

Scientific recommendations for strength and hypertrophy training from 150+ studies (part 1 of 3)

Studies that aim for ecological validity

1. Effects of Different Volume-Equated Resistance Training Loading Strategies on Muscular Adaptations in Well-Trained Men ([Schoenfeld et al., 2014](#))
2. Effects of a Modified German Volume Training Program on Muscular Hypertrophy and Strength ([Amirthalingam et al., 2017](#))

General resources

3. Fundamentals of Resistance Training: Progression and Exercise Prescription ([Kraemer and Ratamess, 2004](#))
4. The influence of frequency, intensity, volume and mode of strength training on whole muscle cross-sectional area in humans ([Wernbom et al., 2007](#))
5. Evidence-Based Resistance Training Recommendations ([Fisher et al., 2011](#))
6. Evidence-Based Resistance Training Recommendations for Muscular Hypertrophy ([Fisher et al., 2013](#))
7. Effects and dose–response relationships of resistance training on physical performance in youth athletes: a systematic review and meta-analysis ([Lesinski et al., 2016](#))
8. Dose-Response Relationships of Resistance Training in Healthy Old Adults: A Systematic Review and Meta-Analysis ([Borde et al., 2015](#))
9. American College of Sports Medicine position stand. Progression models in resistance training for healthy adults ([ACSM, 2009](#))
10. Muscle growth across a variety of exercise modalities and intensities: Contributions of mechanical and metabolic stimuli ([Ozaki et al., 2016](#))

11. A meta-analysis to determine the dose response for strength development ([Rhea et al., 2003](#))
12. Recommendations for natural bodybuilding contest preparation: Resistance and cardiovascular training ([Helms et al., 2014](#))

Failure

13. Concurrent endurance and strength training not to failure optimizes performance gains ([Izquierdo-Gabarren et al., 2010](#))
14. Differential effects of strength training leading to failure versus not to failure on hormonal responses, strength, and muscle power gains ([Izquierdo et al., 2006](#))
15. Fatigue is not a necessary stimulus for strength gains during resistance training ([Folland et al., 2002](#))
16. The impact of metabolic stress on hormonal responses and muscular adaptations ([Goto et al., 2005](#)) (FT)
17. The application of training to failure in periodized multiple-set resistance training programs ([Willardson, 2007](#))
18. Low-Load Bench Press Training to Fatigue Results in Muscle Hypertrophy Similar to High-Load Bench Press Training ([Ogasawara et al., 2013](#)) (FT)
19. The effects of low volume resistance training with and without advanced techniques in trained participants ([Gießing et al., 2016](#))
20. Is repetition failure critical for the development of muscle hypertrophy and strength? ([Sampson and Groeller, 2015](#))
21. Short-term Recovery Following Resistance Exercise Leading or not to Failure ([González-Badillo et al., 2016](#))
22. Nutritional interventions to augment resistance training-induced skeletal muscle hypertrophy ([Morton et al., 2015](#))
23. Training to Fatigue: The Answer for Standardization When Assessing Muscle Hypertrophy? ([Dankel et al., 2016](#))
24. Impact of high versus low fixed loads and non-linear training loads on muscle hypertrophy, strength and force development ([Fink et al., 2016](#))
25. Is Resistance Training to Muscular Failure Necessary? ([Nóbrega and Libardi, 2016](#)) [PMC [here](#)]
26. Heavier- and lighter-load resistance training to momentary failure produce similar increases in strength with differing degrees of discomfort ([Fisher et al., 2016](#))

27. Effects of velocity loss during resistance training on athletic performance, strength gains and muscle adaptations ([Pareja-Blanco et al., 2016](#))
28. Four weeks of high- versus low-load resistance training to failure on the rate of torque development, electromechanical delay, and contractile twitch properties ([Jenkins et al., 2016](#))
29. Effect of Training Leading to Repetition Failure on Muscular Strength: A Systematic Review and Meta-Analysis ([Davies et al., 2015](#))
30. Resistance exercise load does not determine training-mediated hypertrophic gains in young men ([Mitchell et al., 2012](#))
31. Effect Of Resistance Training To Muscle Failure Versus Volitional Interruption At High- And Low-Intensities On Muscle Mass And Strength ([Nóbrega et al., 2017](#))

