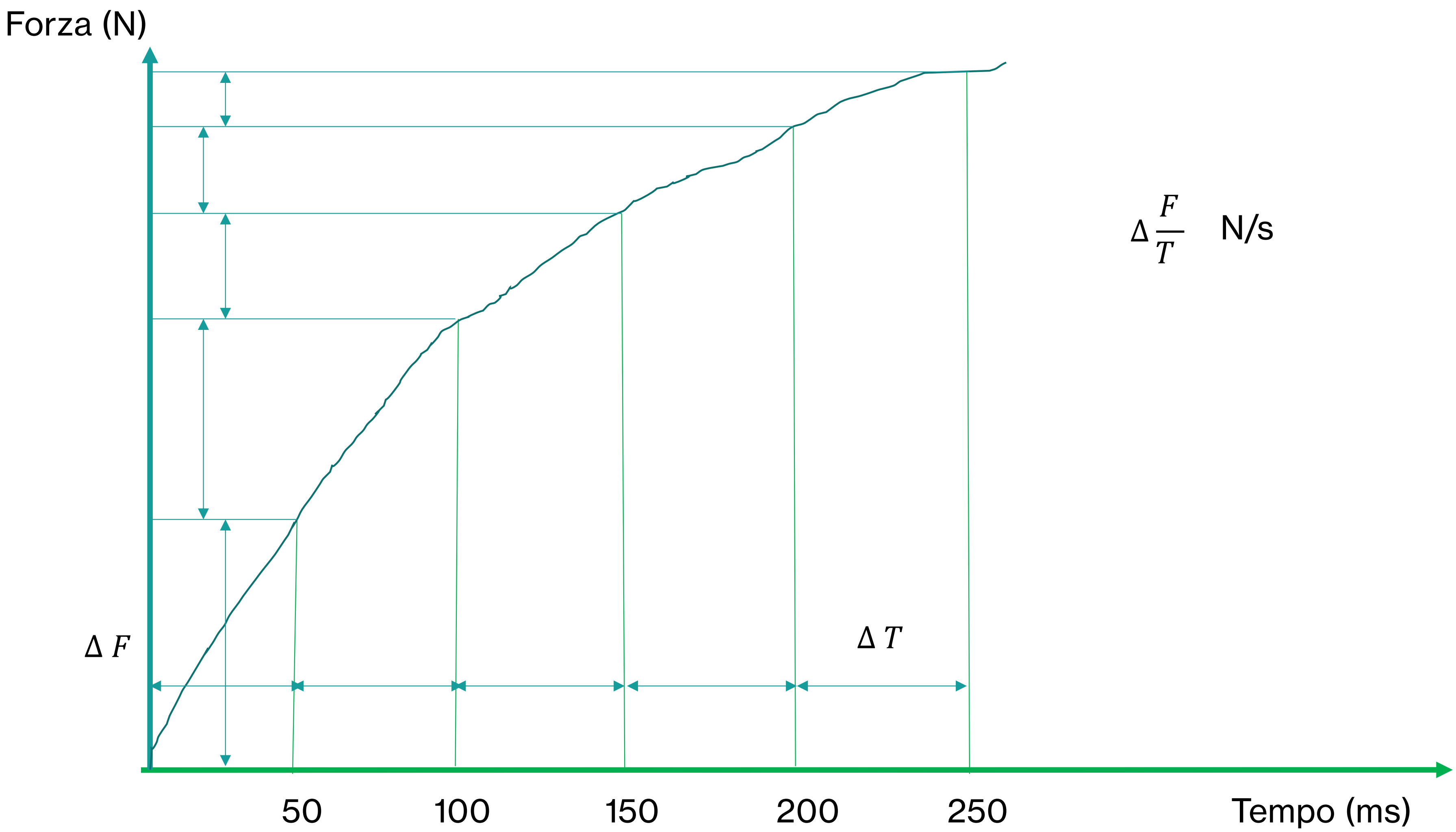
1. Rapporto Δ Forza/ Δ Tempo (intervalli 50ms, vedi sotto)
2. Time to peak: Tempo necessario per arrivare a:

- MVC
- 50% MVC

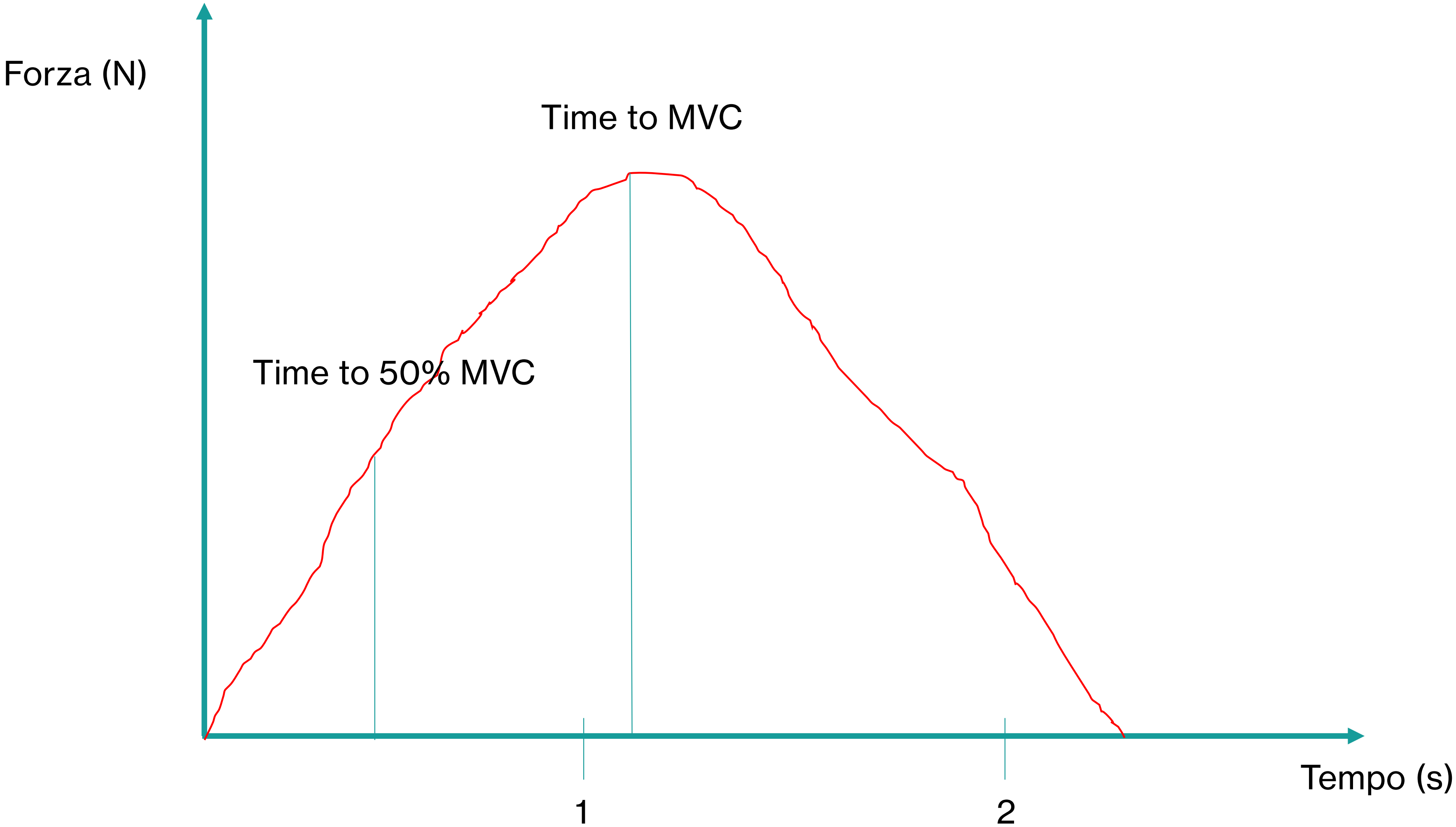
3. Forza espressa dopo:

