

A network diagram with purple and yellow nodes connected by thin lines, set against a white background.

American College of Sports Medicine

Resistance Training Prescription for Muscle Function, Hypertrophy, and Physical Performance: An Overview of Reviews

**Position Stand for the American College of
Sports Medicine**





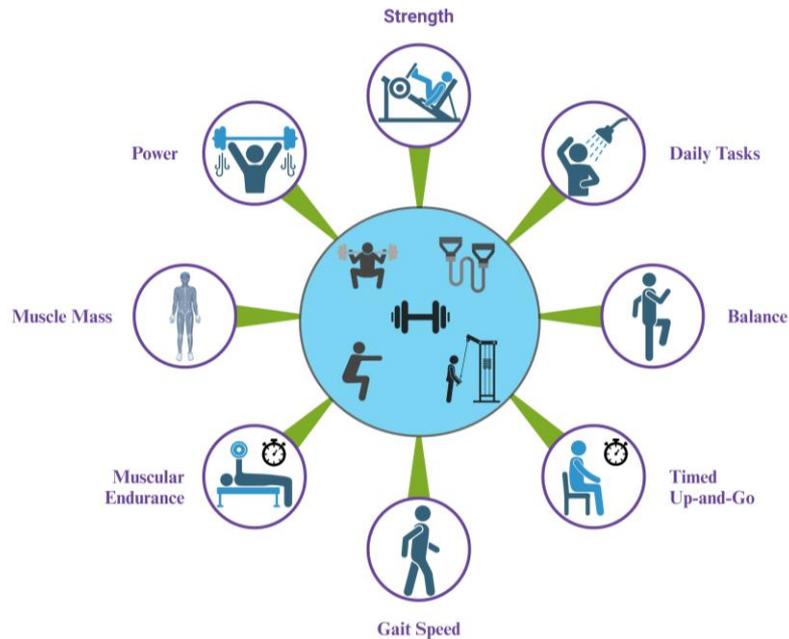
Purpose

Determine the impact of resistance training (RT) prescription on muscle function and hypertrophy, utilizing evidence synthesis methods.

This umbrella review updates the 2009 Position Stand, “*Progression models in resistance training for healthy adults*”¹¹ to provide an updated evidence-based summary of the impact of prescription of various resistance training (RTx) variables.

Research in this area has expanded significantly with data analysis including over 30,000+ participants to provide evidence-based exercise standards for all adults.

* Introduction



Resistance Training (RT)

AKA strength training or weight training is an essential component of fitness.

Contracting against external resistance, progressively increasing force output can improve:

- Muscular strength
- Power
- Hypertrophy
- Endurance
- Sleep quality and overall health ⁹

And reduce:

- Mortality
- Risk for cardiovascular disease, cancer, diabetes, depression ⁴⁻⁸



Introduction

General Health/Wellness Guidelines

At least two days per week at moderate to heavy loads for all major muscle groups of the body.

Prescription

Prescription guidelines are required to support healthcare practitioners and exercise professionals when designing RT programs.

Generally constructed using six factors (FITT-VP):

- *Frequency*
- *Intensity*
- *Time*
- *Type*
- *Volume*
- *Pattern*
- *Progression*

Methods

Record selection and data collection

Four reviewers independently screened all records and extracted data from eligible reviews in duplicate.

All discrepancies were resolved by group consensus.

Table 1. Inclusion Criteria

Population	<ul style="list-style-type: none">▪ Healthy humans ≥ 18 years old with no defined disease(s)▪ Any training status (novice or trained)
Intervention	<ul style="list-style-type: none">▪ Resistance training interventions spanning at least six weeks with a minimum of 12 exposures▪ If a supplement, nutritional, or other co-intervention (e.g., behavioral therapy, medication, counselling) is applied, it must be received by intervention and comparator groups
Comparator	<ul style="list-style-type: none">▪ Distinct resistance training prescription, as defined by FITT-VP (Frequency, Intensity, Time, Type, Volume, Pattern, Progression) principle, and/or▪ Non-exercise control group (performing no RT) and/or alternative exercise control conceived as a sham intervention (e.g., stretching)
Outcome	<ul style="list-style-type: none">▪ Reported pre-and post-intervention change in muscle function (strength, power, endurance, contraction velocity, physical function) or hypertrophy between intervention and comparator arm(s)
Study Design	<ul style="list-style-type: none">▪ A systematic review (including overviews of reviews) of randomized trials with or without statistical synthesis (e.g., meta-analysis, network meta-analysis, meta-regression)