ROM

32. [Full range of motion induces greater muscle damage than partial range of motion in elbow flexion exercise with free weights. - PubMed - NCBI](#)
33. [Effect of ROM in Max Number of Bench Press Repetitions](#) (spanish)
34. [The Efficacy of Incorporating Partial Squats in Maximal Strength Training](#) - ([Bazzyler et al 2013](#))
35. Effect of range of motion on muscle strength and thickness - [Pinto et al., 2012](#)
36. Nonuniform Response of Skeletal Muscle to Heavy Resistance Training: Can Bodybuilders Induce Regional Muscle Hypertrophy? ([Antonio, 2000](#))
37. Impact of range of motion during ecologically valid resistance training protocols on muscle size, subcutaneous fat, and strength ([McMahon et al., 2014](#))
38. Effect of range of motion in heavy load squatting on muscle and tendon adaptations ([Bloomquist et al., 2013](#))
39. [An Examination of Strength and Concentric Work Ratios During Variable ROM Training.](#) - Clark 2008
40. Comparison of strength differences and joint action between full and partial ROM bench press exercise ([Mookerjee and Ratamess, 1999](#))
41. The influence of variable ROM training on neuromuscular performance and control of external loads ([Clark et al., 2011](#))
42. Specificity of limited ROM variable resistance training. ([Graves et al., 1989](#))
43. [Limited ROM lumbar extension motion training.](#) ([Graves et al., 1992](#))
44. Influence of ROM in RT in Women: early phase adaptations - [Massey et al. 2005](#)

45. [An analysis of full ROM vs pROM in the development of strength in untrained men.](#)
[Massey et al., 2004](#)

Rest duration

46. Effect of Two Different Rest Period Lengths on the Number of Repetitions Performed During Resistance Training ([Miranda et al., 2007](#))
47. Influence of Two Different Rest Interval Lengths in Resistance Training Sessions for Upper and Lower Body ([Senna et al., 2009](#))
48. Effects of different rest intervals between sets on muscle performance in the leg press exercise in untrained elderly women ([Filho et al., 2012](#))
49. The Effect of Rest Interval Length on Multi and Single-Joint Exercise Performance and Perceived Exertion ([Senna et al., 2011](#))
50. Short rest interval lengths between sets optimally enhance body composition and performance with 8 weeks of strength resistance training in older men ([Villanueva et al., 2015](#))
51. Influence of Strength Level on the Rest Interval Required During an Upper-Body Power Training Session ([Davó et al., 2017](#)) [Acute and Long-term Responses to Different Rest Intervals in Low-load Resistance Training.](#) (Fink et al., 2016b)
52. [Effect of rest intervals and training loads on metabolic stress and muscle hypertrophy.](#) (Fink et al., 2016a)
53. [Acute and Long-term Responses to Different Rest Intervals in Low-load Resistance Training.](#) (Fink et al., 2016b)
54. [The effect of Resistive Exercise Rest Interval on Hormonal Response, Strength, and Hypertrophy with Training.](#) (Buresh et al., 2009)
55. [The effect of different rest intervals between sets on volume components and strength gains.](#) (Willardson and Burkett, 2008)
56. [Longer interset rest periods enhance muscle strength and hypertrophy in resistance-trained men.](#) (Schoenfeld et al., 2016a)
57. [Greater Gains in Strength and Power with intraset rest intervals in hypertrophic training.](#) (Oliver et al., 2013)
58. [Short inter-set rest blunts resistance exercise-induced increases in MPS and intracellular signalling in young males.](#) (McKendry et al., 2016)
59. [Comparison between constant decreasing rest intervals: influence on maximal strength and hypertrophy.](#) (De Souza et al., 2010)