- 50ms
- 100ms
- 150ms
- 200ms
- 250ms

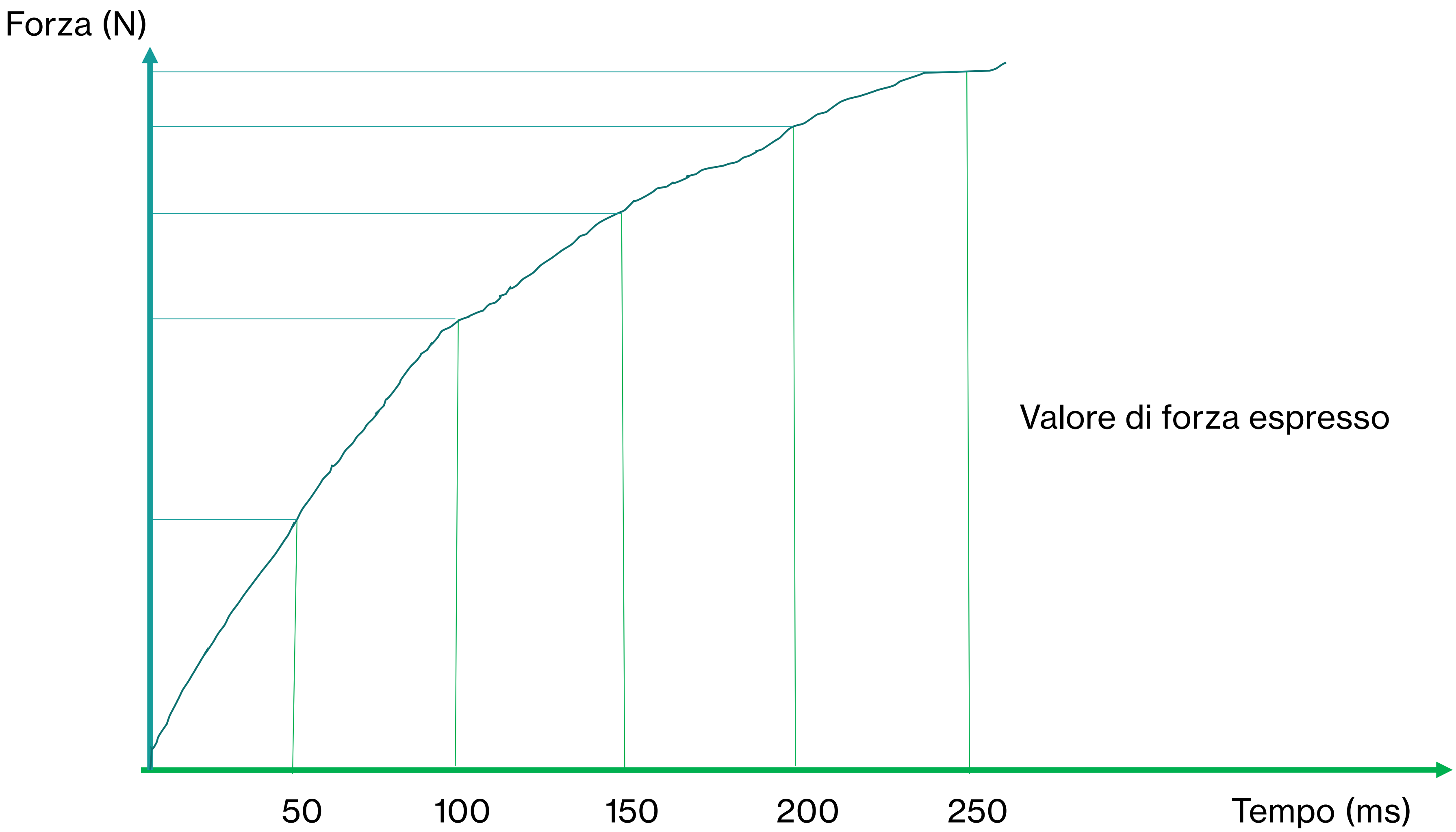
RFD



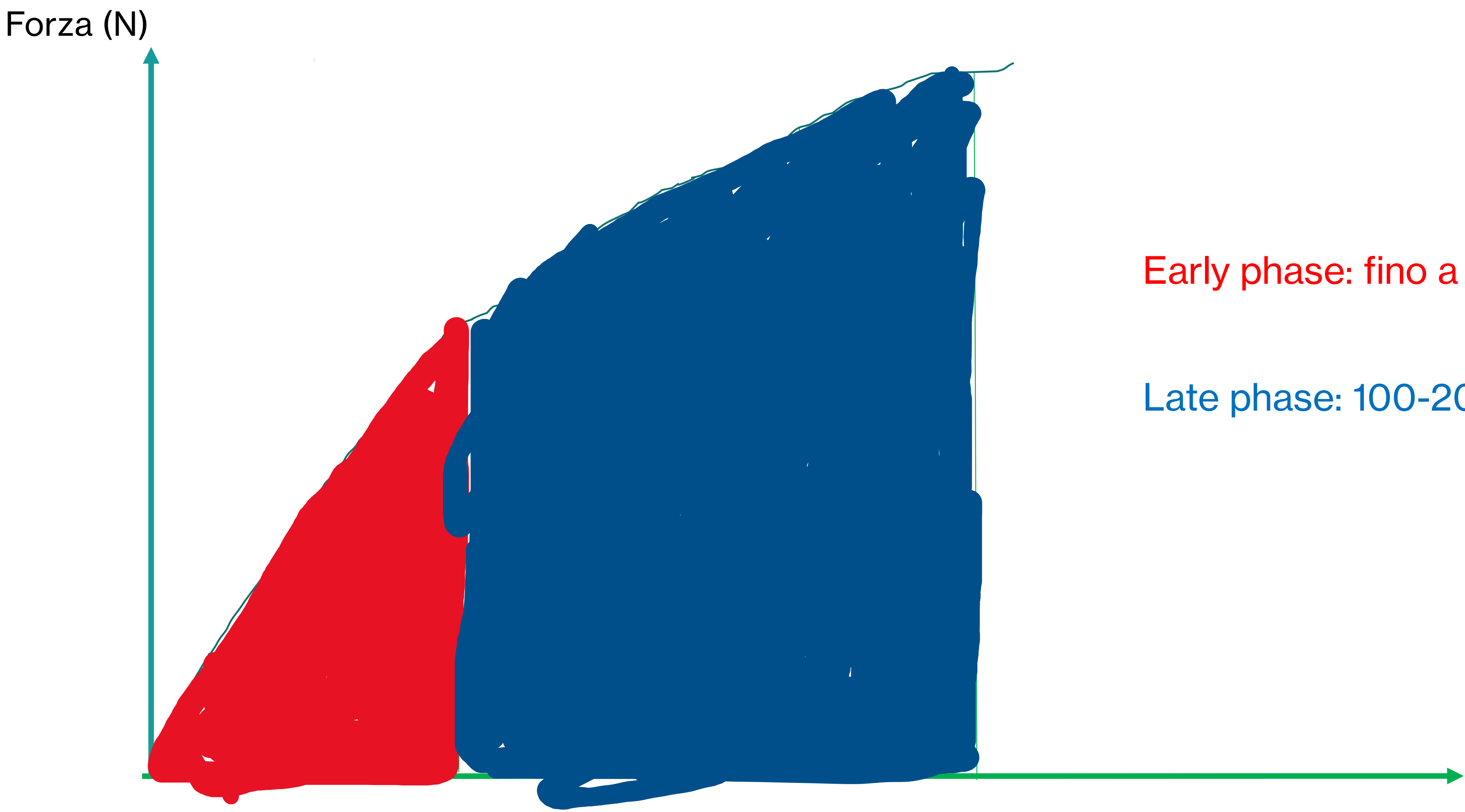
RFD: time to peak



RFD



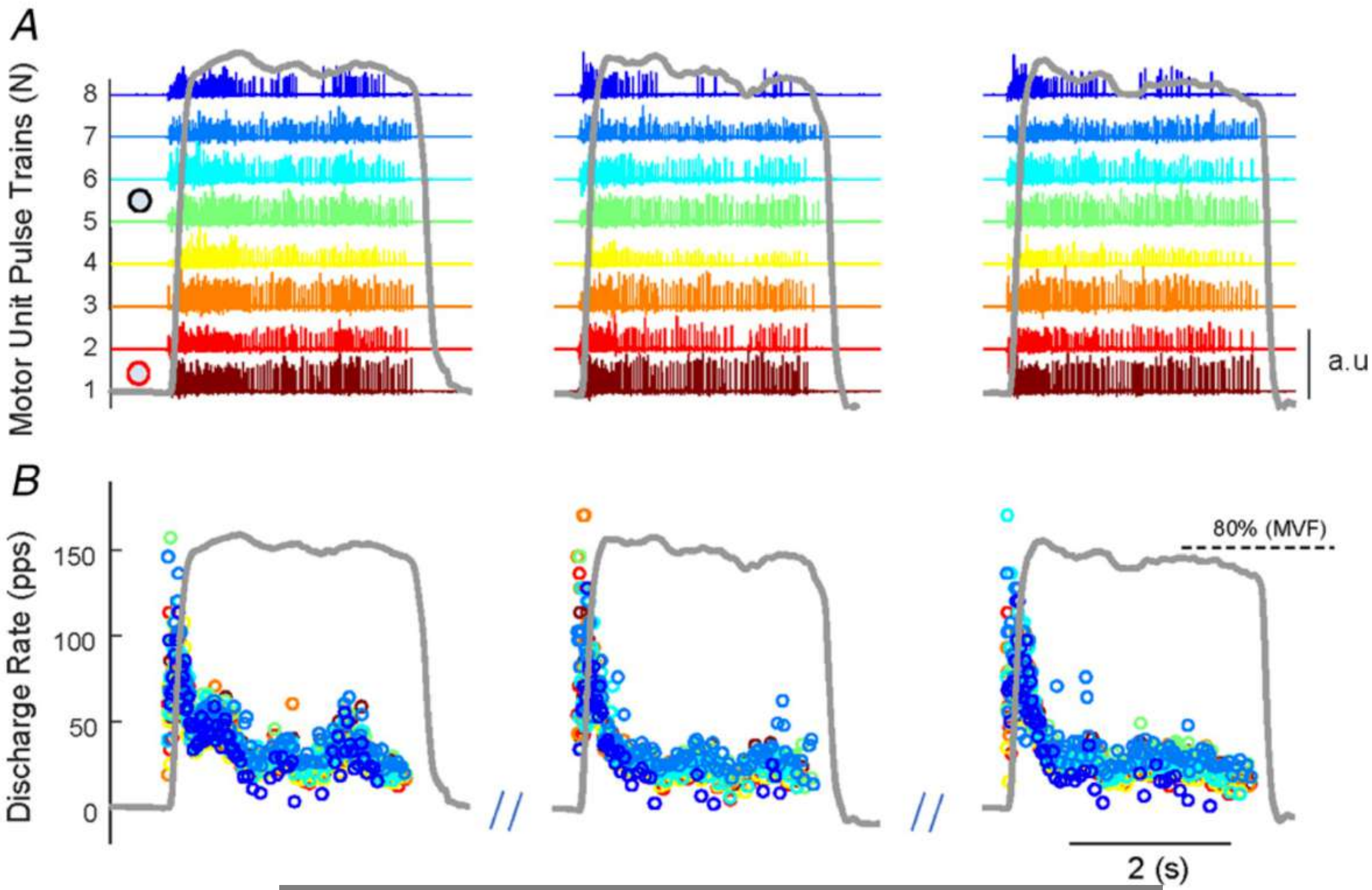
RFD



Early phase: fino a 100 ms

Late phase: 100-200/250 ms

Del Vecchio et al., 2019 *J Physiol*



Ogni colore: 1 unità motoria

Late phase RFD: struttura del muscolo

- Morfologia del muscolo
  - Formazione ponti actomiosinici più rapida in fibre IIx
  - Meccanismi miofibrillari di propagazione Ca^{2+} (maggiore quantità in IIx > I)
  - Meccanismi aumento frequenza scarica per Na^{+} (maggiore quantità in IIx > I)
- Stiffness tendinea
- Dimensioni muscolo
- Architettura muscolare

Maffiuletti et al., 2016 *Eur J Appl Physiol*

Late phase RFD: dimensione e architettura muscolare

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JSAMS Journal of Science and Medicine in Sport

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Original research

Vastus intermedius muscle architecture predicts the late phase of the knee extension rate of force development in recreationally resistance-trained men

Giuseppe Coratella[a,*], Stefano Longo[a], Marta Borrelli[a], Christian Doria[a], Emiliano Cè[a,b], Fabio Esposito[a,b]

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Ruolo dello spessore muscolare

Table 1
The correlation values (above r-value; below p-value) between muscle thickness and the RFD epochs are shown. Significant correlations, reported in *italics*, were observed between VI muscle thickness and the RFD late-phase epochs.

		0–50 ms	50–100 ms	100–150 ms	150–200 ms	200–250 ms
VL	r-value	0.307	0.050	0.005	0.181	0.214
	p-value	0.266	0.859	0.987	0.519	0.444
RF	r-value	0.050	0.157	0.049	0.166	0.211
	p-value	0.858	0.577	0.864	0.553	0.450
VI	r-value	0.455	0.271	*0.694*	*0.597*	*0.546*
	p-value	0.089	0.328	*0.004*	*0.019*	*0.045*
VM	r-value	0.173	0.075	0.090	0.108	0.145
	p-value	0.537	0.790	0.750	0.700	0.606

VL: vastus lateralis; RF: rectus femoris; VI: vastus intermedius; VM: vastus medialis.

Ruolo della lunghezza dei fascicoli

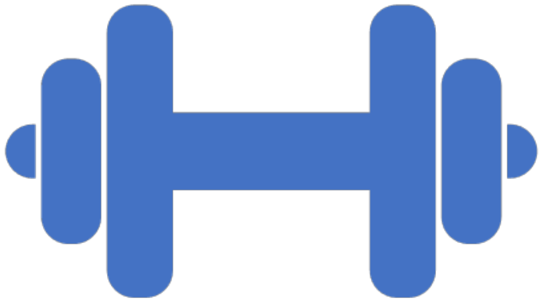
Table 3
The correlation values (above r-value; below p-value) between normalized fascicle length and the RFD epochs are shown. Significant correlations, reported in *italics*, were observed between VI muscle thickness and the RFD late-phase epochs.

		0–50 ms	50–100 ms	100–150 ms	150–200 ms	200–250 ms
VL	r-value	0.368	0.378	*0.535*	*0.629*	*0.563*
	p-value	0.177	0.133	*0.049*	*0.016*	*0.046*
RF	r-value	0.259	0.295	0.278	0.165	0.437
	p-value	0.350	0.286	0.316	0.556	0.103
VI	r-value	0.335	0.363	*0.570*	*0.643*	*0.629*
	p-value	0.242	0.184	*0.043*	*0.010*	*0.012*
VM	r-value	−0.097	−0.010	−0.018	0.121	0.203
	p-value	0.742	0.973	0.952	0.681	0.487

VL: vastus lateralis; RF: rectus femoris; VI: vastus intermedius; VM: vastus medialis.

Late phase RFD e struttura del muscolo

- Dimensione muscolo correlata maggiore late phase RFD
- Fascicoli più lunghi aiutano sviluppo late phase RFD
- Importante perché questi parametri sono modificabili con l'allenamento
- No correlazioni con early phase



Performing fast: come quantificare la prestazione rapida?

Grafico di Hill

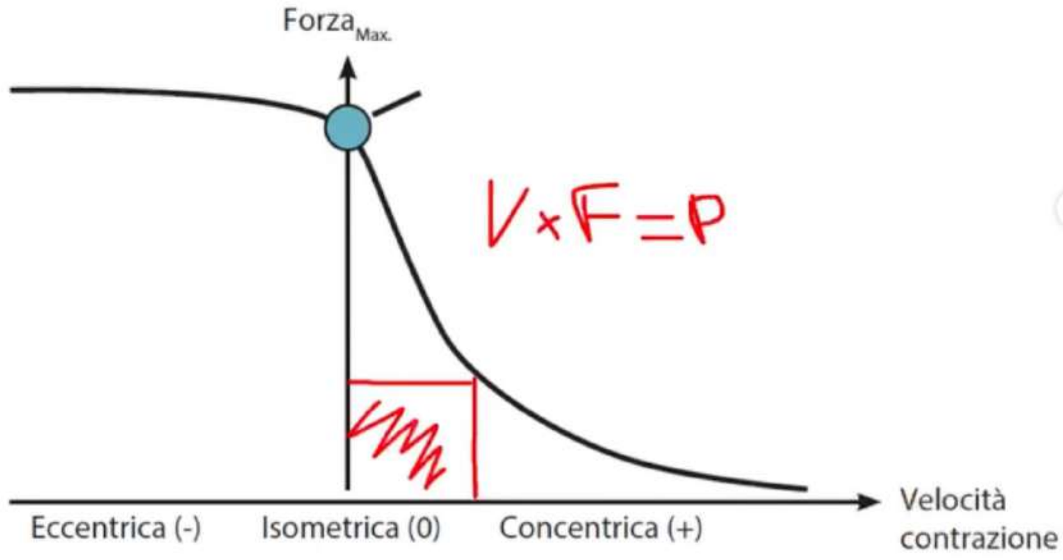


Figura 3 - Schematizzazione del grafico di Hill. Si noti che ci si riferisce a espressioni di forz massimale.

Carico/Vel_{max}

Performing fast: come quantificare la prestazione rapida?

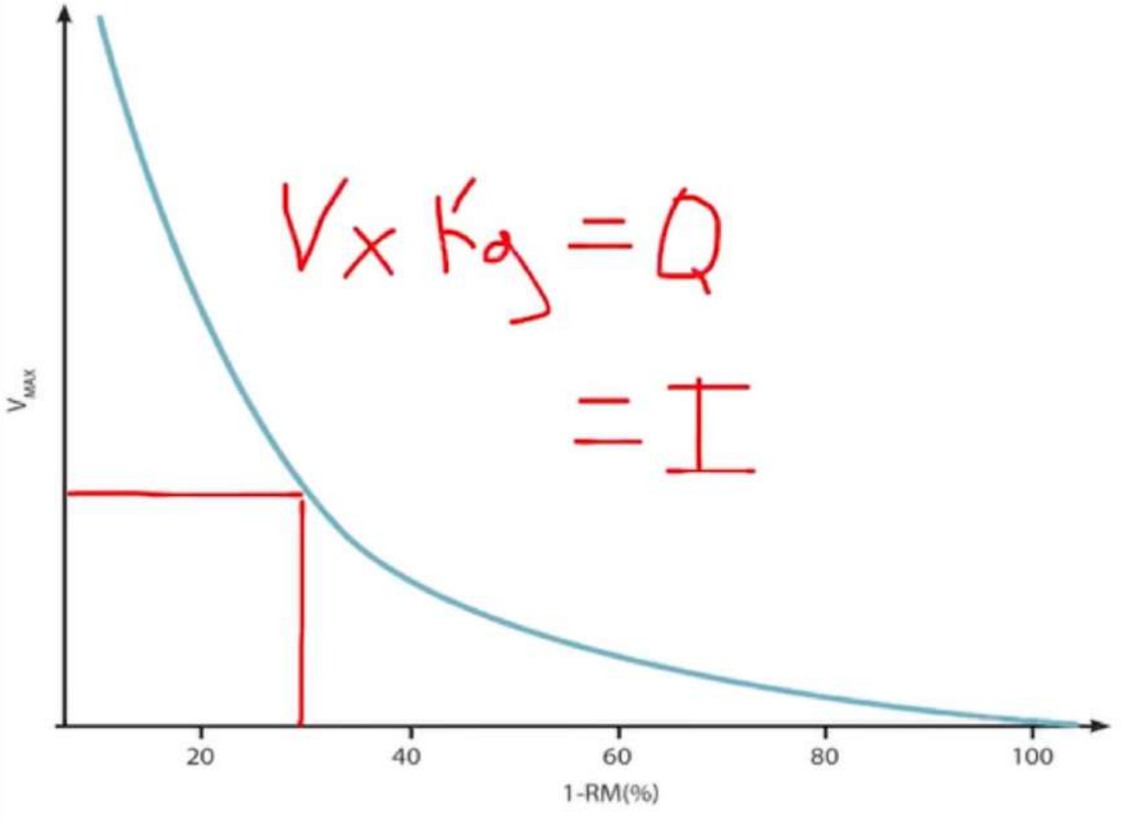


Figura 22 - Schematizzazione del rapporto tra carico esterno espresso in 1-RM(%) e velocità massima di spostamento del carico esterno.

Velocità/forza vs carico/velocità

- Velocità/forza: la forza MAX che il muscolo esprime dipende dalla velocità alla quale viene espressa

- Carico/velocità: la velocità MAX di spostamento di un carico dipende dall'entità dello stesso

Dal libro «**Scienza Forza Ipertrofia**», Prof. Giuseppe Coratella Ph.D., Giacomo Catalani Editore

Allenare l'RFD con allenamento «tradizionale»

Sports Medicine (2020) 50:943–963
https://doi.org/10.1007/s40279-019-01239-x

SYSTEMATIC REVIEW

Effects of Resistance Training Movement Pattern and Velocity on Isometric Muscular Rate of Force Development: A Systematic Review with Meta-analysis and Meta-regression

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Published online: 8 February 2020