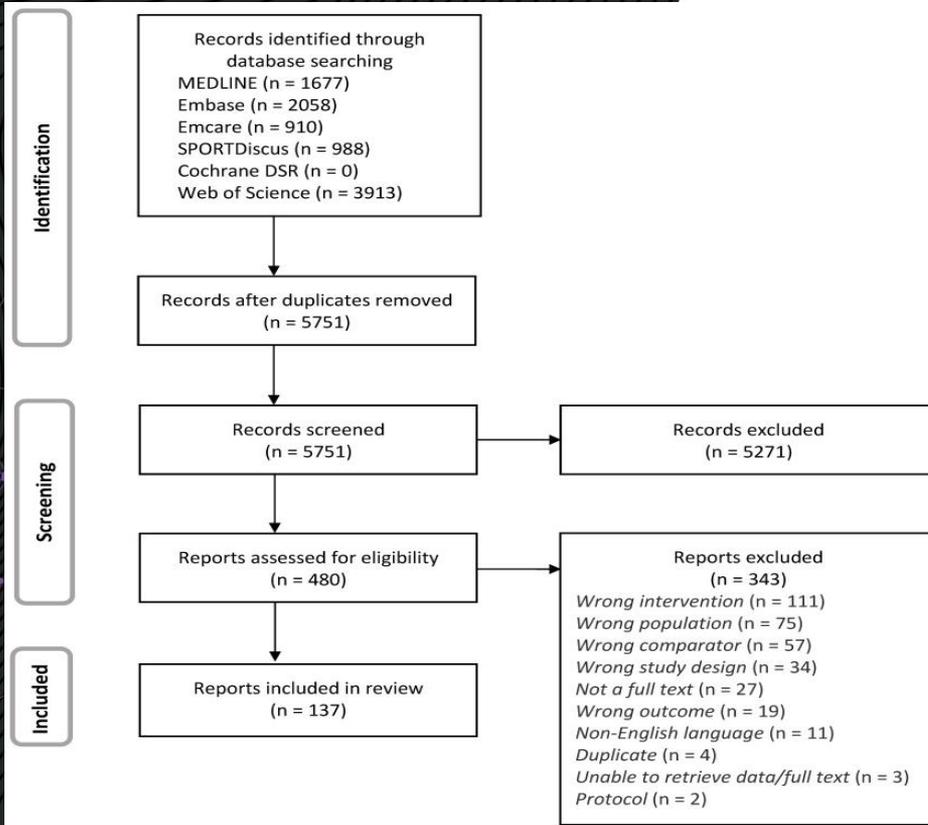
Methods

A review of reviews (umbrella review) can systematically summarize an abundance of information.

Methodological Quality Assessment and Evidence Synthesis

- Two independent reviewers assessed the quality of each review using the AMSTAR (A Measurement Tool to Assess Systematic Reviews) tool¹⁸⁻¹⁹.
 - Provides a 1 – 11 score
 - Incorporates the assessment of publication bias
- Heterogeneity was reported as the I^2 statistic or the fraction of reviews showing a significant effect.
- Outcome statements and standardized effectiveness statements were produced by the methodological quality and extracted data²⁰.
- Outcome level quality of evidence (QoE) was calculated using a method based on Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach for primary evidence^{21, 25}.
- Overlap of reviews was quantified using corrected covered area²⁶⁻²⁹.

* Results



- The systematic search yielded 5,751 records.
- Following duplicate removal, and 137 systematic reviews were included.
- AMSTAR scores ranged from 1 (lowest) to 9 (highest) out of possible 11.
- The effectiveness (impact) of each RTx variable for each outcome was assessed based on the standardized effectiveness statements and the quality of evidence ²⁵.
- Favorable RTx parameters for improving each outcome are included.