60. [Shorts vs. Long rest period between the sets in hypertrophic RT: influence on muscle strength, size, and hormonal adaptations in trained men.](#) (Ahtiainen et al., 2005).
61. [Effect of Different Rest Intervals on Exercise volume completed during squat bouts.](#) (Rahimi 2005)
62. [Effects of Different weight training exercise/rest intervals on strength, power, and high intensity exercise endurance.](#) (Robinson et al., 1995)
63. [A comparison of 3 different rest intervals on the exercise volume completed during a workout.](#) (Willardson and Burkett, 2005)
64. [A brief review: factors affecting the length of rest interval between exercise sets.](#) (Willardson, 2006)
65. [Rest Intervals between sets in Strength Training.](#) (de Salles et al., 2009) *review*
66. [The effect of inter set rest intervals on hypertrophy.](#) (Henselmans and Schoenfeld, 2014)
67. Chronic effects of different between-set rest durations on muscle strength in nonresistance trained young men ([Gentil et al., 2010](#))

Frequency

68. Performance decrements with high-intensity resistance exercise overtraining ([Fry et al., 1994](#))
69. The Effects of Self-selection for Frequency of Training in a Winter Conditioning Program for Football ([Hoffman et al., 1990](#))
70. Comparison of whole and split weight training routines in young women ([Calder et al., 1994](#))
71. Comparison of 1 Day and 3 Days Per Week of Equal-Volume Resistance Training in Experienced Subjects ([McLester et al., 2000](#))
72. A meta-analysis to determine the dose response for strength development ([Rhea et al., 2003](#))
73. Effect of short-term equal-volume resistance training with different workout frequency on muscle mass and strength in untrained men and women ([Candow and Burke, 2007](#))
74. The Influence of Frequency, Intensity, Volume and Mode of Strength Training on Whole Muscle Cross-Sectional Area in Humans ([Wernbom et al., 2007](#))
75. Short-term effects of resistance training frequency on body composition and strength in middle-aged women ([Benton et al., 2011](#))

76. Effects of 8 weeks equal-volume resistance training with different workout frequency on maximal strength, endurance and body composition ([Arazi and Asadi, 2011](#))
77. Evidence-Based Resistance Training Recommendations ([Fisher et al., 2011](#))
78. Evidence-Based Resistance Training Recommendations for Muscular Hypertrophy ([Fisher et al., 2013](#))
79. The development, retention and decay rates of strength and power in elite rugby union, rugby league and American football: a systematic review ([McMaster et al., 2013](#))
80. Effects of resistance training frequency on body composition and metabolics and inflammatory markers in overweight postmenopausal women ([Lera Orsatti et al., 2014](#))
81. The Effects of Resistance Training Frequency on Strength Gains ([Serra et al., 2015](#))
82. Efficacy of Daily 1RM Training in Well-Trained Powerlifters and Weightlifters: A Case Series ([Zourdos et al., 2015](#)) (FT)
83. Effects of equal-volume resistance training performed one or two times a week in upper body muscle size and strength of untrained young men ([Gentil et al., 2015](#))
84. Effects of different resistance training frequencies on flexibility in older women ([Carneiro et al., 2015](#))
85. Influence of Resistance Training Frequency on Muscular Adaptations in Well-Trained Men ([Schoenfeld et al., 2015](#))
86. The effects of two equal-volume training protocols upon strength, body composition and salivary hormones in male rugby union players ([Crewther et al., 2016](#))
87. Effects of Resistance Training Frequency on Measures of Muscle Hypertrophy: A Systematic Review and Meta-Analysis ([Schoenfeld et al., 2016](#))
88. Increasing Lean Mass and Strength: A Comparison of High Frequency Strength Training to Lower Frequency Strength Training ([Thomas and Burns, 2016](#))
89. Frequency: The Overlooked Resistance Training Variable for Inducing Muscle Hypertrophy ([Dankel et al., 2016](#))
90. A comparison of once versus twice per week training on leg press strength in women ([Burt et al., 2007](#))(FT)
91. Effects of Training Frequency on Strength Maintenance in Pubescent Baseball Players ([Derenne et al., 1996](#))
92. Comparison of once-weekly and twice-weekly strength training in older adults ([DiFrancisco-Donoghue et al., 2007](#))