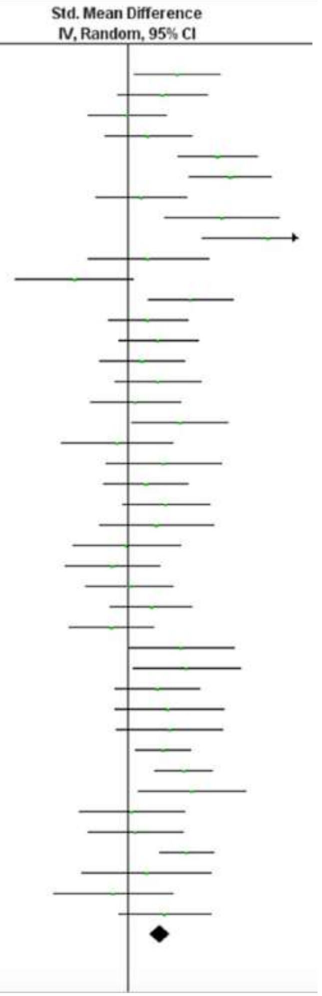
Early phase

a

Study	Post-Training Mean	Post-Training SD	Post-Training Total	Pre-Training Mean	Pre-Training SD	Pre-Training Total	Weight	Std. Mean Difference IV, Random, 95% CI
Early Phase 30 - 100 ms								
Aagaard et al. 2002 [16]	2,201	410.54	15	1,802	468.63	15	1.1%	0.88 [0.13, 1.64]
Balshaw et al. 2016_EC [80]	57	23	13	43	20	13	1.1%	0.63 [-0.16, 1.42]
Balshaw et al. 2016_SC [80]	47	19	16	47	21	16	1.2%	0.00 [-0.69, 0.69]
Behrens et al. 2014 [37]	1,076.32	355.29	13	943.73	333.2	13	1.1%	0.37 [-0.40, 1.15]
Blazevich et al. 2008 G.2 [22]	897.1	56.7	21	790.3	72.9	21	1.2%	1.60 [0.90, 2.31]
Blazevich et al. 2008a [22]	918	63.6	21	790.3	72.9	21	1.2%	1.83 [1.10, 2.56]
Branislav et al. 2013_S [31]	4,362.69	1,633.53	12	3,920.95	1,680.92	12	1.1%	0.26 [-0.55, 1.06]
Cadore et al. 2014 Con [29]	935.9	146	11	663.1	166	11	0.8%	1.68 [0.68, 2.68]
Cadore et al. 2014 Ecc [29]	855.5	136.4	11	578.8	63.7	11	0.6%	2.50 [1.33, 3.67]
Carroll et al. 2018_RI [81]	4,613	2,768	7	3,646	2,034	7	0.7%	0.37 [-0.69, 1.43]
Carroll et al. 2018_RM [81]	3,466	2,118	8	5,534	2,060	8	0.8%	-0.94 [-1.98, 0.11]
Doeringer et al. 2018_PT1 [82]	0.2	0.07	16	0.13	0.05	16	1.1%	1.12 [0.37, 1.87]
Doeringer et al. 2018_PT2 [82]	0.36	0.14	16	0.31	0.12	16	1.2%	0.37 [-0.33, 1.07]
Doeringer et al. 2018_PT3 [82]	0.19	0.08	16	0.15	0.06	16	1.2%	0.55 [-0.16, 1.26]
Ema et al. 2018_HFG [39]	349.5	236.5	14	282.2	255.4	14	1.2%	0.27 [-0.48, 1.01]
Ema et al. 2018_HFGb [39]	378	237	14	251.6	208.5	14	1.1%	0.55 [-0.21, 1.31]
Ema et al. 2018_KEG [39]	204.3	157.8	12	181.2	141.3	12	1.1%	0.15 [-0.65, 0.95]
Ema et al. 2018_KEGb [39]	335	113.6	12	213.5	137.8	12	1.0%	0.93 [0.08, 1.78]
Farup et al. 2014_KE [40]	1,937	306	7	1,979	125	9	0.8%	-0.18 [-1.17, 0.81]
Farup et al. 2014_KF [40]	1,229	163	7	1,125	145	9	0.8%	0.64 [-0.38, 1.66]
Geertsen et al. 2008 [41]	6.05	3.29	14	4.98	2.88	14	1.2%	0.34 [-0.41, 1.08]
Holtermann et al. 2007 [34]	260.6	73.5	14	203.3	87.7	14	1.1%	0.69 [-0.08, 1.45]
Jenkins et al. 2016 HLoad [43]	686.25	302.8	7	542.77	229	9	0.8%	0.52 [-0.49, 1.52]
Jenkins et al. 2016 LLoad [43]	669.95	360.58	8	677.39	363.67	9	0.9%	-0.02 [-0.97, 0.93]
Lamont et al. 2009 SQT [35]	1,512.69	1,688.76	11	2,015.43	1,964.07	11	1.0%	-0.26 [-1.10, 0.58]
Lamont et al. 2009 SQTV [35]	2,443.46	1,483.58	13	2,386.58	2,397.11	13	1.1%	0.03 [-0.74, 0.80]
Mangine et al. 2016 INT [68]	9,151	954	15	7,311	5,820	15	1.2%	0.43 [-0.30, 1.15]
Mangine et al. 2016 VOL [68]	6,262	987	14	7,325	5,125	14	1.2%	-0.28 [-1.02, 0.47]
Manolopoulos et al. 2016R [51]	1.48	0.83	10	0.84	0.35	10	0.9%	0.96 [0.02, 1.90]
Manolopoulos et al. 2016S [51]	1.53	0.79	10	0.83	0.43	10	0.9%	1.05 [0.10, 2.00]
Mosti et al. 2014 [83]	2,396.5	1,184.1	14	1,743.2	1,172.1	15	1.2%	0.54 [-0.20, 1.28]
Oliveira et al. 2013 [70]	2,398.4	479.6	9	1,958.79	640.3	9	0.8%	0.74 [-0.22, 1.70]
Terzis et al. 2016 [84]	7,039	2,834	9	4,471	3,593	10	0.9%	0.75 [-0.19, 1.69]
Thompson et al. 2015 KE [75]	737.3	184.7	34	580.8	284.8	34	1.7%	0.64 [0.16, 1.13]
Thompson et al. 2015 KF [75]	297.5	98.8	34	199.6	94.6	34	1.6%	1.00 [0.49, 1.51]
Tillin et al. 2014_EST [19]	1.89	0.65	10	1.23	0.43	10	0.8%	1.15 [0.18, 2.11]
Tillin et al. 2014_MST [19]	1.7	0.72	9	1.64	0.71	9	0.9%	0.08 [-0.84, 1.00]
Tsitkanou et al. 2017 [52]	11,753.72	5,423.08	11	11,061.9	4,028.42	11	1.0%	0.14 [-0.70, 0.98]
Vanderka et al. 2016 [85]	5.9	1.4	36	4.3	1.6	40	1.7%	1.05 [0.57, 1.53]
Zaras et al. 2014_HT [46]	13,564.5	10,013.7	6	10,420	6,082.2	6	0.7%	0.35 [-0.79, 1.49]
Zaras et al. 2014_LT [46]	9,158.6	4,114.9	7	10,290.7	4,303.1	7	0.8%	-0.25 [-1.31, 0.80]
Zaras et al. 2016 [86]	13,320	4,542	12	10,176	4,511	12	1.0%	0.67 [-0.16, 1.50]
Subtotal (95% CI)			**569**			**582**	**43.8%**	**0.58 [0.40, 0.75]**

Heterogeneity: $Tau^2 = 0.16$; $Chi^2 = 81.19$, $df = 41$ ($P = 0.0002$); $I^2 = 50\%$

Test for overall effect: $Z = 6.49$ ($P < 0.00001$)



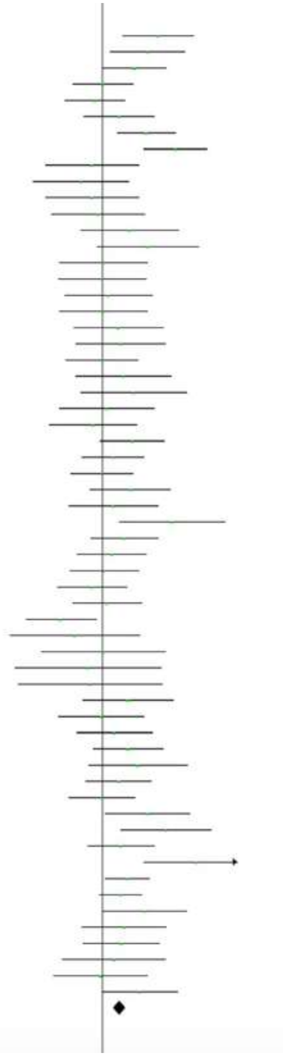
Late phase

Late Phase 150 - 250 ms

Aagaard et al. 2002 [16]	1,363	170.41	15	1,141	174.28	15	1.1%	1.25 [0.46, 2.05]
Balshaw et al. 2016_EC [80]	210	35	13	177	27	13	1.0%	1.02 [0.20, 1.85]
Balshaw et al. 2016_SC [80]	204	25	16	182	34	16	1.2%	0.72 [0.00, 1.44]
Bazyler et al.2015_120 [33]	5,746.8	1,553.12	17	5,714.56	1,949.96	17	1.3%	0.02 [-0.65, 0.69]
Bazyler et al.2015_90 [33]	3,170.48	753.9	17	3,288.06	725.55	17	1.3%	-0.16 [-0.83, 0.52]
Behrens et al. 2014 [37]	737.46	212.46	13	654.06	205.34	13	1.1%	0.39 [-0.39, 1.16]
Blazevich et al. 2008 G.2 [22]	744.5	43.6	21	699.4	45.7	21	1.3%	0.99 [0.35, 1.64]
Blazevich et al. 2008a [22]	772.8	42	21	699.4	45.7	21	1.2%	1.64 [0.93, 2.35]
Bogdanis et al. 2019_IP145_084 [87]	5,844	1,917	7	6,220	1,345	7	0.8%	-0.21 [-1.26, 0.84]
Bogdanis et al. 2019_IP145_100 [87]	6,654	2,046	7	7,547	1,484	7	0.7%	-0.47 [-1.54, 0.60]
Bogdanis et al. 2019_IP145_116 [87]	8,117	2,368	7	8,651	2,274	7	0.8%	-0.22 [-1.27, 0.84]
Bogdanis et al. 2019_IP145_131 [87]	11,281	3,265	7	11,498	1,983	7	0.8%	-0.08 [-1.12, 0.97]
Bogdanis et al. 2019_IP145_146 [87]	14,115	2,779	7	11,977	3,591	7	0.7%	0.62 [-0.46, 1.71]
Bogdanis et al. 2019_IP145_162 [87]	12,681	4,390	7	9,011	1,706	7	0.7%	1.03 [-0.11, 2.17]
Bogdanis et al. 2019_IP85_084 [87]	5,726	2,483	8	5,648	2,437	8	0.8%	0.03 [-0.95, 1.01]
Bogdanis et al. 2019_IP85_100 [87]	6,920	2,810	8	6,896	2,240	8	0.8%	0.01 [-0.97, 0.99]
Bogdanis et al. 2019_IP85_116 [87]	9,165	2,641	8	8,745	2,696	8	0.8%	0.15 [-0.83, 1.13]
Bogdanis et al. 2019_IP85_131 [87]	10,897	3,427	8	10,782	3,729	8	0.8%	0.03 [-0.95, 1.01]
Bogdanis et al. 2019_IP85_146 [87]	11,744	3,435	8	10,377	3,514	8	0.8%	0.37 [-0.62, 1.36]
Bogdanis et al. 2019_IP85_162 [87]	8,978	3,658	8	7,479	3,077	8	0.8%	0.42 [-0.57, 1.41]
Branislav et al. 2013_S [31]	11,577.37	2,864.39	12	11,576.44	3,916.62	12	1.1%	0.00 [-0.80, 0.80]
Burgess et al. 2007_ET [14]	4,270	1,021.26	7	3,813	695.83	7	0.7%	0.49 [-0.58, 1.56]
Burgess et al. 2007_IT [14]	3,447	734.85	6	2,691	1,170.86	6	0.6%	0.71 [-0.47, 1.90]
Carroll et al. 2018_RI [81]	8,821	4,580	7	8,364	2,623	7	0.8%	0.11 [-0.93, 1.16]
Carroll et al. 2018_RM [81]	8,307	3,058	8	8,813	1,681	8	0.8%	-0.19 [-1.18, 0.79]
Doeringer et al. 2018_PT1 [82]	0.21	0.09	16	0.15	0.08	16	1.2%	0.69 [-0.03, 1.40]
Doeringer et al. 2018_PT2 [82]	0.42	0.14	16	0.39	0.09	16	1.2%	0.25 [-0.45, 0.94]
Doeringer et al. 2018_PT3 [82]	0.2	0.04	16	0.2	0.06	16	1.2%	0.00 [-0.69, 0.69]
Driggers and Sato 2018 [36]	5,249.38	1,774.83	10	4,231.01	1,236.03	10	0.9%	0.64 [-0.27, 1.54]
Farup et al. 2014_KE [40]	1,737	159	7	1,700	109	9	0.8%	0.26 [-0.73, 1.26]
Farup et al. 2014_KF [40]	1,106	110	7	930	102	9	0.6%	1.58 [0.41, 2.75]
Geertsen et al. 2008 [41]	31.1	10.03	14	25.87	9.92	14	1.1%	0.51 [-0.25, 1.26]
Gordon et al. 2018_ETG_KE [88]	678.8	251.1	13	623.9	221.4	13	1.1%	0.22 [-0.55, 1.00]
Gordon et al. 2018_ETG_KF [88]	422.2	160.3	13	413.3	161.6	13	1.1%	0.05 [-0.72, 0.82]
Gordon et al. 2018_TLPG_KE [88]	770.7	230.6	13	823.4	247.2	13	1.1%	-0.21 [-0.98, 0.56]
Gordon et al. 2018_TLPG_KF [88]	498.9	218.9	13	472.5	222.5	13	1.1%	0.12 [-0.65, 0.89]
Holtermann et al. 2007 [34]	123.8	51.7	14	172.6	51.8	14	1.1%	-0.92 [-1.70, -0.13]
Hornsby et al. 2017_M_W10 [89]	14,563	2,933	4	16,652	3,042	4	0.5%	-0.61 [-2.06, 0.84]
Hornsby et al. 2017_M_W20 [89]	16,772	3,210	4	16,652	3,042	4	0.5%	0.03 [-1.35, 1.42]
Hornsby et al. 2017_W_W10 [89]	7,069	1,476	3	7,663	1,581	3	0.4%	-0.31 [-1.94, 1.32]
Hornsby et al. 2017_W_W20 [89]	7,152	1,580	3	7,663	1,581	3	0.4%	-0.26 [-1.88, 1.36]
Jenkins et al. 2016 HLoad [43]	499.8	162.38	7	417.84	104.42	9	0.8%	0.59 [-0.43, 1.60]
Jenkins et al. 2016 LLoad [43]	370.42	109.64	8	371.22	103.09	9	0.9%	-0.01 [-0.96, 0.95]
Lamont et al. 2009 SQT [35]	3,592.15	1,268.9	11	3,186.21	1,550.19	11	1.0%	0.28 [-0.56, 1.12]
Lamont et al. 2009 SQTV [35]	5,399.1	1,714.1	13	4,525.87	1,120.4	13	1.1%	0.58 [-0.20, 1.37]
Levernier et al. 2017 [90]	1,412.86	513.52	7	978.29	488.06	7	0.7%	0.81 [-0.29, 1.92]
Mangine et al. 2016 INT [68]	7,303	534	15	6,371	3,337	15	1.2%	0.38 [-0.34, 1.10]
Mangine et al. 2016 VOL [68]	5,954	553	14	5,941	2,428	14	1.2%	0.01 [-0.73, 0.75]
Manolopoulos et al. 2016R [51]	0.97	0.34	10	0.7	0.11	10	0.9%	1.02 [0.08, 1.97]
Manolopoulos et al. 2016S [51]	0.92	0.22	10	0.65	0.13	10	0.8%	1.43 [0.42, 2.44]
Mosti et al. 2014 [83]	2,689.3	681.7	14	2,362.6	809	15	1.2%	0.42 [-0.31, 1.16]
Terzis et al. 2016 [84]	8,947	1,626	9	5,292	1,685	10	0.6%	2.11 [0.93, 3.28]
Thompson et al. 2015 KE [75]	501.1	137	34	408.1	185.1	34	1.7%	0.56 [0.08, 1.05]
Thompson et al. 2015 KF [75]	248	86.3	34	208.8	98.5	34	1.7%	0.42 [-0.06, 0.90]
Tillin et al. 2014_EST [19]	5.71	0.63	10	5.05	0.7	10	0.9%	0.95 [0.01, 1.89]
Tillin et al. 2014_MST [19]	5.96	0.8	9	5.55	0.76	9	0.9%	0.50 [-0.44, 1.44]
Tsitkanou et al. 2017 [52]	12,134.39	2,259.78	11	11,081.51	2,427.31	11	1.0%	0.43 [-0.42, 1.28]
Zaras et al. 2014_HT [46]	14,096.9	5,506.2	6	12,344.6	6,223.8	6	0.7%	0.28 [-0.86, 1.41]
Zaras et al. 2014_LT [46]	12,712.8	4,192.3	7	12,837.4	4,267.2	7	0.8%	-0.03 [-1.08, 1.02]
Zaras et al. 2016 [86]	16,075	4,093	12	12,761	3,434	12	1.0%	0.85 [0.00, 1.69]
Subtotal (95% CI)			**670**			**679**	**56.2%**	**0.39 [0.25, 0.52]**