Part 1 - Tailor load and volume to specific goals

While many styles of lifting work, optimize results by adjusting approach

Outcome	RT vs. CTRL	RTx to Enhance* Adaptation
Strength	Strength is improved by RT, including circuit RT, elastic band RT, home-based RT, and velocity-based RT.	<i>Frequency:</i> ≥2 sessions/week <i>Intensity:</i> ≥80% 1RM (dose-response) <i>Type:</i> Eccentric flywheel RT <i>Technique:</i> Full range of motion <i>Volume:</i> 2-3 sets/session <i>Exercise Order:</i> Beginning of training session
Hypertrophy	Hypertrophy is improved by RT, including circuit RT and elastic band RT.	<i>Type:</i> Eccentric contractions/overload <i>Volume:</i> ≥10 sets/week (dose-response)
Power	Power is improved by RT.	<i>Intensity:</i> Loads = 30-70% 1RM <i>Type:</i> Eccentric flywheel RT <i>Technique:</i> Olympic-style weightlifting; Power RT <i>Volume:</i> Low-moderate (repetitions · sets = <24)
Muscular Endurance	Muscular endurance is improved by RT.	ND
Gait Speed	Gait speed is improved by RT.	ND
Timed Up-and-Go	Timed up-and-go is improved by RT.	ND

1RM, one-repetition maximum; CTRL, no exercise; ND, insufficient data to form conclusion; RT, resistance training; RTx, resistance training prescription; SPPB, Short Physical Performance Battery.

*Enhanced compared to standard RT and based on included meta-analyses showing a significant.

Part 2 -Tailor load and volume to specific goals

While many styles of lifting work, optimize results by adjusting approach

Table 6: Resistance training prescriptions to improve muscle function and hypertrophy (cont'd)		
Outcome	RT vs. CTRL	RTx to Enhance* Adaptation
Chair Stand Test	Chair stand test performance is improved by RT.	ND
Balance	Balance is improved by RT.	ND
Stair Climbing	ND	ND
Multicomponent Function	Multicomponent function is improved by RT, including elastic band RT and home-based RT.	<i>Technique:</i> Power RT
SPPB	SPPB is not improved by RT.	<i>Technique:</i> Power RT
Walking Performance	ND	<i>Technique:</i> Power RT
Running Performance	ND	<i>Type:</i> Velocity-based RT
Jumping Performance	Jumping performance is improved by flywheel RT and velocity-based RT.	<i>Type:</i> Velocity-based RT
Contraction Velocity	Contraction velocity is improved by RT.	ND
Change of direction (agility)	ND	ND

1RM, one-repetition maximum; CTRL, no exercise; ND, insufficient data to form conclusion; RT, resistance training; RTx, resistance training prescription; SPPB, Short Physical Performance Battery.

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Discussion

Prioritize Consistency Over Complexity

The most significant benefits to muscle function, size, and health come from simply transitioning from "no exercise" to "any exercise."

While specific variables can be tweaked, the primary goal for most adults should be regular participation in any form of RT.

Tailor Load and Volume to Specific Goals

While many styles of lifting work, optimize results by adjusting approach:

- For Strength: Lift heavier loads (80% of one-repetition maximum) for 2–3 sets per exercise.
- For Muscle Growth (Hypertrophy): Aim for higher weekly volume (~10 sets per muscle group).
- For Power: Use moderate loads (30–70% 1RM) and emphasize moving the weight as quickly as possible during the concentric (lifting) phase.



Discussion

Individualization is More Important Than Rigid Rules

The new guidelines move away from "one-size-fits-all" prescriptions.

Programs should be individualized based on personal goals, enjoyment, and safety to maximize long-term adherence.

If a program is too demanding to maintain, it loses its effectiveness.

Advanced Techniques are Often Optional

Many popular training concepts are not necessary for general health and fitness.

Training to momentary muscle failure, using specific types of equipment (machines vs. free weights), and complex periodization (systematic variation) did not consistently impact outcomes for the average healthy adult.

Nontraditional Training is Highly Effective

A traditional gym setting is not needed to see results.

Evidence shows that "nontraditional" methods, such as elastic bands, bodyweight exercises, and home-based routines yield marked benefits in strength, hypertrophy, and physical function.



Conclusion

"The best resistance training program is the one you will actually do"

Take home message

- The most critical step for health is to engage all major muscle groups at least twice a week.
- Whether using heavy barbells, resistance bands, or body weight, the effort and consistency put in, result far more than following a perfect, complex formula.
- Start at the right level, choose an enjoyable method, and focus on progressive effort over time.