93. Frequency of Combined Resistance and Aerobic Training in Older Women ([Fisher et al., 2012](#))
 94. Effect of Training Frequency and Specificity on Isometric Lumbar Extension Strength ([Graves et al., 1990](#))
 95. Effect of resistance training frequency on physiological adaptations in older adults ([Murlasits et al., 2012](#))
 96. Effects of exercise frequency on functional fitness in older adult women ([Nakamura et al., 2007](#))
 97. Once-Weekly Resistance Exercise Improves Muscle Strength and Neuromuscular Performance in Older Adults ([Taaffe, 1999](#))
 98. Effects of frequency of weight training on muscle strength enhancement ([Gillam, 1982](#))
 99. Comparison of 2 vs 3 Days/Week of Variable Resistance Training During 10- and 18-Week Programs ([Braith et al., 1990](#))
 100. Effects of different resistance training frequencies on the muscle strength and functional performance of active women older than 60 years ([Farinatti et al., 2013](#))
 101. Comparison of 1 and 2 days per week of strength training in children ([Faigenbaum et al., 2002](#))
 102. Frequency of Training on Strength Development in Women 40 - 65 Years of Age ([Di Brezzo et al., 2002](#))
- Recovery
103. Resistance Training Recovery: Considerations for Single vs. Multi-joint Movements and Upper vs. Lower Body Muscles ([Korak et al., 2015](#))
 104. Stability of a Practical Measure of Recovery From Resistance Training ([Jones et al., 2006](#))
 105. A Series of Studies—A Practical Protocol for Testing Muscular Endurance Recovery ([McLester et al., 2003](#))

Isolation vs compound

106. Understanding and Overcoming the Sticking Point in Resistance Exercise ([Kompf and Arandjelović, 2016](#))
107. Comparison of muscle hypertrophy following 6-month of continuous and periodic strength training ([Ogasawara et al., 2013](#))

108. Dissociated Time Course of Muscle Damage Recovery Between Single- and Multi-Joint Exercises in Highly Resistance-Trained Men ([Soares et al., 2015](#))
109. Effect of adding single-joint exercises to a multi-joint exercise resistance-training program on strength and hypertrophy in untrained subjects ([Gentil et al., 2013](#))
110. Single vs. Multi-Joint Resistance Exercises: Effects on Muscle Strength and Hypertrophy ([Gentil et al., 2015](#))
111. The effects of adding single-joint exercises to a multi-joint exercise resistance training program on upper body muscle strength and size in trained men ([de França et al., 2015](#))
112. A Review of the Acute Effects and Long-Term Adaptations of Single- and Multi-Joint Exercises during Resistance Training ([Gentil et al., 2016](#))
113. Recovery of pectoralis major and triceps brachii after bench press exercise: Pectoralis and triceps recovery ([Ferreira et al., 2016](#))
114. Comment on: "A Review of the Acute Effects and Long-Term Adaptations of Single- and Multi-Joint Exercises During Resistance Training" ([Ribeiro et al., 2016](#))
115. Effect of squat depth and barbell load on relative muscular effort in squatting ([Bryanton et al., 2012](#))
116. Association between regional differences in muscle activation in one session of resistance exercise and in muscle hypertrophy after resistance training ([Wakahara et al., 2012](#))
117. Nonuniform Muscle Hypertrophy: Its Relation to Muscle Activation in Training Session ([Wakahara et al., 2013](#))
118. Regional Differences in Muscle Activation During Hamstrings Exercise ([Schoenfeld et al., 2014](#))
119. Selective hypertrophy of the quadriceps musculature after 14 weeks of isokinetic and conventional resistance training ([Matta et al., 2015](#))
120. Resistance Training Recovery: Considerations for Single vs. Multi-joint Movements and Upper vs. Lower Body Muscles ([Korak et al., 2015](#))
121. Nonuniform Muscle Hypertrophy Along the Length Induced by Resistance Training ([Wakahara, 2015](#))
122. MRI-Based Regional Muscle Use during Hamstring Strengthening Exercises in Elite Soccer Players ([Mendez-Villanueva et al., 2016](#))
123. Prevention and Treatment of Swimmer's Shoulder ([Tovin, 2006](#))
124. Eccentric Knee Flexor Strength and Risk of Hamstring Injuries in Rugby Union ([Bourne et al., 2015](#))