Heterogeneity: $Tau^2 = 0.08$; $Chi^2 = 83.20$, df = 59 ($P = 0.02$); $I^2 = 29\%$

Test for overall effect: $Z = 5.67$ ($P < 0.00001$)



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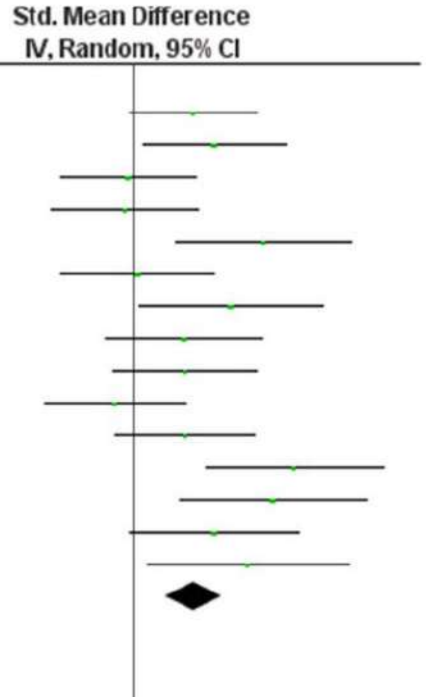
	Post-Training			Pre-Training				Std. Mean Difference
	Mean	SD	Total	Mean	SD	Total	Weight	IV, Random, 95% CI
Fast Movement Velocity								
Alegre et al. 2006 [60]	9,416	2,711	16	7,608	2,638	18	2.1%	0.66 [-0.03, 1.35]
Barak et al. 2004 Con_90 [61]	442.1	157.6	14	286.5	178.9	14	1.8%	0.90 [0.11, 1.68]
Barak et al. 2004 Ecc_90 [61]	412.8	214.8	14	426.3	309.3	14	1.9%	-0.05 [-0.79, 0.69]
Branislav et al. 2013_S [31]	864.3	285	12	896.5	437.2	12	1.8%	-0.08 [-0.88, 0.72]
Cadore et al. 2014 Con [29]	959.2	150.4	11	721.2	167.9	11	1.4%	1.44 [0.48, 2.39]
Cadore et al. 2014 Ecc [29]	874	131.4	11	584.3	6,400	11	1.7%	0.06 [-0.77, 0.90]
De Oliveira et al. 2013 [32]	2,899.1	1,247.2	9	1,787.2	625.4	9	1.3%	1.07 [0.07, 2.08]
Gruber et al. 2007BT [42]	0.75	0.23	11	0.64	0.13	11	1.6%	0.57 [-0.29, 1.42]
Kyröläinen et al. 2005_KE [21]	22,213	6,828	13	18,836	4,282	13	1.8%	0.57 [-0.21, 1.36]
Kyröläinen et al. 2005_PF [21]	20,158	7,728	13	21,657	7,696	13	1.8%	-0.19 [-0.96, 0.58]
Lamas et al. 2012_PT [66]	1,340.37	276.04	14	1,158.86	328.49	14	1.9%	0.58 [-0.18, 1.34]
Oliveira et al. 2016 [50]	1,690	280	12	1,195	260	12	1.4%	1.77 [0.80, 2.74]
Rebutini et al. 2016_HE [72]	1,217.27	512.28	10	585.66	220.07	10	1.3%	1.53 [0.51, 2.56]
Rebutini et al. 2016_KE [72]	604.43	240.42	10	427.45	116.86	10	1.4%	0.90 [-0.03, 1.83]
Winchester et al. 2008 [48]	25,343.8	12,614.4	8	12,687.5	4,644	8	1.1%	1.26 [0.16, 2.36]
Subtotal (95% CI)			**178**			**180**	**24.3%**	**0.67 [0.37, 0.97]**

Heterogeneity: $Tau^2 = 0.16$; $Chi^2 = 26.23$, df = 14 (P = 0.02); $I^2 = 47\%$

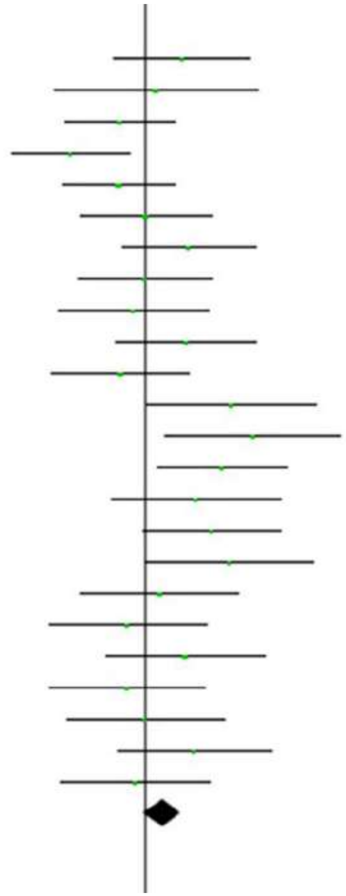
Test for overall effect: Z = 4.36 (P < 0.0001)



Slow Movement Velocity (with intent for rapid force production)								
Geertsen et al. 2008 [41]	39.91	14.52	14	33.9	13.28	14	1.9%	0.42 [-0.33, 1.17]
Haff et al. 2008 [62]	14,309	2,667.1	6	13,997.2	1,879.3	6	1.1%	0.12 [-1.01, 1.26]
Hartmann et al. 2012 BSQ [64]	11.09	1.93	20	11.67	2.15	20	2.3%	-0.28 [-0.90, 0.34]
Hartmann et al. 2012 BSQ1/4 [64]	10.42	1.88	19	12.25	2.43	19	2.2%	-0.82 [-1.49, -0.16]
Hartmann et al. 2012 FSQ [64]	10.46	2.31	20	11.22	2.79	20	2.3%	-0.29 [-0.91, 0.33]
Holtermann et al. 2007 [34]	653.2	95.2	14	495.1	12,200	14	1.9%	0.02 [-0.72, 0.76]
Laird et al. 2016 [67]	4,712.4	1,849.2	14	3,862.8	1,479.1	14	1.9%	0.49 [-0.26, 1.25]
Lamas et al. 2012_PT [66]	1,124.78	396.13	14	1,120.8	439.46	14	1.9%	0.01 [-0.73, 0.75]
Lamont et al. 2009 SQT [35]	7,739.53	2,798.8	11	8,172.45	3,584.1	11	1.7%	-0.13 [-0.97, 0.71]
Lamont et al. 2009 SQTV [35]	12,164.89	3,533.2	13	10,461.4	3,637.24	13	1.8%	0.46 [-0.32, 1.24]
Laroche et al. 2008 [44]	8.12	1.95	13	8.73	2.38	13	1.8%	-0.27 [-1.04, 0.50]
Manolopoulos et al. 2016R [51]	1.97	0.6	10	1.4	0.51	10	1.4%	0.98 [0.04, 1.92]
Manolopoulos et al. 2016S [51]	2.08	0.66	10	1.36	0.46	10	1.4%	1.21 [0.24, 2.18]
Mikkola et al. 2012 [69]	10,017	3,774	16	7,286	2,135	16	2.0%	0.87 [0.14, 1.60]
Oliveira et al. 2013 [70]	2,439	459	9	2,094	664	9	1.4%	0.58 [-0.37, 1.52]
Peltonen et al. 2018 [45]	22,107.11	6,868.724	14	16,790.46	6,804.748	14	1.8%	0.76 [-0.02, 1.53]
Ruas et al. 2018_H_1CON/CON [73]	258.68	121.57	10	155.45	84.27	10	1.4%	0.95 [0.01, 1.88]
Ruas et al. 2018_H_1CON/ECC [73]	258.57	164.33	10	234.6	100.35	10	1.6%	0.17 [-0.71, 1.05]
Ruas et al. 2018_H_1ECC/ECC [73]	220.14	89.023	10	248.35	175.5	10	1.6%	-0.19 [-1.07, 0.68]
Ruas et al. 2018_Q_1CON/CON [73]	191.85	103.92	10	148.93	74.07	10	1.5%	0.46 [-0.44, 1.35]
Ruas et al. 2018_Q_1CON/ECC [73]	161.62	108.66	10	183.76	105.72	10	1.6%	-0.20 [-1.08, 0.68]
Ruas et al. 2018_Q_1ECC/ECC [73]	169.16	108.66	10	168.31	135.83	10	1.6%	0.01 [-0.87, 0.88]
Stone et al. 2003 1-4w [74]	18,873	7,659	11	15,047	5,243	11	1.6%	0.56 [-0.29, 1.42]
Stone et al. 2003 5-8w [74]	18,000	8,357	11	18,873	7,659	11	1.7%	-0.10 [-0.94, 0.73]
Subtotal (95% CI)			**299**			**299**	**41.4%**	**0.20 [-0.01, 0.41]**

Heterogeneity: $Tau^2 = 0.09$; $Chi^2 = 35.85$, $df = 23$ ($P = 0.04$); $I^2 = 36\%$

Test for overall effect: $Z = 1.90$ ($P = 0.06$)

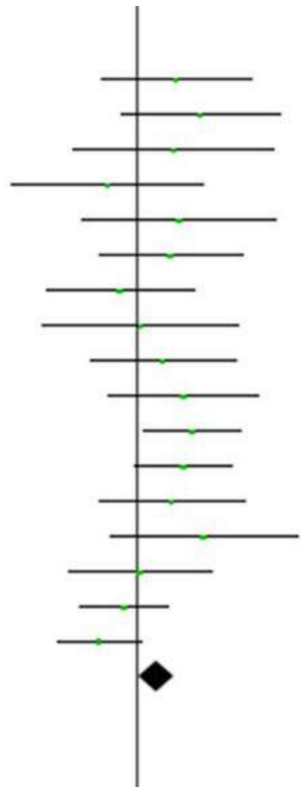


Slow Movement Velocity (without intent for rapid force production)

Barak et al. 2004 Con_30 [61]	439.7	221.9	14	357.42	171.3	14	1.9%	0.40 [-0.35, 1.15]
Barak et al. 2004 Ecc_30 [61]	395.6	159.8	13	296.2	134.9	13	1.8%	0.65 [-0.14, 1.44]
Jenkins et al. 2016 HLoad [43]	1,427.09	612.53	7	1,228.28	383.8	9	1.3%	0.38 [-0.62, 1.38]
Jenkins et al. 2016 LLoad [43]	1,082.24	505.37	8	1,235.24	507.37	9	1.4%	-0.29 [-1.25, 0.67]
Kubo et al. 2001 [65]	343	71	9	302	107	8	1.4%	0.43 [-0.53, 1.40]
Mangine et al. 2016 INT [68]	10,687	919	15	9,216	5,718	15	2.0%	0.35 [-0.37, 1.07]
Mangine et al. 2016 VOL [68]	8,263	951	14	8,880	5,251	14	1.9%	-0.16 [-0.90, 0.58]
Mueller et al. 2015 [78]	1,116	250	8	1,102	279	8	1.3%	0.05 [-0.93, 1.03]
Nie et al. 2010 [79]	978	445	15	847	486	15	2.0%	0.27 [-0.45, 0.99]
Peltonen et al. 2018a [71]	18,222	6,336.211	14	15,383.85	5,092.59	14	1.9%	0.48 [-0.27, 1.23]
Thompson et al. 2015 KE [75]	835.6	236.2	34	668.9	337	34	2.9%	0.57 [0.08, 1.05]
Thompson et al. 2015 KF [75]	370.1	127.2	34	305.1	141.1	34	2.9%	0.48 [-0.00, 0.96]
Vangsgaard et al. 2014 [49]	1,057.8	446.8	15	897.2	417.3	15	2.0%	0.36 [-0.36, 1.08]
Vila-Cha et al. 2010 [47]	4,396.8	1,532.4	9	3,297.5	1,561.4	10	1.4%	0.68 [-0.25, 1.61]
Wirth et al. 2015 [76]	11.6	2.6	15	11.5	2.3	15	2.0%	0.04 [-0.68, 0.76]
Wirth et al. 2016 LP [77]	11.2	2.3	40	11.5	2.6	40	3.1%	-0.12 [-0.56, 0.32]
Wirth et al. 2016 SQ [77]	12.4	2.3	43	13.3	2.6	43	3.2%	-0.36 [-0.79, 0.06]
Subtotal (95% CI)			**307**			**310**	**34.4%**	**0.20 [0.03, 0.38]**

Heterogeneity: $Tau^2 = 0.02$; $Chi^2 = 18.20$, df = 16 (P = 0.31); $I^2 = 12\%$

Test for overall effect: Z = 2.28 (P = 0.02)