References

- 4 Shailendra P, Baldock KL, Li LSK et al. Weight training and risk of all-cause, cardiovascular disease and cancer mortality among older adults. *Int J Epidemiol.* 722 2024;53(3)
- 5 Paluch AE, Boyer WR, Franklin BA et al. Resistance Exercise Training in Individuals With and Without Cardiovascular Disease: 2023 Update: A Scientific Statement From the American Heart Association. *Circulation.* 2024;149(3):e217–e31.
- 6 Momma H, Kawakami R, Honda T, Sawada SS. Muscle-strengthening activities are associated with lower risk and mortality in major non-communicable diseases: a systematic review and meta-analysis of cohort studies. *Br J Sports Med.* 2022;56(13):755–63
- 7 Carneiro L, Afonso J, Ramirez-Campillo R, Murawska-Ciałowicz E, Marques A, Clemente FM. The Effects of Exclusively Resistance Training-Based Supervised Programs in People with Depression: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *Int J Environ Res Public Health.* 2020;17(18).
- 8 Gordon BR, McDowell CP, Hallgren M, Meyer JD, Lyons M, Herring MP. Association of Efficacy of Resistance Exercise Training With Depressive Symptoms: Meta-analysis and Meta-regression Analysis of Randomized Clinical Trials. *JAMA Psychiatry.* 2018;75(6):566–76
- 9 Kovacevic A, Mavros Y, Heisz JJ, Fiatarone Singh MA. The effect of resistance exercise on sleep: A systematic review of randomized controlled trials. *Sleep Med Rev.* 2018;39:52–68
- 18 Gielen E, Beckwee D, Delaere A et al. Nutritional interventions to improve muscle mass, muscle strength, and physical performance in older people: an umbrella review of systematic reviews and meta-analyses. *Nutr Rev.* 2021;79(2):121–47
- 19 Shea BJ, Grimshaw JM, Wells GA et al. Development of AMSTAR: a measurement tool to assess the methodological quality of systematic reviews. *BMC Med Res Methodol.* 2007;7:10
- 20 Phillips SM, Lau KJ, D'Souza AC, Nunes EA. An umbrella review of systematic reviews of beta-hydroxy-beta-methyl butyrate supplementation in ageing and clinical practice. *J Cachexia Sarcopenia Muscle.* 2022.
- 21 Austin TM, Richter RR, Sebelski CA. Introduction to the GRADE approach for guideline development: considerations for physical therapist practice. *Phys Ther.* 2014;94(11):1652–9.
- 22 Sadoyu S, Tanni KA, Punrum N et al. Methodological approaches for assessing certainty of the evidence in umbrella reviews: A scoping review. *PLoS One.* 2022;17(6):e0269009.
- 23 Nunes EA, D'Souza AC, Steen JP, Phillips SM. Lack of evidence for Omega-3 fatty acid supplementation in enhancing lean mass, muscle strength, and physical function in healthy adults and clinical populations: An overview of reviews. *Clin Nutr ESPEN.* 2025;67:155–65.

References

24. Gielen E, Beckwée D, Delaere A, De Breucker S, Vandewoude M, Bautmans I. Nutritional interventions to improve muscle mass, muscle strength, and physical performance in older people: an umbrella review of systematic reviews and meta785 analyses. *Nutr Rev.* 2021;79(2):121–47.
25. McLeod JC, Currier BS, Lowisz CV, Phillips SM. The influence of resistance exercise training prescription variables on skeletal muscle mass, strength, and physical function in healthy adults: An umbrella review. *J Sport Health Sci.* 2024;13(1):47–60.
26. Lunny C, Pieper D, Thabet P, Kanji S. Managing overlap of primary study results across systematic reviews: practical considerations for authors of overviews of reviews. *BMC Med Res Methodol.* 2021;21(1):140.
27. Pieper D, Antoine SL, Mathes T, Neugebauer EA, Eikermann M. Systematic review finds overlapping reviews were not mentioned in every other overview. *J Clin Epidemiol.* 2014;67(4):368–75.
28. Kirvalidze M, Abbadi A, Dahlberg L, Sacco LB, Calderón-Larrañaga A, Morin L. Estimating pairwise overlap in umbrella reviews: Considerations for using the corrected covered area (CCA) index methodology. *Res Synth Methods.* 2023;14(5):764–7.
29. Bougioukas KI, Diakonidis T, Mavromanoli AC, Haidich AB. ccaR: A package for 799 assessing primary study overlap across systematic reviews in overviews. *Res Synth 800 Methods.* 2023;14(3):443–54.

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