125. Characteristics of Shoulder Impingement in the Recreational Weight-Training Population ([Kolber et al., 2014](#))
126. Intrinsic functional deficits associated with increased risk of ankle injuries: a systematic review with meta-analysis ([Witchalls et al., 2012](#))
127. A prospective study of ankle injury risk factors ([Baumhauer et al., 1995](#))
128. Injury risk factors, screening tests and preventative strategies: a systematic review of the evidence that underpins the perceptions and practices of 44 football (soccer) teams from various premier leagues ([McCall et al., 2015](#))
129. Hamstring Muscle Strain Recurrence and Strength Performance Disorders ([Croisier et al., 2002](#))
130. Mobility impairment, muscle imbalance, muscle weakness, scapular asymmetry and shoulder injury in elite volleyball athletes ([Wang and Cochrane, 2001](#))

Exercise order

131. Exercise order interacts with rest interval during upper-body resistance exercise ([Miranda et al., 2010](#))
132. Influence of exercise order on the number of repetitions, oxygen uptake, and rate of perceived exertion during strength training in younger and older women ([Farinatti et al., 2013](#))
133. [Effects of resistance exercise order on the number of repetitions performed to failure and perceived exertion in untrained young males.](#) (Romano 2013)
134. [Comparison between pre-exhaustion and traditional exercise order on muscle activation and performance in trained men.](#) (Soares 2016)
135. [Comparison of the effects of RE Order on Number of repetitions, Serum IGF-1, testosterone and cortisol levels in normal-weight and obese men.](#) (Shelkholeslami-Vatani 2016)
136. [Influence of exercise order on electromyographic activity during upper body resistance training.](#) (Soncin 2014)
137. [The effects of pre-exhaustion, exercise order, and rest intervals in a full-body resistance training intervention.](#) (Fisher 2014)
138. [Influence of exercise order on maximum strength in untrained young men.](#) (Dias et al., 2010)
139. [Exercise order in Resistance Training](#) (Simao 2012)

140. [Effects of Exercise Order on Upper-Body Muscle Activation and Exercise Performance](#) (Gentil 2007)
 141. Influence of exercise order in a resistance-training exercise session ([Sprenuwenberg et al., 2006](#))
 142. Manipulating Exercise Order Affects Muscular Performance During a Resistance Exercise Training Session ([Sforzo and Touey, 1996](#))
- Coach supervision
143. The influence of direct supervision of resistance training on strength performance ([Mazzetti et al., 2000](#))
 144. Effect of direct supervision of a strength coach on measures of muscular strength and power in young rugby league players ([Coutts et al., 2004](#))
 145. Influence of supervision ratio on muscle adaptations to resistance training in nontrained subjects ([Gentil and Bottaro, 2010](#))
 146. Type of Encouragement Influences Peak Muscle Force in College-Age Women ([Amagliani et al., 2010](#))

Specificity

147. https://www.researchgate.net/publication/304607794_Joint-Angle_Specific_Strength_Adaptations_Influence_Improvements_in_Power_in_Highly_Trained_Athletes
148. <https://www.ncbi.nlm.nih.gov/pubmed/18981046> (Roig et al., 2009)
149. <https://www.ncbi.nlm.nih.gov/pubmed/26543850> (Hedayatpour and Falla, 2015)

EMG STUDIES

150. [Vigotsky et al., 2015](#)
151. [Enoka et al., 2015](#)