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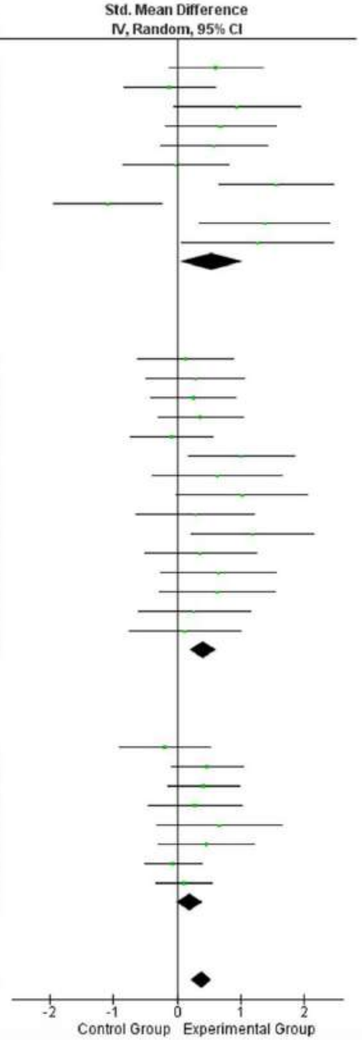
	Experimental Group Mean	Experimental Group SD	Experimental Group Total	Control Group Mean	Control Group SD	Control Group Total	Weight	Std. Mean Difference IV, Random, 95% CI
Fast Movement Velocity								
Alegre et al. 2006 [60]	1,808	3,625.06	16	-706	4,503.67	14	3.3%	0.60 [-0.13, 1.34]
Branislav et al. 2013_S [31]	-32.2	464.74	12	13.23	310.57	20	3.4%	-0.12 [-0.83, 0.60]
De Oliveira et al. 2013 [32]	1,111.9	1,185.86	9	127.7	747.98	9	2.1%	0.95 [-0.04, 1.93]
Gruber et al. 2007BT [42]	0.11	0.24	11	-0.06	0.24	11	2.6%	0.68 [-0.18, 1.55]
Kyröläinen et al. 2005_KE [21]	3,377	7,250.06	13	-1,324	8,465.1	10	2.7%	0.58 [-0.26, 1.43]
Kyröläinen et al. 2005_PF [21]	-1,499	9,810.95	13	-1,324	8,465.1	10	2.8%	-0.02 [-0.84, 0.81]
Lamas et al. 2012_PT [66]	181.51	389.27	14	-551.15	520.15	12	2.5%	1.56 [0.66, 2.46]
Laroche et al. 2008 [44]	-0.61	2.76	13	3.14	3.9	12	2.7%	-1.08 [-1.93, -0.23]
Oliveira et al. 2016 [50]	495	340.26	12	20	315.08	8	2.1%	1.38 [0.36, 2.39]
Winchester et al. 2008 [48]	12,656.3	11,141.73	8	891.7	2,809.52	6	1.6%	1.27 [0.07, 2.46]
Subtotal (95% CI)			**121**			**112**	**25.8%**	**0.54 [0.05, 1.03]**
Heterogeneity: Tau² = 0.43; Chi² = 28.51, df = 9 (P = 0.0008); I² = 68%								
Test for overall effect: Z = 2.14 (P = 0.03)								
Slow Movement Velocity (with intent for rapid force production)								
Hartmann et al. 2009 DUP [63]	-0.01	2.63	14	-0.41	2.96	13	3.2%	0.14 [-0.62, 0.89]
Hartmann et al. 2009 SPP [63]	0.22	0.38	13	-0.41	2.96	13	3.1%	0.29 [-0.48, 1.06]
Hartmann et al. 2012 BSQ [64]	-0.76	3.4	20	-1.58	2.68	16	3.8%	0.26 [-0.40, 0.92]
Hartmann et al. 2012 BSQ1/4 [64]	-0.58	2.63	19	-1.58	2.68	16	3.7%	0.37 [-0.30, 1.04]
Hartmann et al. 2012 FSQ [64]	-1.83	2.95	20	-1.58	2.68	16	3.8%	-0.09 [-0.74, 0.57]
Lamas et al. 2012_ST [66]	3.98	536.77	14	-551.15	520.15	12	2.8%	1.02 [0.19, 1.84]
Lamont et al. 2009 SQT [35]	-432.92	4,000.11	11	-3,421.06	5,261.8	6	2.0%	0.64 [-0.39, 1.66]
Lamont et al. 2009 SQTV [35]	1,703.49	4,561.47	13	-3,421.06	5,261.8	6	2.0%	1.02 [-0.01, 2.06]
Oliveira et al. 2013 [70]	345	686.07	9	128	747.37	9	2.4%	0.29 [-0.64, 1.22]
Ruas et al. 2018_H_1CON/CON [73]	103.23	128.16	10	-98.37	191.12	10	2.2%	1.19 [0.22, 2.15]
Ruas et al. 2018_H_1CON/ECC [73]	-28.21	170.5	10	-98.37	191.12	10	2.5%	0.37 [-0.51, 1.26]
Ruas et al. 2018_H_1ECC/ECC [73]	23.97	166.83	10	-98.37	191.12	10	2.5%	0.65 [-0.25, 1.56]
Ruas et al. 2018_Q_1CON/CON [73]	42.92	110.57	10	-40.71	141.08	10	2.5%	0.63 [-0.27, 1.54]
Ruas et al. 2018_Q_1CON/ECC [73]	0.85	150.71	10	-40.71	141.08	10	2.5%	0.27 [-0.61, 1.15]
Ruas et al. 2018_Q_1ECC/ECC [73]	-22.14	131.35	10	-40.71	141.08	10	2.6%	0.13 [-0.75, 1.01]
Subtotal (95% CI)			**193**			**167**	**41.5%**	**0.41 [0.20, 0.63]**
Heterogeneity: Tau² = 0.00; Chi² = 10.13, df = 14 (P = 0.75); I² = 0%								
Test for overall effect: Z = 3.81 (P = 0.0001)								
Slow Movement Velocity (without intent for rapid force production)								
Nie et al. 2010 [79]	131	602.17	15	243	510.44	15	3.4%	-0.20 [-0.91, 0.52]
Thompson et al. 2015 KE [75]	166.7	396.46	34	-17.5	347.02	20	4.6%	0.48 [-0.08, 1.04]
Thompson et al. 2015 KF [75]	65	183.02	34	-9.4	163.05	20	4.6%	0.42 [-0.14, 0.97]
Vangsgaard et al. 2014 [49]	160.6	558.69	15	-38.5	796.49	14	3.3%	0.28 [-0.45, 1.02]
Vila-Cha et al. 2010 [47]	1,099.3	1,946.47	9	-135.8	1,547.4	8	2.1%	0.66 [-0.32, 1.65]
Wirth et al. 2015 [76]	0.1	3.18	15	-1.4	3.06	13	3.2%	0.47 [-0.29, 1.22]
Wirth et al. 2016 LP [77]	-0.9	3.25	40	-0.7	3.57	37	5.7%	-0.06 [-0.51, 0.39]
Wirth et al. 2016 SQ [77]	-0.3	3.51	43	-0.7	3.57	37	5.8%	0.11 [-0.33, 0.55]
Subtotal (95% CI)			**205**			**164**	**32.7%**	**0.21 [-0.00, 0.42]**
Heterogeneity: Tau² = 0.00; Chi² = 5.49, df = 7 (P = 0.60); I² = 0%								
Test for overall effect: Z = 1.95 (P = 0.05)								
Total (95% CI)			**519**			**443**	**100.0%**	**0.38 [0.22, 0.55]**
Heterogeneity: Tau² = 0.07; Chi² = 46.98, df = 32 (P = 0.04); I² = 32%								
Test for overall effect: Z = 4.60 (P < 0.00001)								
Test for subgroup differences: Chi² = 2.62, df = 2 (P = 0.27), I² = 23.8%								



Specificità dell'allenamento

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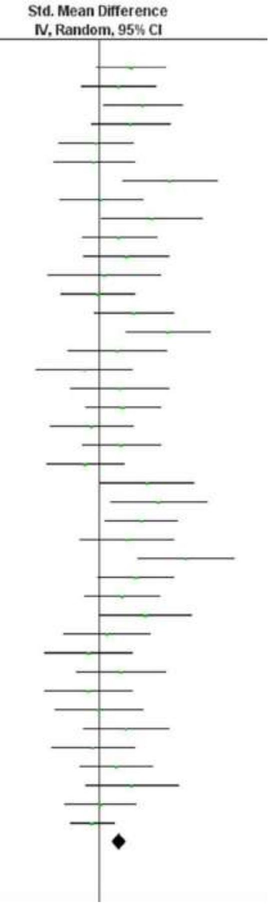
	Post-Training Mean	Post-Training SD	Post-Training Total	Pre-Training Mean	Pre-Training SD	Pre-Training Total	Weight	Std. Mean Difference IV, Random, 95% CI
Training Specific								
Alegre et al. 2006 [60]	9,416	2,711	16	7,608	2,638	18	2.0%	0.66 [-0.03, 1.35]
Barak et al. 2004 Con_30 [61]	439.7	221.9	14	357.42	171.3	14	1.8%	0.40 [-0.35, 1.15]
Barak et al. 2004 Con_90 [61]	442.1	157.6	14	286.5	178.9	14	1.8%	0.90 [0.11, 1.68]
Barak et al. 2004 Ecc_30 [61]	395.6	159.8	13	296.2	134.9	13	1.7%	0.65 [-0.14, 1.44]
Barak et al. 2004 Ecc_90 [61]	412.8	214.8	14	426.3	309.3	14	1.9%	-0.05 [-0.79, 0.69]
Branislav et al. 2013_S [31]	864.3	285	12	896.5	437.2	12	1.7%	-0.08 [-0.88, 0.72]
Cadore et al. 2014 Con [29]	959.2	150.4	11	721.2	167.9	11	1.4%	1.44 [0.48, 2.39]
Cadore et al. 2014 Ecc [29]	874	131.4	11	584.3	6,400	11	1.6%	0.06 [-0.77, 0.90]
De Oliveira et al. 2013 [32]	2,899.1	1,247.2	9	1,787.2	625.4	9	1.3%	1.07 [0.07, 2.08]
Geertsen et al. 2008 [41]	39.91	14.52	14	33.9	13.28	14	1.8%	0.42 [-0.33, 1.17]
Gruber et al. 2007BT [42]	0.75	0.23	11	0.64	0.13	11	1.6%	0.57 [-0.29, 1.42]
Haff et al. 2008 [62]	14,309	2,667.1	6	13,997.2	1,879.3	6	1.1%	0.12 [-1.01, 1.26]
Hartmann et al. 2009 DUP [63]	10.78	2.12	14	10.79	1.99	14	1.9%	-0.00 [-0.75, 0.74]
Hartmann et al. 2009 SPP [63]	3.25	0.28	13	3.03	0.31	13	1.7%	0.72 [-0.08, 1.52]
Holtermann et al. 2007 [34]	653.2	95.2	14	495.1	122	14	1.6%	1.40 [0.56, 2.24]
Jenkins et al. 2016 HLoad [43]	1,427.09	612.53	7	1,228.28	383.8	9	1.3%	0.38 [-0.62, 1.38]
Jenkins et al. 2016 LLoad [43]	1,082.24	505.37	8	1,235.24	507.37	9	1.4%	-0.29 [-1.25, 0.67]
Kubo et al. 2001 [65]	343	71	8	302	107	8	1.3%	0.43 [-0.57, 1.42]
Laird et al. 2016 [67]	4,712.4	1,849.2	14	3,862.8	1,479.1	14	1.8%	0.49 [-0.26, 1.25]
Lamont et al. 2009 SQT [35]	7,739.53	2,798.8	11	8,172.45	3,584.1	11	1.6%	-0.13 [-0.97, 0.71]
Lamont et al. 2009 SQTV [35]	12,164.89	3,533.2	13	10,461.4	3,637.24	13	1.8%	0.46 [-0.32, 1.24]
Laroche et al. 2008 [44]	8.12	1.95	13	8.73	2.38	13	1.8%	-0.27 [-1.04, 0.50]
Manolopoulos et al. 2016R [51]	1.97	0.6	10	1.4	0.51	10	1.4%	0.98 [0.04, 1.92]
Manolopoulos et al. 2016S [51]	2.08	0.66	10	1.36	0.46	10	1.3%	1.21 [0.24, 2.18]
Mikkola et al. 2012 [69]	10,017	3,774	16	7,286	2,135	16	1.9%	0.87 [0.14, 1.60]
Oliveira et al. 2013 [70]	2,439	459	9	2,094	664	9	1.4%	0.58 [-0.37, 1.52]
Oliveira et al. 2016 [50]	1,690	280	12	1,195	260	12	1.3%	1.77 [0.80, 2.74]
Peltonen et al. 2018 [45]	22,107.11	6,868.724	14	16,790.46	6,804.748	14	1.8%	0.76 [-0.02, 1.53]
Peltonen et al. 2018a [71]	18,222	6,336.211	14	15,383.85	5,092.59	14	1.8%	0.48 [-0.27, 1.23]
Ruas et al. 2018_H_1CON/CON [73]	258.68	121.57	10	155.45	84.27	10	1.4%	0.95 [0.01, 1.88]
Ruas et al. 2018_H_1CON/ECC [73]	258.57	164.33	10	234.6	100.35	10	1.5%	0.17 [-0.71, 1.05]
Ruas et al. 2018_H_1ECC/ECC [73]	220.14	89.023	10	248.35	175.5	10	1.5%	-0.19 [-1.07, 0.68]
Ruas et al. 2018_Q_1CON/CON [73]	191.85	103.92	10	148.93	74.07	10	1.5%	0.46 [-0.44, 1.35]
Ruas et al. 2018_Q_1CON/ECC [73]	161.62	108.66	10	183.76	105.72	10	1.5%	-0.20 [-1.08, 0.68]
Ruas et al. 2018_Q_1ECC/ECC [73]	169.16	108.66	10	168.31	135.83	10	1.5%	0.01 [-0.87, 0.88]
Stone et al. 2003 1-4w [74]	18,873	7,659	11	15,047	5,243	11	1.6%	0.56 [-0.29, 1.42]
Stone et al. 2003 5-8w [74]	18,000	8,357	11	18,873	7,659	11	1.6%	-0.10 [-0.94, 0.73]
Vangsgaard et al. 2014 [49]	1,057.8	446.8	15	897.2	417.3	15	1.9%	0.36 [-0.36, 1.08]
Vila-Cha et al. 2010 [47]	4,396.8	1,532.4	9	3,297.5	1,561.4	10	1.4%	0.68 [-0.25, 1.61]
Wirth et al. 2015 [76]	11.6	2.6	15	11.5	2.3	15	1.9%	0.04 [-0.68, 0.76]
Wirth et al. 2016 LP [77]	11.2	2.3	40	11.5	2.6	40	2.9%	-0.12 [-0.56, 0.32]
Subtotal (95% CI)			**506**			**512**	**67.1%**	**0.42 [0.27, 0.57]**

Heterogeneity: $Tau^2 = 0.06$; $Chi^2 = 54.80$, $df = 40$ ($P = 0.06$); $I^2 = 27\%$

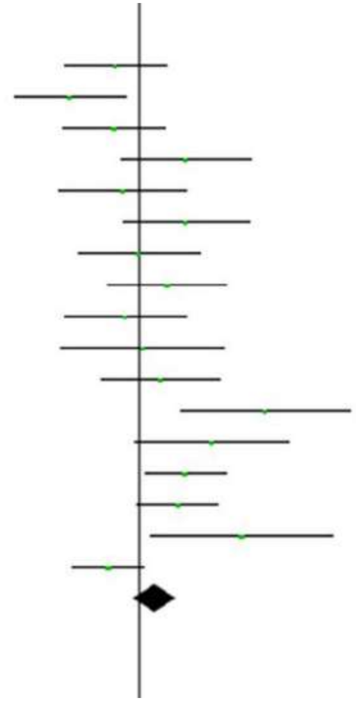
Test for overall effect: $Z = 5.49$ ($P < 0.00001$)



NON-specificità

Training Non-specific								
Hartmann et al. 2012 BSQ [64]	11.09	1.93	20	11.67	2.15	20	2.2%	-0.28 [-0.90, 0.34]
Hartmann et al. 2012 BSQ1/4 [64]	10.42	1.88	19	12.25	2.43	19	2.1%	-0.82 [-1.49, -0.16]
Hartmann et al. 2012 FSQ [64]	10.46	2.31	20	11.22	2.79	20	2.2%	-0.29 [-0.91, 0.33]
Kyröläinen et al. 2005_KE [21]	22,213	6,828	13	18,836	4,282	13	1.7%	0.57 [-0.21, 1.36]
Kyröläinen et al. 2005_PF [21]	20,158	7,728	13	21,657	7,696	13	1.8%	-0.19 [-0.96, 0.58]
Lamas et al. 2012_PT [66]	1,340.37	276.04	14	1,158.86	328.49	14	1.8%	0.58 [-0.18, 1.34]
Lamas et al. 2012_ST [66]	1,124.78	396.13	14	1,120.8	439.46	14	1.9%	0.01 [-0.73, 0.75]
Mangine et al. 2016 INT [68]	10,687	919	15	9,216	5,718	15	1.9%	0.35 [-0.37, 1.07]
Mangine et al. 2016 VOL [68]	8,263	951	14	8,880	5,251	14	1.9%	-0.16 [-0.90, 0.58]
Mueller et al. 2015 [78]	1,116	250	8	1,102	279	8	1.3%	0.05 [-0.93, 1.03]
Nie et al. 2010 [79]	978	445	15	847	486	15	1.9%	0.27 [-0.45, 0.99]
Rebutini et al. 2016_HE [72]	1,217.27	512.28	10	585.66	220.07	10	1.2%	1.53 [0.51, 2.56]
Rebutini et al. 2016_KE [72]	604.43	240.42	10	427.45	116.86	10	1.4%	0.90 [-0.03, 1.83]
Thompson et al. 2015 KE [75]	835.6	236.2	34	668.9	337	34	2.7%	0.57 [0.08, 1.05]
Thompson et al. 2015 KF [75]	370.1	127.2	34	305.1	141.1	34	2.7%	0.48 [-0.00, 0.96]
Winchester et al. 2008 [48]	25,343.8	12,614.4	8	12,687.5	4,644	8	1.1%	1.26 [0.16, 2.36]
Wirth et al. 2016 SQ [77]	12.4	2.3	43	13.3	2.6	43	3.0%	-0.36 [-0.79, 0.06]
Subtotal (95% CI)			**304**			**304**	**32.9%**	**0.20 [-0.07, 0.46]**

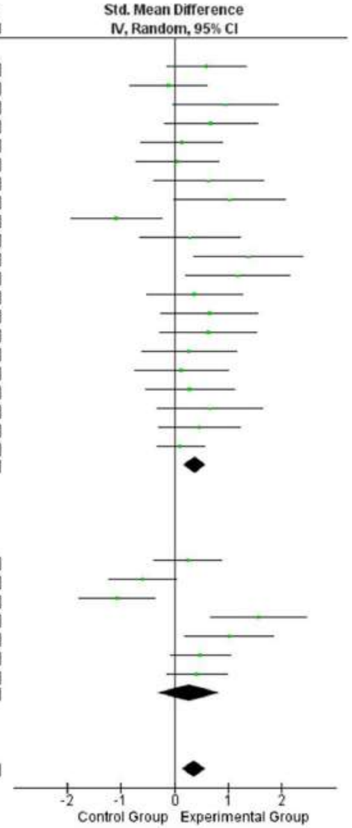
Heterogeneity: $Tau^2 = 0.18$; $Chi^2 = 39.86$, $df = 16$ ($P = 0.0008$); $I^2 = 60\%$
Test for overall effect: $Z = 1.44$ ($P = 0.15$)



Vs controllo

b

	Experimental Group			Control Group				Std. Mean Difference
	Mean	SD	Total	Mean	SD	Total	Weight	IV, Random, 95% CI
Training Specific								
Alegre et al. 2006 [60]	1,808	3,625.06	16	-706	4,503.67	14	3.9%	0.60 [-0.13, 1.34]
Branislav et al. 2013_S [31]	-32.2	464.74	12	13.23	310.57	20	4.0%	-0.12 [-0.83, 0.60]
De Oliveira et al. 2013 [32]	1,111.9	1,185.86	9	127.7	747.98	9	2.9%	0.95 [-0.04, 1.93]
Gruber et al. 2007BT [42]	0.11	0.24	11	-0.06	0.24	11	3.3%	0.68 [-0.18, 1.55]
Hartmann et al. 2009 DUP [63]	-0.01	2.63	14	-0.41	2.96	13	3.8%	0.14 [-0.62, 0.89]
Hartmann et al. 2009 SPP [63]	0.22	0.38	13	0.17	1.27	13	3.7%	0.05 [-0.72, 0.82]
Lamont et al. 2009 SQT [35]	-432.92	4,000.11	11	-3,421.06	5,261.8	6	2.8%	0.64 [-0.39, 1.66]
Lamont et al. 2009 SQTV [35]	1,703.49	4,561.47	13	-3,421.06	5,261.8	6	2.7%	1.02 [-0.01, 2.06]
Laroche et al. 2008 [44]	-0.61	2.76	13	3.14	3.9	12	3.4%	-1.08 [-1.93, -0.23]
Oliveira et al. 2013 [70]	345	686.07	9	128	747.37	9	3.1%	0.29 [-0.64, 1.22]
Oliveira et al. 2016 [50]	495	340.26	12	20	315.08	8	2.8%	1.38 [0.36, 2.39]
Ruas et al. 2018_H_1CON/CON [73]	103.23	128.16	10	-98.37	191.12	10	3.0%	1.19 [0.22, 2.15]
Ruas et al. 2018_H_1CON/ECC [73]	-28.21	170.5	10	-98.37	191.12	10	3.3%	0.37 [-0.51, 1.26]
Ruas et al. 2018_H_1ECC/ECC [73]	23.97	166.83	10	-98.37	191.12	10	3.2%	0.65 [-0.25, 1.56]
Ruas et al. 2018_Q_1CON/CON [73]	42.92	110.57	10	-40.71	141.08	10	3.2%	0.63 [-0.27, 1.54]
Ruas et al. 2018_Q_1CON/ECC [73]	0.85	150.71	10	-40.71	141.08	10	3.3%	0.27 [-0.61, 1.15]
Ruas et al. 2018_Q_1ECC/ECC [73]	-22.14	131.35	10	-40.71	141.08	10	3.3%	0.13 [-0.75, 1.01]
Vangsgaard et al. 2014 [49]	160.6	432.5	10	-38.5	796.49	14	3.5%	0.29 [-0.53, 1.10]
Vila-Cha et al. 2010 [47]	1,099.3	1,946.47	9	-135.8	1,547.4	8	2.9%	0.66 [-0.32, 1.65]
Wirth et al. 2015 [76]	0.1	3.18	15	-1.4	3.06	13	3.8%	0.47 [-0.29, 1.22]
Wirth et al. 2016 LP [77]	-0.3	3.51	43	-0.7	3.57	37	5.3%	0.11 [-0.33, 0.55]
Subtotal (95% CI)			**270**			**253**	**71.1%**	**0.38 [0.17, 0.59]**
Heterogeneity: Tau² = 0.06; Chi² = 27.29, df = 20 (P = 0.13); I² = 27%								
Test for overall effect: Z = 3.52 (P = 0.0004)								
Training Non-specific								
Hartmann et al. 2012 BSQ [64]	-0.76	3.4	20	-1.58	3.06	20	4.4%	0.25 [-0.37, 0.87]
Hartmann et al. 2012 BSQ1/4 [64]	-0.58	2.71	20	0.75	1.54	20	4.4%	-0.59 [-1.23, 0.04]
Hartmann et al. 2012 FSQ [64]	-1.83	2.95	20	0.75	1.35	16	4.0%	-1.06 [-1.77, -0.35]
Lamas et al. 2012_PT [66]	181.51	389.27	14	-551.15	520.15	12	3.2%	1.56 [0.66, 2.46]
Lamas et al. 2012_ST [66]	3.98	536.77	14	-551.15	520.15	12	3.5%	1.02 [0.19, 1.84]
Thompson et al. 2015 KE [75]	166.7	396.46	34	-17.5	347.02	20	4.7%	0.48 [-0.08, 1.04]
Thompson et al. 2015 KF [75]	65	183.02	34	-9.4	163.05	20	4.7%	0.42 [-0.14, 0.97]
Subtotal (95% CI)			**156**			**120**	**28.9%**	**0.27 [-0.32, 0.85]**
Heterogeneity: Tau² = 0.50; Chi² = 32.31, df = 6 (P < 0.0001); I² = 81%								
Test for overall effect: Z = 0.89 (P = 0.37)								
Total (95% CI)			**426**			**373**	**100.0%**	**0.36 [0.14, 0.58]**
Heterogeneity: Tau² = 0.19; Chi² = 60.46, df = 27 (P = 0.0002); I² = 55%								
Test for overall effect: Z = 3.15 (P = 0.002)								
Test for subgroup differences: Chi² = 0.13, df = 1 (P = 0.72), I² = 0%								

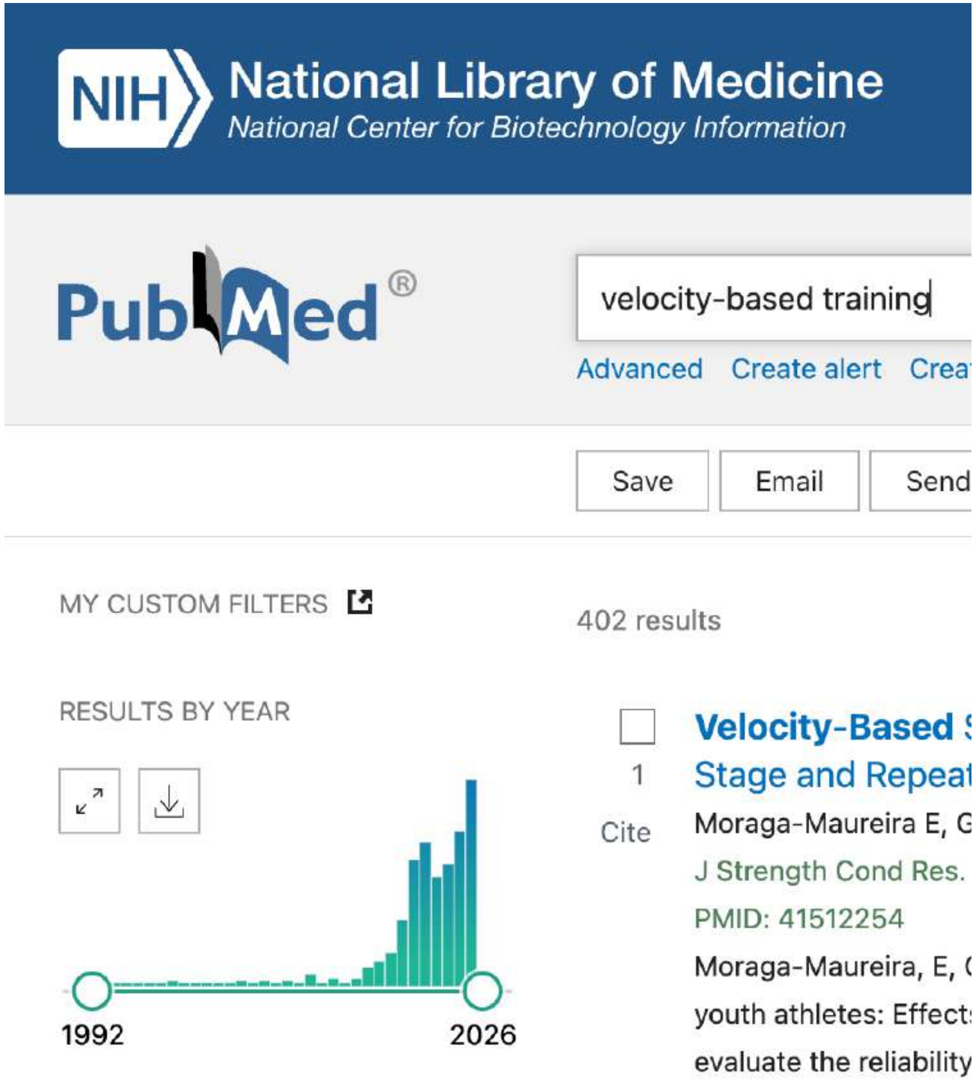


Allenare RFD

1) Gesti rapidi migliorano RFD
2) Allenamento tradizionale per migliorare azione muscolare
3) Allenamento tradizionale specifico per aumentare dimensioni muscolari
4) Allenamento tradizionale specifico (eccentrico) per allungare i fascicoli muscolari
5) Allenamento tradizionale migliora vari aspetti mentre migliora RFD

Alternare velocità allenamento «esplosiva» vs. tradizionale

Forza rapida dinamica → Allenamento velocità massimale?



VBT vs. Allenamento tradizionale

frontiers | Frontiers in Physiology

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The effectiveness of traditional vs. velocity-based strength training on explosive and maximal strength performance: A network meta-analysis

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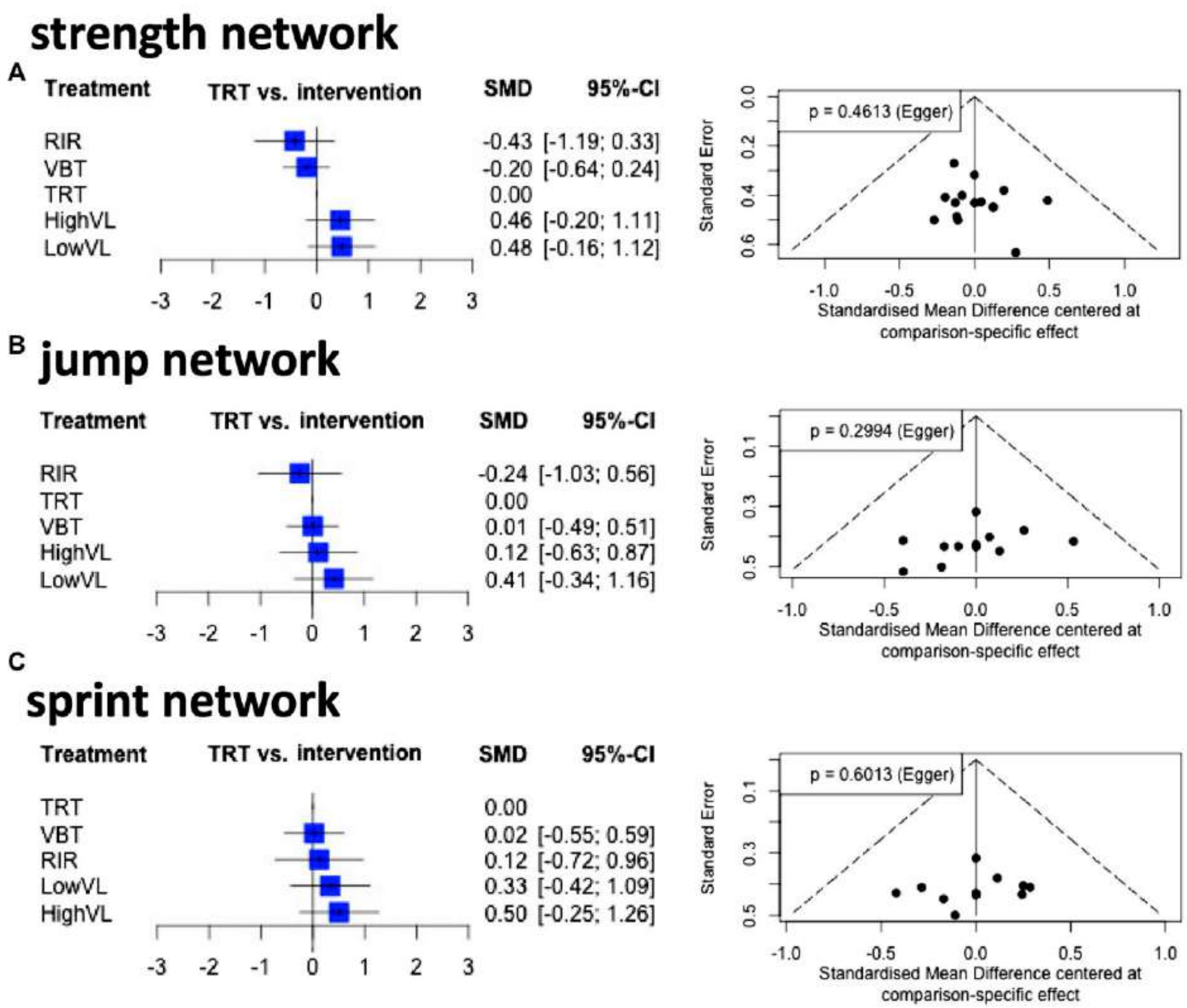

FIGURE 4
Forest and funnel plots for the strength **(A)**, jump **(B)**, and sprint **(C)** network. In addition, Egger´s p scores are given. LowVL: low velocity loss (≤20%); HighVL: high velocity loss (>20%); RIR: repetitions in reserve-based training; VBT: velocity-based resistance training; TRT: traditional 1RM based resistance training (TRT).

Velocity-based training

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PHYSIOLOGY AND NUTRITION

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Comparison of the effects of velocity-based vs. traditional resistance training methods on adaptations in strength, power, and sprint speed: A systematic review, meta-analysis, and quality of evidence appraisal

Samuel T. Orange[a,b], Adam Hritz[a], Liam Pearson[c], Owen Jeffries[a], Thomas W. Jones[c] and James Steele[d]

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ABSTRACT

We estimated the effectiveness of using velocity feedback to regulate resistance training load on changes in muscle strength, power, and linear sprint speed in apparently healthy participants. Academic and grey literature databases were systematically searched to identify randomised trials that compared a velocity-based training intervention to a 'traditional' resistance training intervention that did not use velocity feedback. Standardised mean differences (SMDs) were pooled using a random effects model. Risk of bias was assessed with the Risk of Bias 2 tool and the quality of evidence was evaluated using the GRADE approach. Four trials met the eligibility criteria, comprising 27 effect estimates and 88 participants. The main analyses showed trivial differences and imprecise interval estimates for effects on muscle strength (SMD 0.06, 95% CI −0.51–0.63; I^2 = 42.9%; 10 effects from 4 studies; low-quality evidence), power (SMD 0.11, 95% CI −0.28–0.49; I^2 = 13.5%; 10 effects from 3 studies; low-quality evidence), and sprint speed (SMD −0.10, 95% CI −0.72–0.53; I^2 = 30.0%; 7 effects from 2 studies; very low-quality evidence). The results were robust to various sensitivity analyses. In conclusion, there is currently no evidence that VBT and traditional resistance training methods lead to different alterations in muscle strength, power, or linear sprint speed.

ARTICLE HISTORY
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KEYWORDS
Resistance exercise; velocity feedback; muscle strength; muscle power; sprint speed

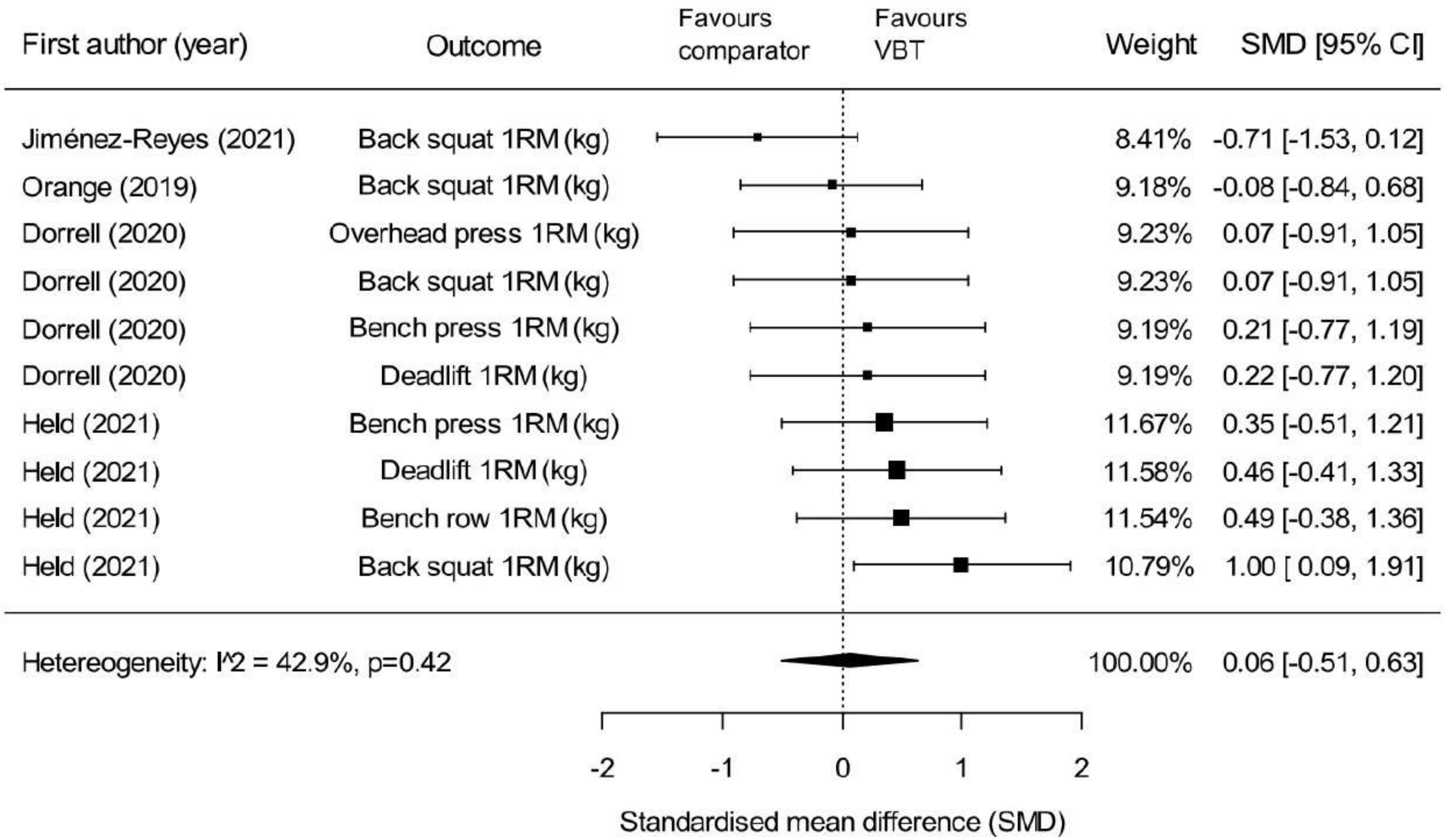

Figure 3. Forest plot of the results from a multi-level random-effects meta-analysis on muscle strength effects. Data are presented as standardised mean differences (SMDs) between velocity-based training (VBT) and comparison interventions with corresponding 95% confidence intervals (95% CIs). Effects in the positive direction favour the VBT condition whereas effects in a negative direction favour the comparison interventions.

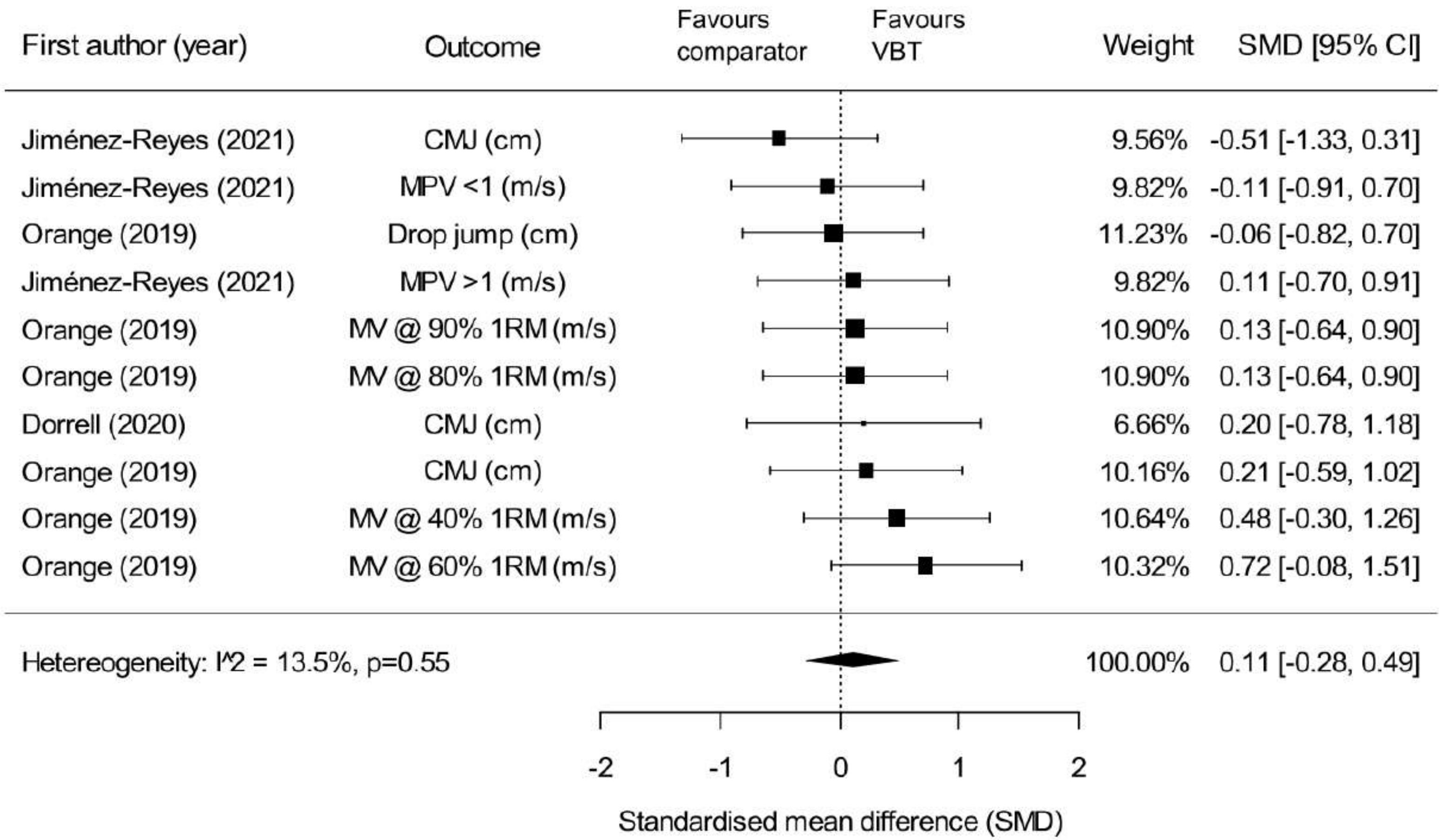

Figure 5. Forest plot of the results from a multi-level random-effects meta-analysis on muscle power effects. Data are presented as standardised mean differences (SMDs) between velocity-based training (VBT) and comparison interventions with corresponding 95% confidence intervals (95% CIs). Effects in the positive direction favour the VBT condition whereas effects in a negative direction favour the comparison interventions.

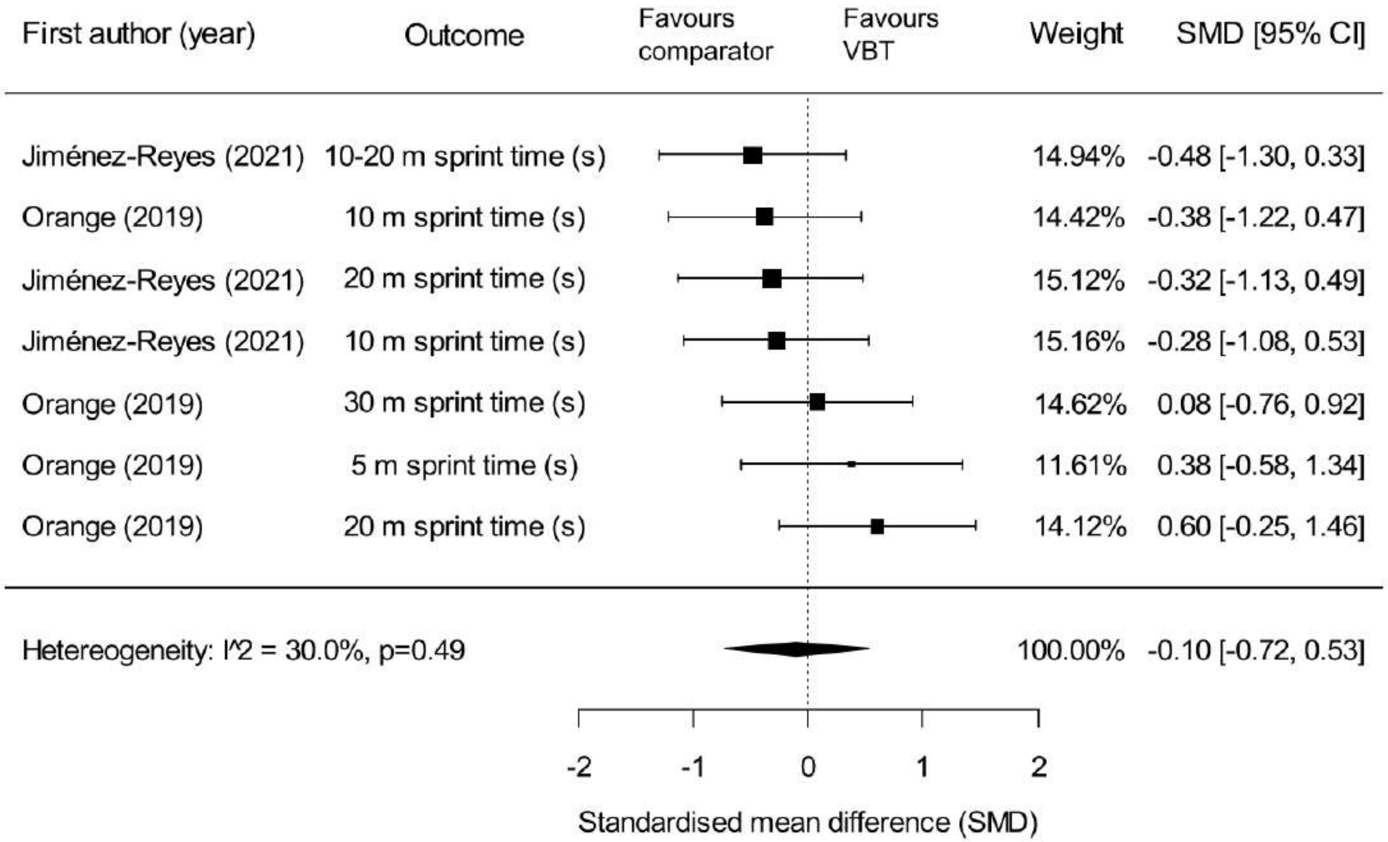

Figure 6. Forest plot of the results from a multi-level random-effects meta-analysis on sprint linear speed effects. Data are presented as standardised mean differences (SMDs) between velocity-based training (VBT) and comparison interventions with corresponding 95% confidence intervals (95% CIs). Effects in the positive direction favour the VBT condition whereas effects in a negative direction favour the comparison interventions.

PLOS ONE

RESEARCH ARTICLE

Effects of velocity based training vs. traditional 1RM percentage-based training on improving strength, jump, linear sprint and change of direction speed performance: A Systematic review with meta-analysis

Kai-Fang Liao[1,2], **Xin-Xin Wang**[1], **Meng-Yuan Han**[1], **Lin-Long Li**[1], **George P. Nassis**[3,4], **Yong-Ming Li**[1,5]*

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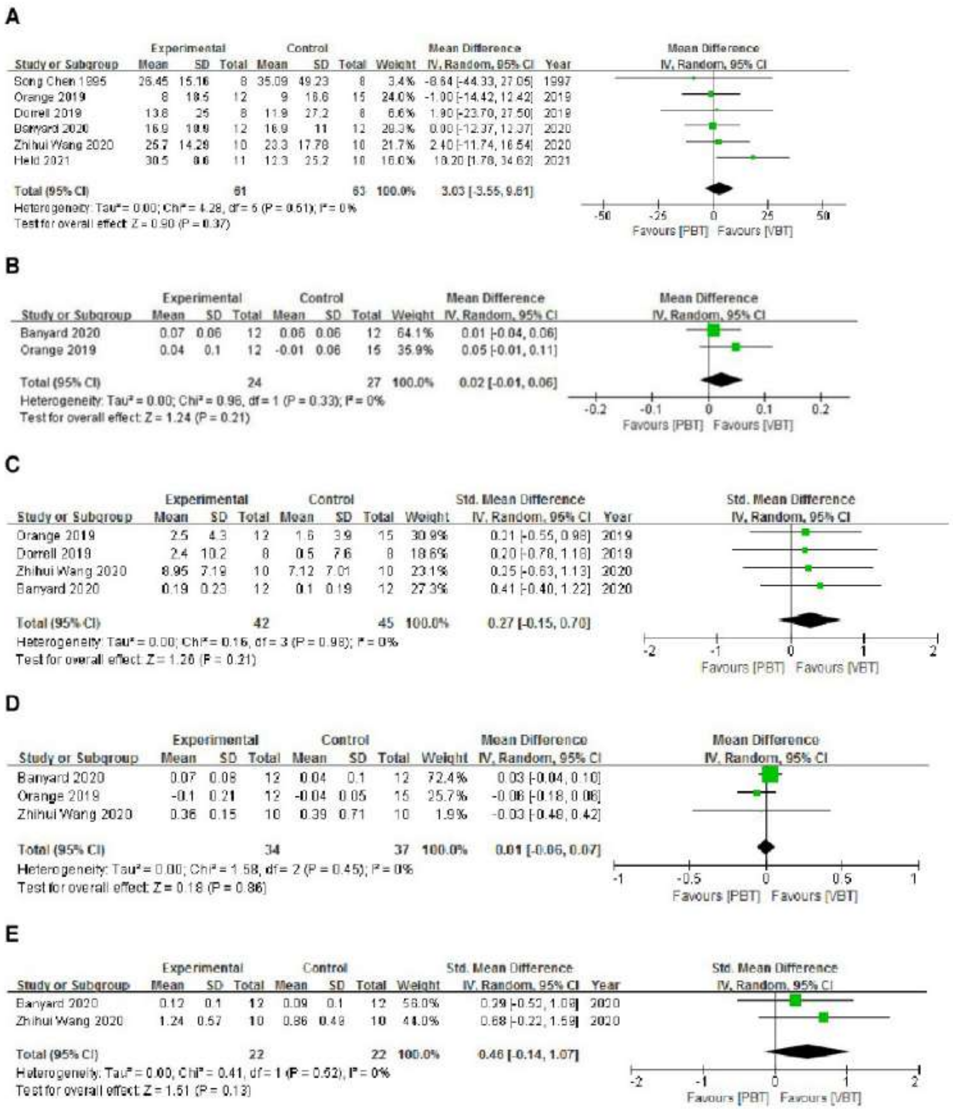

Fig 3. Forest plot of the results on strength performance (A), Load velocity 60%1RM (B), jump performance (C), linear sprint performance (D) and change of direction speed performance (E).

Allenare la forza rapida

- Il VBT funziona? Certo!
- Il VBT funziona meglio dell’allenamento tradizionale? NO!
- Posso usare il VBT nei piani di allenamento? Certo!
- Devo escludere l’allenamento tradizionale? NO!

Considerazioni aggiuntive sul VBT

Table 2 Benefits, limitations, and additional considerations for velocity-based training (VBT) uses

VBT Uses	Benefits	Limitations	Additional considerations
Real-time feedback	May increase athlete motivation May increase competitiveness in the weight room	Potential loss of focus on exercise technique to achieve higher velocities	Feedback should be provided consistently during exercise sets [75] Best implemented with heavy load, multi-joint movements (e.g., squat, bench press, etc.) or velocity-focused exercises (e.g., jump variations) [75–79]
Daily 1RM prediction	Daily training percentages are based on the current training state of the athlete	An athlete may not give maximal effort during their warm-up repetitions resulting in an underestimation of the daily 1RM Load–velocity profiles may overestimate a 1RM [80–83] Additional time may be needed to determine exercise load–velocity profiles, especially with group training sessions and multiple exercises performed throughout each week	General equations that use the velocity at 1RM from all athletes may help simplify load–velocity assessments [75] The two-point method may be useful for upper body exercises [84–86], but not lower body exercises [80]
Velocity loss thresholds	Increased ability to monitor fatigue during exercise sets Potential use of "flexible" repetition schemes that may compensate for athlete fatigue	Additional time may be needed with more frequent load adjustment throughout training sessions, especially with group training sessions Individual testing variability and time needed to establish velocity baselines	Accumulation phases may warrant the maintenance of the greatest velocity despite dropping below a threshold "Flexible" repetition schemes may modify the training stimulus and effectively alter the focus of the training day/phase [87]

Considerazioni aggiuntive sull'allenamento tradizionale

Journal of
Functional Morphology and Kinesiology

MDPI

Review

Manipulating Resistance Exercise Variables to Improve Jumps, Sprints, and Changes of Direction in Soccer: What We Know and What We Don't Know

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L’allenamento tradizionale consiste nella combinazione di molte variabili

Table 1. A summary of the influence of the resistance training variables on jumps, sprints, and changes of direction.

Influence of Resistance Training Variables on Jumps, Sprints and Changes of Direction (CODs)		
Resistance Training Variable	**What Is Known**	**What Is Not Known**
Magnitude external load	Moderate-to-high > low loads	Short-term recovery should be considered after high vs low loads
Type external resistance	Flywheel and constant external loads are equally effective for jumps and sprints. Flywheel is possibly better than constant load for CODs.	Elastic training as an alternative method for sprints and CODs.
Movement velocity	Movement velocity does not affect gains in jumps, sprints, and CODs.	Over-slowing movement velocity (>4 s per phase) should be avoided, although not completely proven.
Range of motion (ROM)	Full > partial ROM for jumps.	No sufficient information for ROM and sprints and CODs.
Eccentric vs. concentric vs. traditional eccentric/concentric training	Eccentric training is effective in improving jumps, sprints, and CODs. Eccentric training requires long initial recovery.	No direct comparison, so it is not clear if one methodology is more, less, or equally effective.
External internal focus	External focus should equalize or increase strength during a movement. External focus suggested for complex tasks.	No direct long-term comparison, albeit external focus has more favorable theoretical bases.
Failure/Non-failure	Velocity loss thresholds > 15% to improve jumps and sprints.	Few information indicates non-failure > failure. No information about velocity loss thresholds and CODs.
Total number of repetitions (N)	A wide range of N could be selected to improve jumps, sprints, and CODs. Higher N is needed to improve CODs than jumps and sprints in young athletes.	N may not affect COD in adults. No information about the effects of N of jumps and sprints in adults.
Inter-set rest	Longer durations may be suggested since it is more effective for increasing strength.	No direct comparison between longer/shorter durations available.
Exercise selection	Squat variations, hip thrusts, and deadlift improve sprints equally.	No exercise superiority can be claimed. No information for jumps and COD.

Effetti allenamento isometrico

- ✅ Aumento di forza
- ✅ Aumento dimensioni muscolari
- ✅ Aumento capacità di salto
- ✅ Economia di corsa
- 🔲 Sprint
- 🔲 Cambi di direzione

Ultimo punto: velocità nulla?

Review

Thieme

Brief Review: Effects of Isometric Strength Training on Strength and Dynamic Performance

Authors
Danny Lum[1, 2], Tiago M. Barbosa[3, 4]

Coratella *Sports Medicine - Open* (2022) 8:99
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Sports Medicine - Open

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Appropriate Reporting of Exercise Variables in Resistance Training Protocols: Much more than Load and Number of Repetitions

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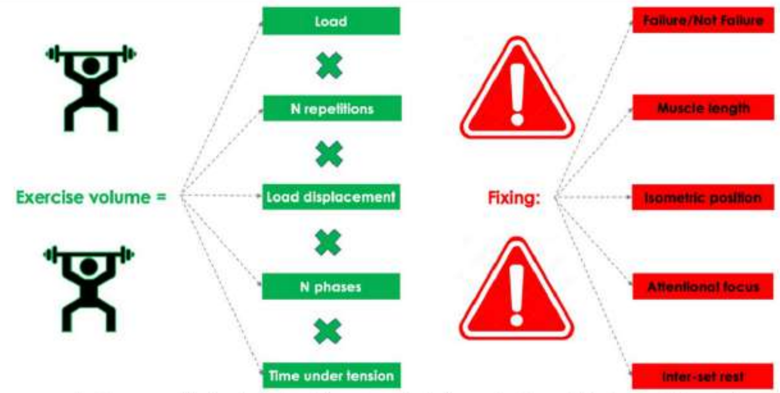

Fig. 2 A more comprehensive approach to the calculation of the volume of a single exercise. The variables in green determine the volume, provided that the variables in red are fixed

Fig. 1 A checklist of the variables to be reported for each exercise within the resistance training protocols

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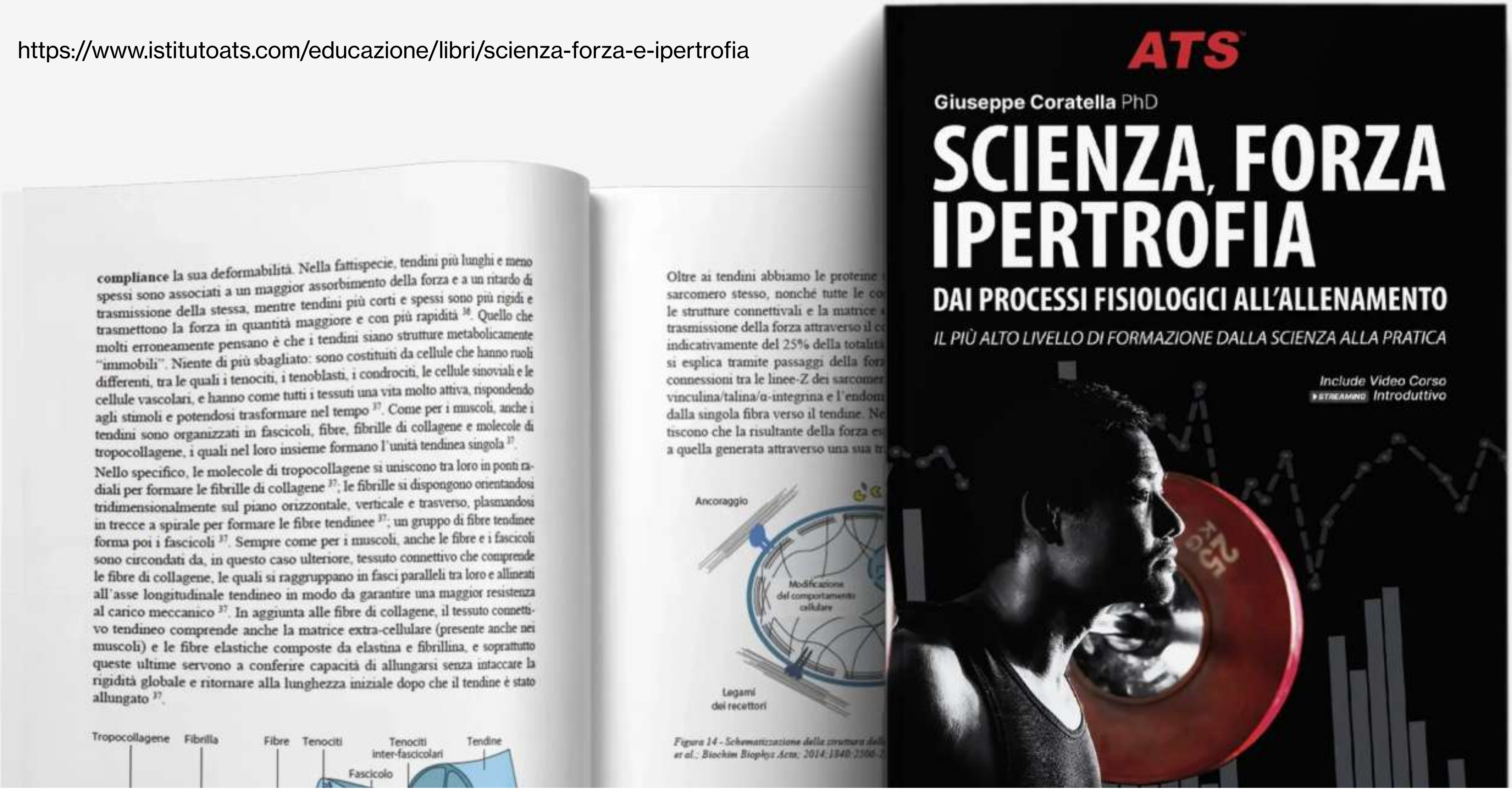

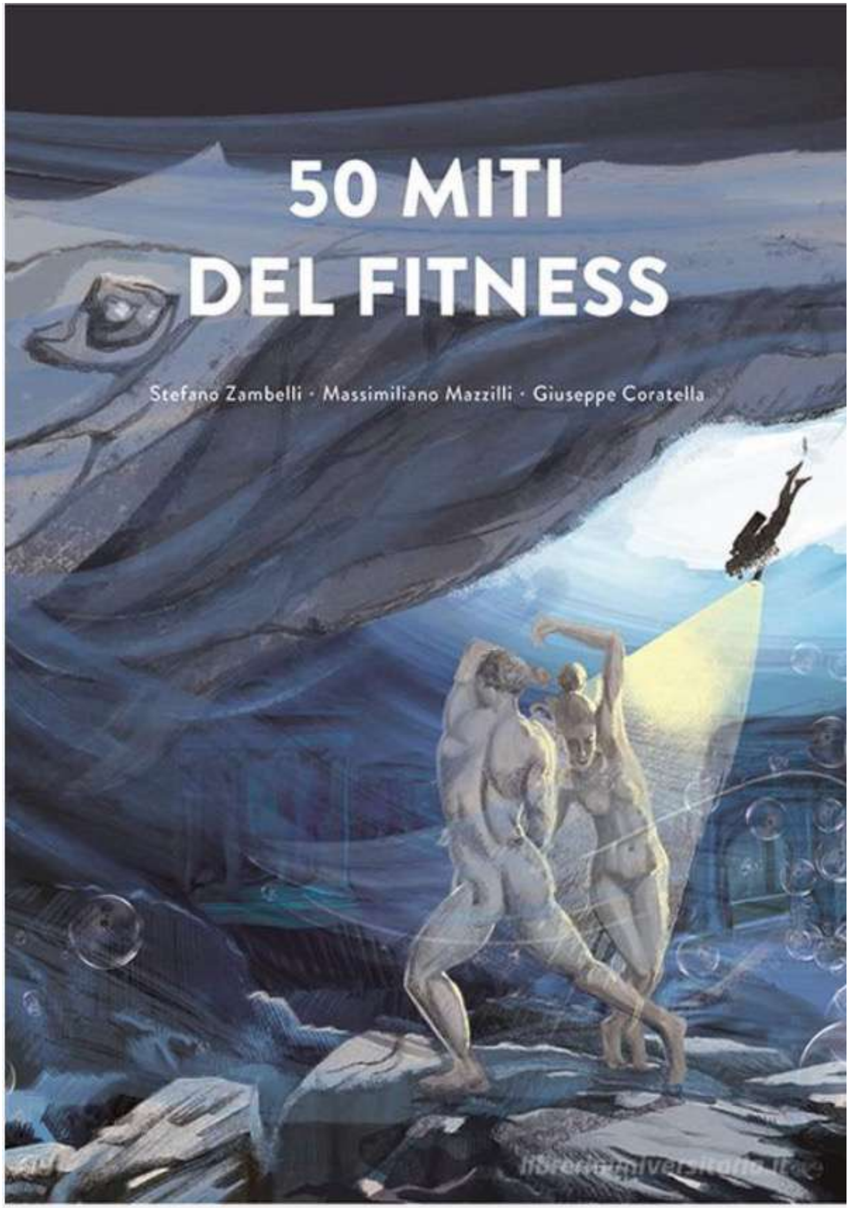

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